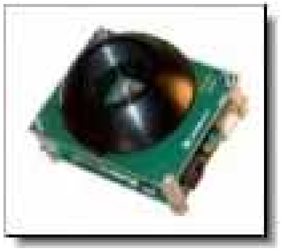
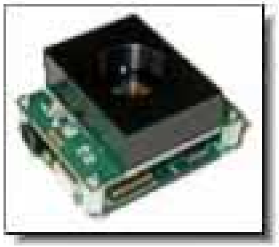
# Lumenera USB Camera User's Manual

Release 5.0





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## 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

# 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 and images on any USB 2.0 equipped desktop, laptop or embedded computer.

Designed with flexibility in mind, each camera model has its own distinct advantage 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 power, full command and control and data transfer at speeds of up to 24 MB/s (Lu series) or 48 MB/s (Lw series).

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 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.

The software can be found on the CD-ROM that shipped with your product.

### 2.1.1 Minimum System Requirements

- Windows 2000 (Service Pack 4), or
- Windows XP (Service Pack 2)
- 450 MHz Pentium III or higher (compatible)
- 128 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

The camera can typically run off of the USB bus. In some cases and/or camera models, there may be a need to externally power the camera. 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. **If you are using a 3rd party USB 2.0 PCI add-in card, please ensure the add-in card is properly installed on your computer before proceeding.**
2. **If you have purchased a developers kit and are using the supplied USB 2.0 PCI add-in card, the drivers are built-in when using Windows XP with Service Pack 2. Windows 2000 users should first upgrade to Service Pack 4, and then go to the Windows upgrade site (http://windowsupdate.microsoft.com) to obtain the USB 2 Host controller drivers.**
3. You must ensure you are logged into the computer with administrator privileges prior to continuing the installation.
4. Close all application software that is running and then insert the Lumenera Installer CD into your CD-ROM drive.
5. Double-click on "setup.exe", or wait a few moments for the auto-play function to load the setup program automatically.
6. Follow the onscreen prompts to install the software drivers and user application.
7. After the software has been installed, plug the USB 2.0 Camera into a free USB 2.0 High-Speed port.
8. **Windows 2000 & XP Users:**
    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 to you 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 Mega 092 Camera" device. Select "Install the software automatically" from the options that are presented to you 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.

9. Restart your computer
10. Run the LuCam Capture application software from your Start menu to control the camera.

### 2.1.4 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. You will need to rerun the Software Upgrade to install the new software.

## 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 website at:

http://www.lumenera.com/support/index.php

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.

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

### 2.3.1 Drivers & INF

Files with a .sys extension are copied to …\SYSTEM32\DRIVERS folder in the standard Windows folder on your system. There are two of these files for each camera model supported by the software. The names of these files are LucamXXX.sys and LuldrXXX.sys or LwcamXXX.sys and LwldrXXX.sys (the XXX represents the 3 digit camera ID number.)

Files with a .inf extension are copied to …\INF folder in the standard Windows folder of your system. There are up to two of these files for each camera model supported by the software. The names of these files are LucamXXX.inf and LuldrXXX.inf or LwcamXXX.inf and LwldrXXX.inf (the XXX represents the 3 digit camera ID number.)

### 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. 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 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.

### 2.3.5 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

To obtain the latest documentation and other technical information you may visit our Support website at:

http://www.lumenera.com/support/index.php

### 2.3.6 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 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 purchased 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.

### 2.4.1 Menu Items

**"Preview Frame Rate…"** will display 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…"** will display 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"** will move the capture window to the top left corner of your desktop.

**"Read/Write Registers…"** will pop up a dialog 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"** will put 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.

**"Image Averaging"** averages 5 frames of video together to reduce random image noise, when the Capture button is pressed. This option will produce undesireable 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 undesireable 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, Brigtness, Contrast).

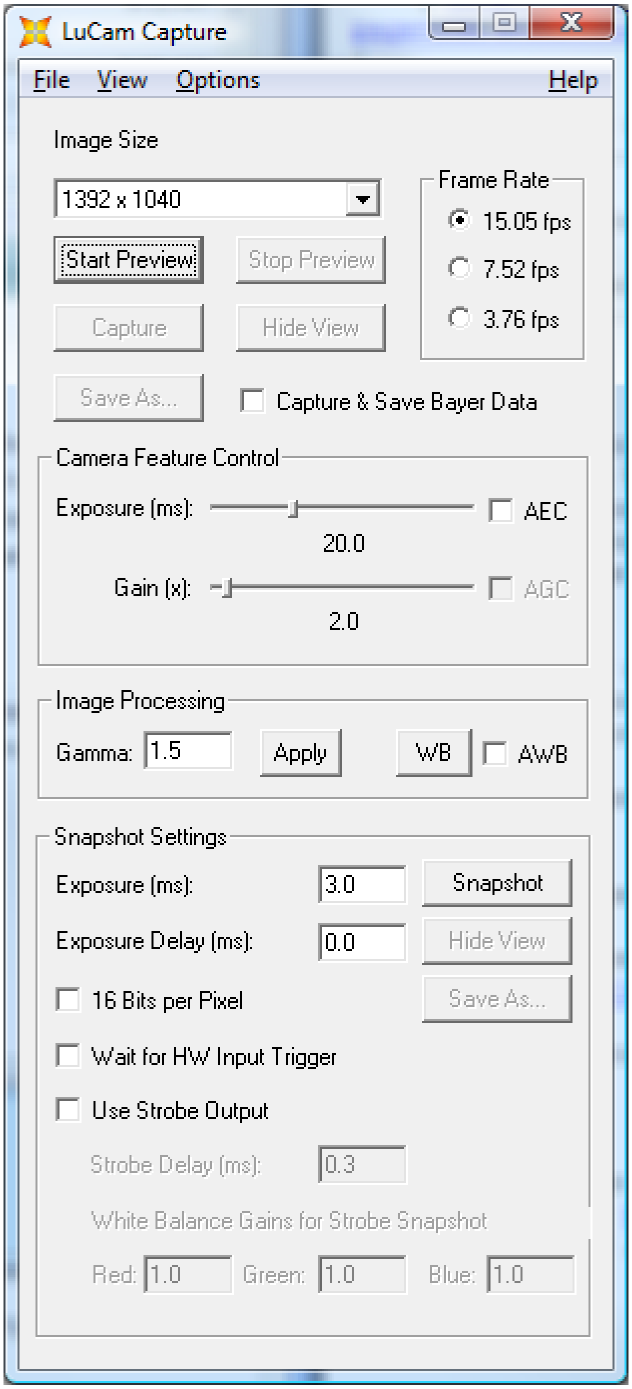

Image Size: 1392 x 1040

Frame Rate
● 15.05 fps
○ 7.52 fps
○ 3.76 fps

□ Capture & Save Bayer Data

Exposure (ms): 20.0 □ AEC
Gain (x): 2.0 □ AGC

Gamma: 1.5 □ AWB

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
Red: 1.0 Green: 1.0 Blue: 1.0

**Figure 1 - LuCam Capture Main Window**

### 2.4.2 Buttons and Interface Controls

The "**Start Preview**" button is used to start the video display to the screen.

The "**Stop Preview**" button is used to stop the video display to the screen.

### Video Frame Capture

The "**Capture**" button is used to grab a frame of video from the video stream and display it on screen.

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

The "**Hide View**" button will close the 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.

### Video Image Control

The "**Image Size**" dropdown list provides the available video display resolutions.

The "**Frame Rate**" toggle buttons provide the selection of the available display frame rates. Not all cameras have this capability.

The "**Exposure**" slider is used to adjust the video exposure 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.

The "**Gain**" slider is used to adjust the global 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 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).

### 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 is used to grab an image from the camera using its snapshot 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 will close the snapshot image display window.

The “**Wait for HW Input Trigger**” toggle is used to specify that the snapshot should be hardware triggered using the HW trigger input of the camera’s external header. 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 artifact 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 artifact 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 artifacts as there is in the other modes.

**Table 1 - Shutter Types by Camera Model**

| Camera Model | Rolling Shutter | Half Global Shutter | Global Shutter |
|---|---|---|---|
| **Lu050, Lu055** | Yes | No | Yes |
| **Lu070, Lu075, Lw070, Lw075, Lm075** | No | No | Yes |
| **Lu080, Lu085, Lm085** | No | No | Yes |
| **Lu100, Lu105** | Yes | Yes | No |
| **Lu110, Lu115** | Yes | No | No |
| **Lu120, Lu125** | Yes | No | Yes |
| **Lu130, Lu135, Lw130, Lw135, Lm135** | No | No | Yes |

| Camera Model | Rolling Shutter | Half Global Shutter | Global Shutter |
|---|---|---|---|
| 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 |

## 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 |
|---|---|
| **Lu050, Lu055** | Progressive |
| **Lu070, Lu075, Lw070, Lw075, Lm075** | Progressive |
| **Lu080, Lu085, Lm085** | Progressive |
| **Lu100, Lu105** | Progressive |
| **Lu110, Lu115** | 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** | Interlaced |
| **Lw570, Lw575** | Progressive |
| **Lw620, Lw625** | Progressive |
| **Lw11050, Lw11056, Lw11057, Lw11058, Lw11059** | 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 modes. An output signal is provided on the external 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 necessarily 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 1.

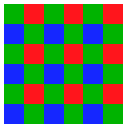

**Figure 2 - Example of a 6x6 Pixel Area of Color Imager Mosaic Pattern**

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 |
| Lu050, Lu055 | Red | Green 1 | Green 2 | Blue |
| 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 |
| Lu110, Lu115 | Green 1 | Red | Blue | 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 |

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 $n^{th}$ 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

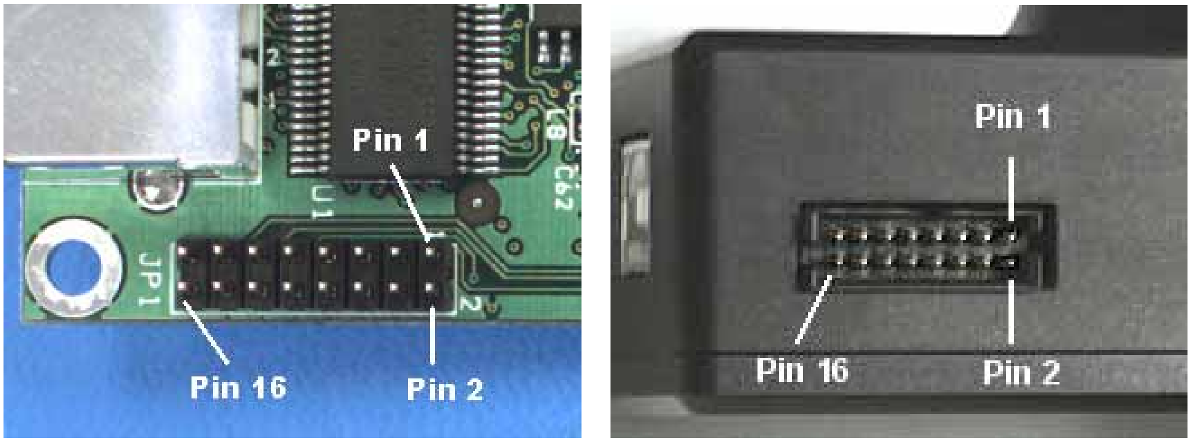

**Figure 3 - External Header Location and Pin Numbering**

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 2.

#### 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.

#### 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.)* |

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.

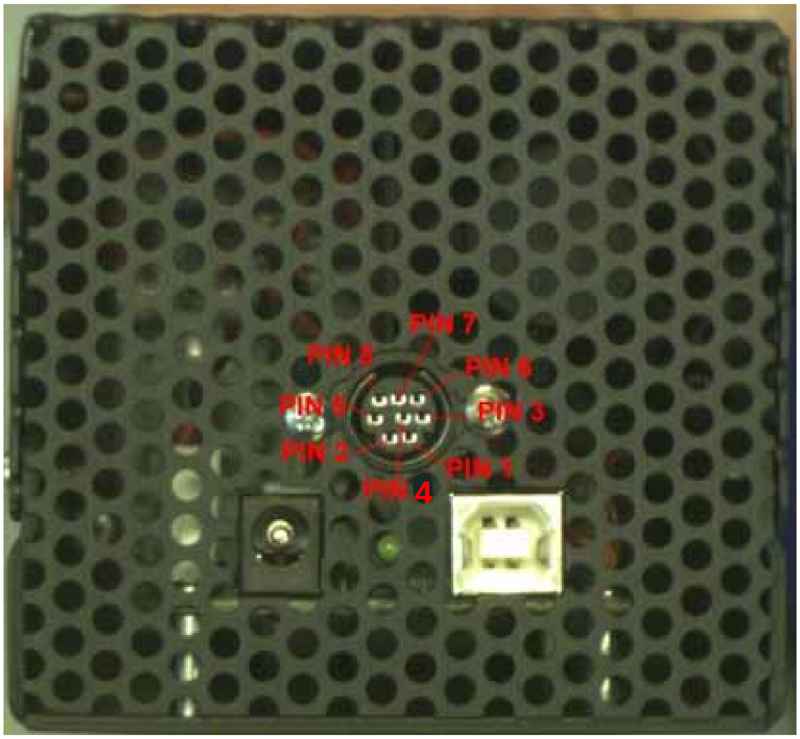

**Figure 4 - Large Format Camera External Header Location and Pin Numbering**

### 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.

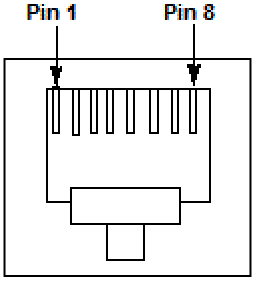

**Figure 5 - Mini Camera External Header Location and Pin Numbering**

#### 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

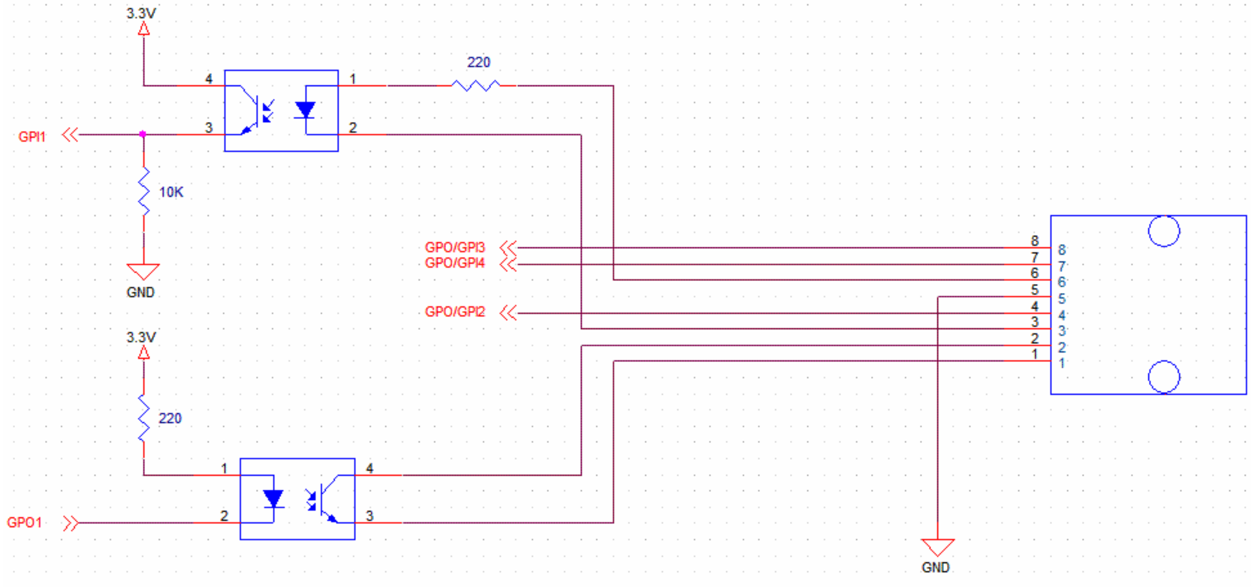

**Figure 6 - Mini Camera GPIO Connector Circuit Diagram**

### 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

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.

## 3.8 External Power

The camera is normally powered via the USB cable, which nominally supplies 5 Volts. 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**

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

**For Lw series cameras**

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

**For large format cameras**

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.

## 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 |
|---|---|
| Lu050M, Lu055M (Discontinued) | 0x091 |
| Lu050C, Lu055C (Discontinued) | 0x095 |
| Lu056C (Discontinued) | 0x093 |
| 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 |
| Lu110M, Lu115M, Lu110C, Lu115C (Discontinued) | 0x094 |
| 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 |
| Lw570C, Lw575 | 0x1C5 |

| Camera Model | ID |
|---|---|
| Lw620M, Lw625M, Lw620C, Lw625C | 0x186 |
| Lw11050C, Lw11056C, Lw11057C, Lw11058C, Lw11059C | 0x1C8 |
| InfinityX-21 | 0x0A0 |
| Infinity1-1, Infinity 1 | 0x0A1 |
| Infinity1-3, Infinity 3 | 0x0A3 |
| Infinity1-5 | 0x1Ac |
| Infinity1-6 | 0x1A6 |
| Infinity 2 | 0x0A2 |
| Infinity2-1 | 0x1A2 |
| Infinity2-2 | 0x1A7 |
| Infinity 4 | 0x0A4 |
| Infinity2-3 | 0x1A4 |
| Infinity3-1 | 0x1A5 |
| Infinity4-4 | 0x1AB |
| Infinity4-11 | 0x1A8 |

# 4

# Application Programming Interface User's Guide

## 4.1 General Overview

The LuCam API is composed of various functions that are used to control the camera, query its state and acquire data from it.  There are two groups of functions, namely, a basic group and an advanced group.

The functions in the basic group are very simple to understand and use, and the majority of an application's functionality can be realized quickly using only these functions.

The functions of the advanced group are more powerful and provide greater flexibility and tighter control over the camera's operation; however, they require a more in-depth understanding of the inner workings of the camera.  This understanding can be gained from the information in the previous sections.  If you have questions that are not covered in this manual, you can e-mail our TAC group at:

support@lumenera.com

The following section provides guidance for performing specific and common tasks using the LuCam API.  The source code provided with the SDK contains concrete examples of these tasks.  For details and further information about calling specific API functions, see the *Lumenera USB Camera API Reference Manual*.

## 4.2 Basic Tasks

### 4.2.1 Connecting and Disconnecting

In order to communicate with a camera you must first open a connection to it and obtain its handle.  This handle is used as an input parameter to most of the other API functions.   The function used for this task is ***LucamCameraOpen()***.  When you are completely finished with the camera, you should terminate the connection using ***LucamCameraClose()***.

Multiple cameras may be attached to the computer at one time. You can obtain the number of cameras attached prior to connecting with any of them using the ***LucamNumCameras()*** function. The ***LucamEnumCameras()*** function can be used to obtain the unique serial numbers and camera type for all cameras attached to the computer. Thus, it is possible for a specific camera to be opened.

### 4.2.2 Query the Camera

Several functions exist to obtain information about the camera. To obtain the version information for the camera, its driver and the API, you can use the ***LucamQueryVersion()*** function.

To determine the USB connection type (e.g. USB2.0 or USB1.1) you can call ***LucamQueryExternInterface()***.

To determine the available frame rates for the camera you can use the ***LucamEnumAvailableFrameRates()*** function.

### 4.2.3 Preview Video

After a camera has been opened, a video preview can be displayed simply by calling ***LucamStreamVideoControl()***. This function takes three parameters; 1) the handle to the camera, 2) a control flag (set to START_DISPLAY) and, 3) a window handle (if NULL a window is automatically created for the video display).

More advanced applications may wish to create their own display window. The handle to this window can be passed to the function and the video will be previewed in it.

Pausing or stopping the preview can be achieved using the same function with the control flag set to PAUSE_STREAM or STOP_STREAMING. When the video stream is stopped, the display window is removed (unless you have created your own display window.)

While video is previewing, the displayed frame rate can be obtained using the function ***LucamQueryDisplayFrameRate()***.

### 4.2.4 Adjusting the Video

The API allows for the simple adjustment of several of the video properties by providing the ability to pop up one of two pre-defined dialogs. These dialogs are based on the DirectShow libraries. ***LucamDisplayPropertyPage()*** will pop up a dialog for adjusting image properties (exposure, gain, etc.) ***LucamDisplayVideoFormatPage()*** will pop up a dialog for adjusting the video format (resolution, pixel bit depth, etc.)

### 4.2.5 Configuring Video Format

At any time when the camera is not streaming video, you can configure the video format using the ***LucamSetFormat()*** function. This will allow you to select the following video properties:

1. Subwindow size
2. Subwindow position
3. Subsampling/binning mode
4. Pixel format
5. Video frame rate

There are some constraints and limitations on and associated with the above properties.

1. The subwindow size is provided as the window width and height. Both the width and height must be a multiple of 8.
2. The subwindow position is provided as the x and y coordinates of the top left corner of the subwindow. Both x and y must be multiples of 8.
3. Subsampling must be the same for both x and y directions.
4. The pixel format is provided as LUCAM_PF_8 or LUCAM_PF_16 and indicates the bit depth of the data. Using LUCAM_PF_16 doubles the amount of data coming from the camera and will cause the maximum frame rate to be cut in half. Although there are 16 bits per pixel in this mode, only 10, 12, or 14 bits of data are valid (depending on the maximum bit depth of the particular camera being used.)
5. The video frame rate provided may not be exactly as requested. The closest smaller available rate will be provided.

### 4.2.6 Grab Video Data

As long as video streaming is turned on (with the ***LucamStreamVideoControl()*** function), video data can be grabbed from the camera. The function to use for this is ***LucamTakeVideo()***. The number of frames must be specified as well as a pointer to a buffer that will accept the data. The data returned from the camera is in its raw form with each byte (for LUCAM_PF_8) or word (for LUCAM_PF_16) returned from the camera representing a single pixel in the image. For color cameras, the data is still in the Bayer format as described in a previous section.

It's not necessary to be previewing the data to capture it. Grabbing video while the preview is turned off is much more efficient and leaves the CPU free to do other processing tasks.

### 4.2.7 Take a Snapshot (or many)

Single snapshots can be taken using one of several functions. The ***LucamTakeSnapshot()*** function can be used any time a camera is open to asynchronously take a single snapshot using the camera's snapshot mode. Even if the camera is streaming video, the function will handle the stream, stopping and then restarting it as necessary. The overhead associated with managing the stream means this function is not extremely fast. However, it is a very simple way to obtain snapshots when time is not critical.

For quicker snapshot capturing, individual functions exist to enable the snapshot mode (***LucamEnableFastFrames()***), take snapshots (***LucamTakeFastFrames()***) and then disable the snapshot mode (***LucamDisableFastFrames()***) separately. The use of these functions helps eliminate overhead associated with managing the streaming snapshot mode. When the ***LucamEnableFastFrames()*** function is called, streaming is stopped, and then snapshots can be captured repeatedly at a faster rate than with ***LucamTakeSnapshot()***.

As with the ***LucamTakeVideo()*** functions, the data returned from the camera is in its raw, unprocessed form.

### 4.2.8 Processing Images

For monochrome cameras, the data that arrives from the camera is ready for user processing, display or capture to disk.

Data from color cameras, on the other hand, is in the raw Bayer format and will typically need to be converted to 24-bit RGB before being user processed, displayed or captured to disk. This conversion can be accomplished using the ***LucamConvertFrameToRgb24()*** function.

The two additional functions ***LucamConvertFrameToRgb32()*** and ***LucamConvertFrameToRgb48()*** are available to convert the raw Bayer data into 32 and 48-bit RGB data respectively.

The ***LucamConvertBmp24ToRgb24()*** function will convert the byte order for each pixel from .bmp file standard (or DIB, Device Independent Bitmap) Blue, Green, Red (BGR) to the order Red, Green, Blue (RGB). Also the image is flipped top to bottom so that the first row of data is found at the starting of the buffer.

The color data can also be converted to 8-bit and 16-bit monochrome (Greyscale) using the ***LucamConvertFrameToGreyscale8()*** and ***LucamConvertFrameToGreyscale16()*** respectively.

### 4.2.9 Save Image to Disk

Saving images to disk can be accomplished with the ***LucamSaveImage()*** or ***LucamSaveImageW()*** functions. Once a frame of data has been taken from the camera (video or snapshot) it can be saved in one of several image formats.

(For color cameras, first convert to 24-bit or 48-bit RGB to obtain a proper color image.)

The available formats are:

1. Raw Data (.raw) - no header, no compression
2. Bitmap (.bmp) – Windows bitmap file, no compression
3. TIFF (.tif) – Tagged Image File Format, lossless compression
4. JPEG (.jpg) – JPEG compression, lossy compression

The JPEG and Bitmap formats are not capable of storing the camera output when the camera is set to 16-bit. Only TIFF and Raw data formats support the 16-bit output.
The ***LucamSaveImageEx()*** and ***LucamSaveImageWEx()*** account for the differences in Endianness between the Lu-based and Lw-based cameras when saving 16-bit data to files.

### 4.2.10 Setting and Getting Camera Properties

Camera properties are items such as exposure, gain, contrast, etc. There are only three functions associated with camera properties. ***LucamSetProperty()*** is used to set the value of a camera property. ***LucamGetProperty()*** is used to get the value of a camera property. ***LucamPropertyRange()*** will return the valid range and default value for a given camera property. It is important to note that not all properties are available for every camera supported by the API. The table below indicates which properties are available for each camera model.

**Table 9 – Property Availability By Camera Model**

| Property | Lu050 | Lu070, Lw070, Lm075 | Lu080, Lm085 | Lu100 | Lu110 | Lu120 | Lu130, Lw130, Lm130 | Lu160, Lw160, Lm165 | Lu170 |
|---|---|---|---|---|---|---|---|---|---|
| **Brightness** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Contrast** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Hue** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Saturation** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Sharpness** | No | No | No | No | No | No | No | No | No |
| **Gamma** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Exposure** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Gain** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Red Gain** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Blue Gain** | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Green1 Gain** | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes |
| **Green2 Gain** | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes |

| Property | Lu200 | Lw230 | Lu270 | Lw290 | Lu330 | Lu370 | Lw560 | Lw570 | Lw620 | Lw11050 |
|---|---|---|---|---|---|---|---|---|---|---|
| Brightness | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Contrast | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Hue | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Saturation | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Sharpness | No | No | No | No | No | No | No | No | No | No |
| Gamma | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Exposure | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Gain | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Red Gain | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Blue Gain | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Green1 Gain | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Green2 Gain | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

## 4.3 Advanced Tasks

### 4.3.1 Manage Your Own Video Display Window

When the ***LucamStreamVideoControl()*** is used to start previewing video data, the window is created automatically. Using ***LucamCreateDisplayWindow()*** you can create your own display window and specify its size and location on the screen.

### 4.3.2 Custom Color Correction Matrix

For color cameras, the data returned from the camera is in the Bayer format. However, this data needs to be color corrected to obtain true color. Normally, one of the standard matrices would be selected from the available ones in the API, but there may be instances where a custom matrix is desired. For example, a color image can be converted to monochrome with the appropriate matrix. Changing the Hue and Saturation can also be performed using a custom matrix. In order to apply a custom matrix, it must first be defined. This is done using the ***LucamSetupCustomMatrix()*** function.

To make use of this custom matrix in video mode, you set the LUCAM_PROP_CORRECTION_MATRIX property to LUCAM_CM_CUSTOM using ***LucamSetProperty()***.

If you want the custom matrix to be used when converting raw images from the camera to RGB24 using ***LucamConvertFrameToRgb24()***, set the CorrectionMatrix field of the LUCAM_CONVERSION structure to LUCAM_CM_CUSTOM.

### 4.3.3 Custom Look-Up-Tables (LUT)

The camera has a built-in 8-bit LUT, which is used by the Brightness, Contrast and Gamma properties. You can provide your own customized LUT, which will be applied to all data coming from the camera, using the ***LucamSetup8bitsLUT()*** function. If you provide your own LUT, the Brightness, Contrast and Gamma properties should not be used; otherwise they will overwrite the custom LUT.

A separate LUT can be applied to individual color channels of a color camera, using the ***LucamSetup8bitsColorLUT()*** function.

### 4.3.4 Video Callback functions

The Video Callback feature allows you to supply your own function that will be called for every frame of data that arrives from the camera, giving you access to the data stream for frame-by-frame processing. This can be used to provide a graphic overlay, for example, or false color to a monochrome image etc.

There are two functions that can be used to register your callback. The first is named ***LucamAddStreamingCallback()***. The second is named ***LucamAddRgbPreviewCallback()***. The only difference between them is the data format of the frame of data that is passed to them. The first function will be passed the raw data as it comes out of the camera. The second function will be passed the data after it has been processed into RGB data. (For monochrome cameras, there will be no difference between the data passed for either function.)

The ***LucamQueryRgbPreviewPixelFormat()*** function can be used to determine the bit depth of the RGB data (either 24 bpp or 32 bpp).

The callback function can be removed using either ***LucamRemoveStreamingCallback()*** or ***LucamRemoveRgbPreviewCallback()*** depending on which function was used to add it.

### 4.3.5 Snapshot Callback Functions

The Snapshot Callback feature allows you to supply your own function that will be called for every snapshot frame that arrives from the camera, giving you access to the snapshot stream for frame-by-frame processing. This can be used to provide a graphic overlay, for example, or false color to a monochrome image etc. The ***LucamAddSnapshotCallback()*** function can be used to register your callback. The callback function can be removed by using the ***LucamRemoveSnapshotCallback()*** function.

### 4.3.6 Multiple Camera, Simultaneous Image Capture

Several cameras can be connected to the same computer and used to capture an image at the same time. This is accomplished using a set of three API functions. ***LucamEnableSynchronousSnapshots()*** enables this mode for all the cameras. ***LucamTakeSynchronousSnapshots()*** is used to perform the snapshot capture. ***LucamDisableSynchronousSnapshots()*** is used to disable this mode for all the cameras.

### 4.3.7 Non-Volatile User Accessible Camera Memory

The camera contains a 1024-byte area of non-volatile memory that is user-accessible. The ***LucamPermanentBufferWrite()*** function can be used to write arbitrary data to the memory area that won't get erased when the camera is powered down. The ***LucamPermanentBufferRead()*** function can be used to read the memory area. There is a limit of 100,000 times that the memory area can be overwritten reliably.

## 4.4 SDK Sample Code Descriptions

Included in the SDK are several sample applications that demonstrate the use of many LuCam API functions. This section describes the sample applications provided.

If you have not purchased the SDK, compiled executables of all the sample applications are provided "as-is" in the Sample Code directory.

### 4.4.1 AutoLens Sample Application

Application type: Windows Dialog

Compiler: Visual C++.Net

Description: This sample application demonstrates how to control the lenses used with the Lw11059 based cameras. It provides controls for the focus and iris of this lens.

Functions Used:
LucamAddRgbPreviewCallback()
LucamAdjustDisplayWindow()
LucamCameraClose()
LucamCameraOpen()
LucamConvertFrameToGreyscale8()
LucamConvertFrameToGreyscale16()
LucamConvertFrameToRgb24()
LucamConvertFrameToRgb48()
LucamDestroyDisplayWindow()
LucamDigitalWhiteBalance()
LucamDisableFastFrames()
LucamEnableFastFrames()
LucamGetCameraId()
LucamGetFormat()
LucamGetLastError()
LucamGetProperty()
LucamGetPropertyRange()
LucamOneShotAutoWhiteBalance()
LucamQueryVersion()
LucamRemoveRgbPreviewCallback()
LucamSaveImage()
LucamSetProperty()
LucamStreamVideoControl()

### 4.4.2 AVISample Sample Application

Application type: Windows Dialog

Compiler: Visual C++.Net

Description: This sample application demonstrates how to use the AVI capture and playback functions.

Functions Used: LucamAddRgbPreviewCallback()
LucamAdjustDisplayWindow()
LucamCameraClose()
LucamCameraOpen()
LucamConvertFrameToGreyscale8()
LucamConvertFrameToGreyscale16()
LucamConvertFrameToRgb24()
LucamConvertFrameToRgb48()
LucamConvertRawAVIToStdVideo()
LucamDestroyDisplayWindow()
LucamDigitalWhiteBalance()
LucamDisableFastFrames()
LucamEnableFastFrames()
LucamGetCameraId()
LucamGetCurrentMatrix()
LucamGetFormat()
LucamGetLastError()
LucamGetProperty()
LucamGetPropertyRange()
LucamNumCameras()
LucamOneShotAutoWhiteBalance()
LucamPreviewAVIClose()
LucamPreviewAVIControl()
LucamPreviewAVIOpen()
LucamQueryVersion()
LucamRemoveRgbPreviewCallback()
LucamSaveImage()
LucamSetFormat()
LucamSetProperty()
LucamSetupCustomMatrix()
LucamStreamVideoControl()
LucamStreamVideoControlAVI()
LucamTakeSnapshot()
LucamTakeVideo()
LucamTakeVideoEx()

### 4.4.3 BlankCamera Sample Application

Application type: Windows Dialog

Compiler: Visual C++.Net

Description: This sample application demonstrates how to use the AVI capture and playback functions.

Functions Used: LucamAddRgbPreviewCallback()
LucamAdjustDisplayWindow()
LucamCameraClose()
LucamCameraOpen()
LucamConvertFrameToGreyscale8()
LucamConvertFrameToGreyscale16()
LucamConvertFrameToRgb24()
LucamConvertFrameToRgb48()
LucamConvertRawAVIToStdVideo()
LucamDestroyDisplayWindow()
LucamDigitalWhiteBalance()
LucamGetCameraId()
LucamGetCurrentMatrix()
LucamGetFormat()
LucamGetLastError()
LucamGetProperty()
LucamGetTruePixelDepth()
LucamNumCameras()
LucamOneShotAutoWhiteBalance()
LucamPreviewAVIClose()
LucamPreviewAVIControl()
LucamPreviewAVIOpen()
LucamQueryVersion()
LucamRegisterEventNotification()
LucamRemoveRgbPreviewCallback()
LucamSaveImage()
LucamSetFormat()
LucamSetProperty()
LucamSetupCustomMatrix()
LucamStreamVideoControl()
LucamStreamVideoControlAVI()
LucamTakeSnapshot()
LucamTakeVideo()
LucamTakeVideoEx()
LucamUnregisterEventNotification()

### 4.4.4 Callback Sample Application

Application type: Windows Dialog

Compiler: Visual C++ .Net

Description: This sample application demonstrates how to create a callback function for both a snapshot callback and a preview callback. The application measures the number of frames captured by the computer for both video frames and snapshot frames. It calculates the capture time of each frame and the average frame rate.

Functions Used:
LucamAddRgbPreviewCallback()
LucamAddSnapshotCallback()
LucamCameraClose()
LucamCameraOpen()
LucamCreateDisplayWindow()
LucamDestroyDisplayWindow()
LucamDisableFastFrames()
LucamEnableFastFrames()
LucamGetCameraId()
LucamGetFormat()
LucamGetLastError()
LucamGetProperty()
LucamQueryVersion()
LucamRemoveRgbPreviewCallback()
LucamRemoveSnapshotCallback()
LucamStreamVideoControl()

### 4.4.5 CaptureToFile Sample Application

Application type: Windows Dialog

Compiler: Visual C++.Net

Description: This sample application demonstrates how to convert the pixel data into ASCII text and saves this data to either a text file or to an MS Excel® spreadsheet.

Functions Used:
LucamCameraClose()
LucamCameraOpen()
LucamConvetFrameToRgb24()
LucamConvertFrameToRgb48()
LucamDestroyDisplayWindow()
LucamGetFormat()
LucamGetLastError()
LucamGetProperty()
LucamSaveImage()
LucamSetProperty()
LucamStreamVideoControl()
LucamTakeVideo()

### 4.4.6 ClickCrop Sample Application

Application type: Windows Dialog

Compiler: Visual C++ .Net

Description: This sample application 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.

Functions Used:
LucamAddRgbPreviewCallback()
LucamCameraClose()
LucamCameraOpen()
LucamDestroyDisplayWindow()
LucamDigitalWhiteBalance()
LucamGetFormat()
LucamGetLastError()
LucamGetProperty()
LucamOneShotAutoWhiteBalance()
LucamQueryVersion()
LucamRemoveRgbPreviewCallback()
LucamSaveImage()
LucamSetProperty()
LucamStreamVideoControl()
LucamTakeSnapshot()

### 4.4.7 CSharp Sample Application

Application type: Windows Dialog

Compiler: Visual C#.Net

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

Functions Used:
LucamCameraClose()
LucamCameraOpen()
LucamConvetFrameToRgb24()
LucamDestroyDisplayWindow()
LucamGetFormat()
LucamGetProperty()
LucamSaveImage()
LucamSetFormat()
LucamSetProperty()

LucamStreamVideoControl()
LucamTakeSnapshot()

### 4.4.8 DirectShow Callback Sample Application

Application type: Windows Dialog

Compiler: Visual C++ .Net

Description: This sample application 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).

Functions Used: NA

### 4.4.9 DirectX Sample Application

Application type: Windows Dialog

Compiler: Visual C++.Net

Description: This sample application demonstrates how to access the camera through its DirectX interface using Visual C++.Net. 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.

Functions Used: NA

### 4.4.10 DirectX Snapshot Sample Application

Application type: Windows Dialog

Compiler: Visual C++ .Net

Description: This sample application demonstrates how to acquire a snapshot through the DirectX interface. It demonstrates how to change the exposure and gains values, use the strobe output and toggle the trigger input between a SW trigger and HW trigger.

Functions Used: NA

### 4.4.11 DualSlope Sample Application

Application type: Windows Dialog

Compiler: Visual C++ .Net

Description: This sample application demonstrates how to use the dual slope feature of the Lu120 and Lw620 cameras.

Functions Used: LucamCameraClose()
LucamCameraOpen()
LucamConvetFrameToRgb24()
LucamConvetFrameToRgb48()
LucamDestroyDisplayWindow()
LucamGetCameraId()
LucamGetFormat()
LucamGetLastError()
LucamGetProperty()
LucamPropertyRange()
LucamQueryVersion()
LucamSaveImage()
LucamSetFormat()
LucamSetProperty()
LucamStreamVideoControl()
LucamTakeVideo()
LucamTakeSnapshot()

### 4.4.12 DX Control Net Sample Application

Application type: Windows Console

Compiler: Visual C++.Net

Description: This sample application is a console based application that uses the DirectX interface of the camera.

Functions Used: NA

### 4.4.13 EnumFrameRates Sample Application

Application type: Windows Console

Compiler: Visual C++.Net

Description: This sample application is a console based application that lists the available frames rates for the camera.

Functions Used: LucamCameraClose()
LucamCameraOpen()
LucamEnumAvailableFrameRates()
LucamGetCameraId()
LucamGetFormat()
LucamQueryVersion()

### 4.4.14 FastSynchSnaps Sample Application

Application type: Windows Dialog

Compiler: Visual C++ 6.0 and Visual C++ .Net

Description: This sample application demonstrates how to do fast synchronous snapshots from multiple cameras.

Functions Used: LucamCameraClose()
LucamCameraOpen()
LucamConvetFrameToRgb24()
LucamDisableSynchronousSnapshots()
LucamEnableSynchronousSnapshots()
LucamGetLastError()
LucamQueryVersion()
LucamTakeSynchronousSnapshots()
LucamSaveImage()

### 4.4.15 Flipping Sample Application

Application type: Windows Dialog

Compiler: Visual C++ .Net

Description: This sample demonstrates how to flip and mirror the video preview.

Functions Used: LucamCameraClose()
LucamCameraOpen()
LucamDestroyDisplayWindow()
LucamGetCameraId()
LucamGetFormat()
LucamGetProperty()
LucamQueryVersion()
LucamSetFormat()
LucamSetProperty()
LucamStreamVideoControl()

### 4.4.16 FrameRate Sample Application

Application type: Windows Dialog

Compiler: Visual C++ .Net

Description: This sample demonstrates how to read the various available frame rates.

Functions Used: LucamCameraClose()
LucamCameraOpen()
LucamCreateDisplayWindow()
LucamDestroyDisplayWindow()
LucamGetCameraId()
LucamGetFormat()
LucamSetFormat()
LucamSetProperty()
LucamStreamVideoControl()

### 4.4.17 Get16BitInfo Sample Application

Application type: Windows Console

Compiler: Visual C++.Net

Description: This sample application is a console based application that provides information on the 16 bit mode of the camera such as its bit depth and endianness.

Functions Used: LucamCameraClose()
LucamCameraOpen()
LucamGetCameraId()
LucamGetFormat()
LucamGetTruePixelDepth()
LucamQueryVersion()

### 4.4.18 GetRanges Sample Application

Application type: Windows Dialog

Compiler: Visual C++ .Net

Description: This sample demonstrates how to read and write the camera properties and get their value ranges.

Functions Used: LucamCameraClose()
LucamCameraOpen()
LucamDestroyDisplayWindow()
LucamGetProperty()
LucamPropertyRange()
LucamSetProperty()
LucamStreamVideoControl()

### 4.4.19 GPI Event Signalling Sample Application

Application type: Windows Dialog

Compiler: Visual C++ .Net

Description: This sample application demonstrates how to link an event to the camera's GPI events.

Functions Used: LucamCameraClose()
LucamCameraOpen()
LucamRegisterEventNotification()
LucamUnregisterEventNotification()

### 4.4.20 GpioTest Sample Application

Application type: Windows Dialog

Compiler: Visual C++ .Net

Description: This sample application demonstrates how to read the GPI port of the camera and write to the GPO port.

Functions Used: LucamCameraClose()
LucamCameraOpen()
LucamCreateDisplayWindow()
LucamGetLastError()
LucamGpioRead()
LucamGpioWrite()
LucamGpoSelect()
LucamQueryVersion()
LucamStreamVideoControl()

### 4.4.21 Histogram Sample Application

Application type: Windows Dialog

Compiler: Visual C++ .Net

Description: This sample application demonstrates how to link an event to the camera's GPI events.

Functions Used: LucamAddRgbPreviewCallback()
LucamAdjustDisplayWindow()
LucamCameraClose()
LucamCameraOpen()
LucamConvertFrameToRgb24()
LucamConvertFrameToRgb48()
LucamConvertRawAVIToStdVideo()
LucamDestroyDisplayWindow()
LucamDigitalWhiteBalance()
LucamGetCameraId()
LucamGetCurrentMatrix()
LucamGetFormat()
LucamGetLastError()
LucamGetProperty()
LucamGetTruePixelDepth()
LucamNumCameras()
LucamOneShotAutoWhiteBalance()
LucamQueryVersion()
LucamPreviewAVIClose()
LucamPreviewAVIControl()
LucamPreviewAVIOpen()
LucamRemoveRgbPreviewCallback()
LucamSaveImage()
LucamStreamVideoControl()
LucamStreamVideoControlAVI()
LucamSetFormat()

LucamSetProperty()
LucamSetupCustomMatrix()
LucamStreamVideoControl()
LucamTakeVideo()
LucamTakeVideoEx()

### 4.4.22 HwTrigCount Sample Application

Application type: Windows Dialog

Compiler: Visual C++ .Net

Description: This sample demonstrates how to configure the camera to use the HW trigger to capture snapshots.

Functions Used:
LucamAddSnapshotCallback()
LucamCameraClose()
LucamCameraOpen()
LucamCreateDisplayWindow()
LucamDestroyDisplayWindow()
LucamDisableFastFrames()
LucamEnableFastFrames()
LucamGetCameraId()
LucamGetFormat()
LucamQueryVersion()
LucamRemoveSnapshotCallback()
LucamSetFormat()
LucamStreamVideoControl()

### 4.4.23 InfinityTest Sample Application

Application type: Windows Dialog

Compiler: Visual C++ .Net

Description: This sample demonstrates how to capture DeltaVu type snapshots with the InfinityX-21 camera.

Functions Used:
LucamBuildHighResImage()
LucamCameraClose()
LucamCameraOpen()
LucamConvertFrameToRgb24()
LucamCreateDisplayWindow()
LucamDestroyDisplayWindow()
LucamGetCameraId()
LucamQueryVersion()
LucamSaveImage()
LucamSetFormat()
LucamSetProperty()

LucamStreamVideoControl()
LucamTakeVideo()

### 4.4.24 Lucam Capture Sample Application

Application type: Windows Dialog

Compiler: Visual C++ .Net

Description: This sample is the source code for the LuCam Capture application that is included with the LuCam Software.

Functions Used: LucamAddStreamingCallback()
LucamBuildHighResImage()
LucamCameraClose()
LucamCameraOpen()
LucamConvertBmp24ToRgb24()
LucamConvertFrameToRgb24()
LucamDestroyDisplayWindow()
LucamEnumCameras()
LucamGetCameraId()
LucamGetFormat()
LucamGetProperty()
LucamGetLastError()
LucamGetProperty()
LucamNumCameras()
LucamOneShotWhiteBalance()
LucamQueryExternalInterface()
LucamQueryDisplayFrameRate()
LucamQueryVersion()
LucamPropertyRange()
LucamReadRegister()
LucamRemoveRgbPreviewCallback()
LucamRemoveStreamingCallback()
LucamSaveImage()
LucamSaveImageEx()
LucamSaveImageW()
LucamSetFormat()
LucamSetProperty()
LucamSetupCustomMatrix()
LucamStreamVideoControl()
LucamTakeSnapshot()
LucamTakeVideo()
LucamWriteRegister()

### 4.4.25 LucamX Sample Application

Application type: Windows Dialog

Compiler: Visual C++ .Net

Description: This sample application 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.

Functions Used:
LucamAddStreamingCallback()
LucamBuildHighResImage()
LucamCameraClose()
LucamCameraOpen()
LucamConvertBmp24ToRgb24()
LucamConvertFrameToRgb24()
LucamDestroyDisplayWindow()
LucamEnumCameras()
LucamGetCameraId()
LucamGetFormat()
LucamGetProperty()
LucamGetLastError()
LucamGetProperty()
LucamNumCameras()
LucamOneShotWhiteBalance()
LucamQueryExternalInterface()
LucamQueryDisplayFrameRate()
LucamQueryVersion()
LucamPropertyRange()
LucamReadRegister()
LucamRemoveRgbPreviewCallback()
LucamRemoveStreamingCallback()
LucamSaveImage()
LucamSaveImageEx()
LucamSaveImageW()
LucamSetFormat()
LucamSetProperty()
LucamSetupCustomMatrix()
LucamStreamVideoControl()
LucamTakeSnapshot()
LucamTakeVideo()
LucamWriteRegister()

### 4.4.26 MonoCheck Sample Application

Application type: Windows Dialog

Compiler: Visual C++ .Net

Description: Example on how to check for mono or color versions of camera

Functions Used: LucamCameraClose()
LucamCameraOpen()
LucamGetProperty()

### 4.4.27 MultiSnapshot Sample Application

Application type: Windows Dialog

Compiler: Visual C++ .Net

Description: This sample demonstrates how to take snapshots from different cameras.

Functions Used: LucamCameraClose()
LucamCameraOpen()
LucamConvertFrameToRgb24()
LucamCreateDisplayWindow()
LucamDestroyDisplayWindow()
LucamDisableFastFrames()
LucamEnableFastFrames()
LucamGetCameraId()
LucamGetFormat()
LucamGetLastError()
LucamQueryVersion()
LucamSaveImage()
LucamSetFormat()
LucamStreamVideoControl()
LucamTakeFastFrame()

### 4.4.28 PermStorage Sample Application

Application type: Windows Dialog

Compiler: Visual C++ .Net

Description: This sample demonstrates how to access and use the permanent storage buffer on the camera.

Functions Used: LucamCameraClose()
LucamCameraOpen()
LucamPermanentBufferRead()
LucamPermanentBufferWrite()

### 4.4.29 ResetAndFF Sample Application

Application type: Windows Console

Compiler: Visual C++.Net

Description: This sample application is a console based application that demonstrates how to reset the camera and configure it to perform Fast Frame snapshots.

Functions Used: LucamCameraClose()
LucamCameraOpen()
LucamCameraReset()
LucamConvertFrameToRgb24()
LucamConvertFrameToRgb48()
LucamDisableFastFrames()
LucamEnableFastFrames()
LucamGetCameraId()
LucamGetFormat()
LucamQueryVersion()
LucamSaveImage()
LucamSetProperty(()
LucamTakeFastFrame()

### 4.4.30 ScrollingPreview Sample Application

Application type: Windows Dialog

Compiler: Visual C++ .Net

Description: Example on how to create a scrolling preview window

Functions Used: LucamAdjustDisplayWindow()
LucamCameraClose()
LucamCameraOpen()
LucamGetFormat()
LucamStreamVideoControl()

### 4.4.31 Snapshot Sample Application

Application type: Windows Dialog

Compiler: Visual C++ .Net

Description: This example demonstrates how to take snapshots.

Functions Used: LucamCameraClose()
LucamCameraOpen()
LucamConvertFrameToRgb24()
LucamConvertFrameToRgb48()
LucamCreateDisplayWindow()
LucamDestroyDisplayWindow()
LucamDisableFastFrames()
LucamEnableFastFrames()
LucamForceTakeFastFrame()
LucamGetCameraId()
LucamGetFormat()
LucamGetLastError()
LucamGetProperty()
LucamGetTruePixelDepth()

LucamQueryVersion()
LucamSaveImage()
LucamSetFormat()
LucamSetProperty()
LucamStreamVideoControl()
LucamTakeFastFrame()
LucamTakeSnapshot()

### 4.4.32 Threshold Sample Application

Application type: Windows Dialog

Compiler: Visual C++ .Net

Description: This sample 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.

Functions Used: LucamAddStreamingCallback()
LucamCameraClose()
LucamCameraOpen()
LucamCreateDisplayWindow()
LucamDestroyDisplayWindow()
LucamGetFormat()
LucamGetLastError()
LucamGetProperty()
LucamSetFormat()
LucamSetProperty()
LucamStreamVideoControl()

### 4.4.33 VB Picture Flip Sample Application

Application type: Windows Dialog

Compiler: Visual Basic 6.0

Description: This sample demonstrates how to flip and mirror the video preview.

Functions Used: LucamCameraClose()
LucamCameraOpen()
LucamGetFormat()
LucamGetProperty()
LucamSetFormat()
LucamSetProperty()
LucamStreamVideoControl()

### 4.4.34 VB Sync Snaps Sample Application

Application type: Windows Dialog

Compiler: Visual Basic 6.0

Description: This sample demonstrates how to do synchronous snapshot captures from 2 cameras.

Functions Used: LucamCameraClose()
LucamCameraOpen()
LucamDisableSynchronousSnapshots()
LucamEnableSynchronousSnapshots()
LucamGetLastError()
LucamTakeSynchronousSnapshots()

### 4.4.35 VBlucamCOMSample Application

Application type: Windows Dialog

Compiler: Visual Basic.Net

Description: This sample application demonstrates how to access the camera features using the LuCamAPICOM COM object.

Functions Used: NA

### 4.4.36 VBNet Sample Application

Application type: Windows Dialog

Compiler: Visual Basic.Net

Description: This sample application demonstrates how to access the camera using VB.Net. This application is similar to the VB Sample application described earlier.

Functions Used: LucamAddRgbPreviewCallback()
LucamCameraClose()
LucamCameraOpen()
LucamConvertFrameToGreyscale8()
LucamConvertFrameToRgb24()
LucamDestroyDisplayWindow()
LucamDisplayPropertyPage()
LucamDisableSynchronousSnapshots()
LucamEnableSynchronousSnapshots()
LucamEnumCameras()
LucamGetFormat()
LucamGetLastError()
LucamGetProperty()
LucamGpioRead()
LucamGpioWrite()

LucamGpoSelect()
LucamOneShotWhiteBalance()
LucamRemoveRgbPreviewCallback()
LucamSaveImage()
LucamSetFormat()
LucamSetPropert()
LucamStreamVideoControl()
LucamTakeSnapshot()
LucamTakeSynchronousSnapshots()
LucamTakeVideo()