



## IL3, IL4 and IL5 High-Speed Cameras Operator's Manual

Firmware / Software Version 2.4.2

2017-9

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# Chapter Summary

(Where to find things in this manual)

## Chapter 1, Product Overview

The first chapter contains general information regarding the ILx product family, common applications for which the camera is used, and the basic guide to the component parts of the camera. Look here for the names and locations of all camera controls and indicators.

## Chapter 2, Getting Started

This chapter guides the user through the camera setup process from unpacking the camera to attaching, connecting, or installing the pieces necessary to begin using the camera: i.e. the power supply and/or battery, lenses, mass memory devices, etc., as well as optional devices such as triggers, monitors, PCs, etc.

## Chapter 3, Camera Setup

This chapter is about learning to use the ILx user interface and setting the camera up for use, including naming the camera and setting up the time. It also covers controls for the built-in LCD display, connecting with an external display, and connecting the ILx to a computer network.

## Chapter 4, Recording

Chapter 4 covers the recording process from setting up the recording parameters to Arming and Triggering the camera. It also covers bit selection, image processing and saving the imagery in its different formats.

## Chapter 5, Synchronizing Timing and Markers

Cameras may be synchronized to external timing devices as well as to other cameras. This chapter tells you how to do it on the ILx.

## Chapter 6, Web-Application

ILx camera's Web-Application makes it easy to control the camera from virtually any device that can attach to a network and run a standard internet browser. No need to load any software! Chapter 6 walks you through the Web-App and how to control the camera, and capture and manage imagery with it.

## Appendices

Technical details are to be found in these sections. They include a glossary of terms, camera and sensor specifications, lens FOV vs. resolutions tables, an index, connector schematics, back focus adjustment procedures, system optimization and much more.

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# 1 Product Overview

## 1-1 Product Description

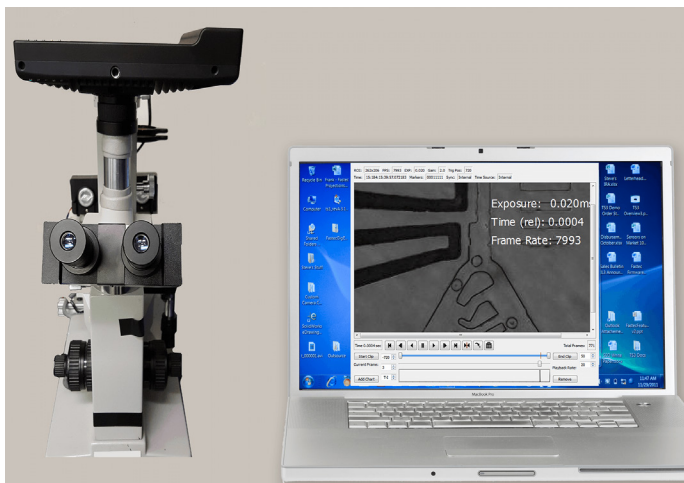
The Fastec ILx is a high-speed digital camera line with models capable of capturing high-resolution 1920 x 1080 pixel images at 634 frames per second, smaller-resolution images at much higher frame rates, and higher-resolution images at lower frame rates. Recording image data at high frame rates makes it possible to play back high quality video sequences in slow motion, enabling the user a greatly enhanced ability to analyze events that occur much too quickly for human vision to perceive.

The ILx, with its many modes of operation, including its unique stand-alone capabilities and its high-speed imaging performance, resolution and sensitivity, make it an excellent choice for many different applications. For multi-camera use or where the camera might be set up and left in more remote applications, its networking and master/slave capabilities come into play. When the action becomes fast and furious, FasFire mode helps to capture many triggered events. When triggering isn't an option, and for very long events, models with Long Recording (LR) modes capture all the action by streaming image data to built-in SSDs.

Fastec Imaging high-speed cameras are used in hundreds of different industrial manufacturing sites to analyze motion in machinery and production line processes. Reduce jams, speed up line setup and changeovers, lower scrap and rejected material costs and reduce downtime and maintenance expenses.



Universities worldwide use Fastec cameras for a variety of research studies. Animal locomotion, mechanical engineering, flow visualization, combustion studies, biomechanics & kinesiology, physics, chemistry, tensile testing and more.



High-speed cameras are used in mining and blasting applications to determine the effects of blasts on structures or vehicles or determine the actual firing times of blast holes and the nature of the rock movement. Delay detonators provide the timing blasts needed under specific blasting

conditions. Blast holes firing at incorrect times reduce rock fragmentation, effect blast movement, and can increase blast vibrations.

Military customers worldwide use high-speed video to design and test weapons, counter measure and defensive systems and components. Fastec cameras have been used for "chase plane" applications such as airborne stores separation and in-flight aeronautics testing.



## 1-2 ILx Product Differentiation

Fastec Imaging sells a number of different ILx high-speed digital camera models. These cameras are offered in either monochrome or color with various high-speed digital recording capabilities using a wide range of recording rates, sensor resolutions, and on-board memory options. All cameras are equipped with a standard C-mount lens mount, and 1/4-20 tripod mount. Additional lens mount options are available.

ILx cameras support the following modes of operation:

- Local or remote operation via a wired GigE connection, using FasMotion, the Fastec camera control software or the Fastec Web Application via GigE, wired or WiFi (with WiFi option). With the Web Application, any host device (PC, tablet, smartphone) with a common Web browser may be used to control the camera.
- Unattended operation: The camera is set up using the camera control or web application, set for AutoSave and Armed, then left waiting only for a trigger input.

The ILx camera housing is made of 100% machined aluminum with a black anodized finish. It is both attractive and extremely durable. LEMO connectors are used for critical power and Sync/Trigger connections. It has side-mounted USB-OTG, HDMI, Gig-E, Sync/Trigger, and Power connectors as well as a SD-Card slot. Power is supplied by an AC power adapter or any 10-26v DC source.

**Table 1-1: ILx Models**

Camera	Max Resolution / Frame Rate	Standard Memory	Sensor Size	Optional Memory	Optional Solid-State Drive
IL3L	800 x 600 @1250fps	4GB	14mm	8GB	256GB / 512GB / 1TB / 2TB
IL3S	1280 x 1024 @ 510fps	4GB	22.9mm	8GB	256GB / 512GB / 1TB / 2TB
IL4100-LR2/3	1280 x 1024 @ 510fps	8GB	22.9mm	8GB	256GB / 512GB / 1TB
IL5L	800 x 600 @ 1126fps	4GB	5mm	8GB	256GB / 512GB / 1TB / 2TB
IL5S	1280 x 1024 @ 668fps	4GB	8.2mm	8GB	256GB / 512GB / 1TB / 2TB
IL5H	1920 x 1080 @ 634fps	4GB	11mm	8GB	256GB / 512GB / 1TB / 2TB
IL5Q	2560 x 2048 @ 253fps	4GB	16.4mm	8GB	256GB / 512GB / 1TB / 2TB

With the exception of the IL3L, all cameras record at higher frame rates at higher frame rates at reduced resolutions.

The IL4100 in Long Recording Mode: 1280 x 1024 @ 183fps (LR2: SATA II) / 366fps (LR3: SATA III)

IL3 and IL5 cameras with the “D” (Dual Mode) option also record in Long record mode at SATA III speeds.

**Table 1-2: Part Number Legend**

IL3XXXxxxX	Component	Options	Examples
IL3LM8512D	Long Record	None / D*	IL3LM8512D = 800 x 600, Mono, 512GB SSD, Dual Mode
IL4LR3C8512	Drive (GB SSD)	None/ 256 / 512	IL4LR3C8512 = 512GB SSD
IL3100LC4	Memory (GB)	4 / 8	IL3100LC4 = 800 x 600, Color, 4GB (no SSD)
IL3100SM4	Sensor	Color or Mono	IL3100SM4 = 1280 x 1024, Mono, 4GB (no SSD)
IL3100LSM8256	Sub-Model	L / S / LR / H / Q	IL3100LSM8256 = 1280 x 1024, Mono, 8GB, 256GB SSD
IL4LR3C8512	Model	3 / 4 / 5	IL4LR3C8512 = 1280 x 1024, Color, Long Rec, 512GB SATA III

## 1-3 ILx Controls, Indicators, and Connectors

Table 1-3: Camera Part Locations

Camera Part	Link to View
LED Indicators	"Figure 1-1: ILx Back View" / "Figure 1-2: ILx Front View"
C-Mount	"Figure 1-2: ILx Front View"
C-Mount Lock Screws	"Figure 1-3: ILx Top View" / "Figure 1-5: ILx Bottom View"
Lens Mount Holes	"Figure 1-3: ILx Top View"
1/4-20 Tripod Mounts	"Figure 1-3: ILx Top View" / "Figure 1-5: ILx Bottom View"
USB Port	"Figure 1-3: ILx Top View"
USB OTG Port	"Figure 1-4: ILx Side Views"
SD-Card Slot	"Figure 1-4: ILx Side Views"
Gig-E Connector	"Figure 1-4: ILx Side Views"
Sync I/O Connector	"Figure 1-4: ILx Side Views"
HDMI Connector	"Figure 1-4: ILx Side Views"
Power Connector	"Figure 1-4: ILx Side Views"

Figure 1-1: ILx Back View

Note: See "Appendix L: Physical Measurements" on page 124 for dimensions.



Figure 1-2: ILx Front View

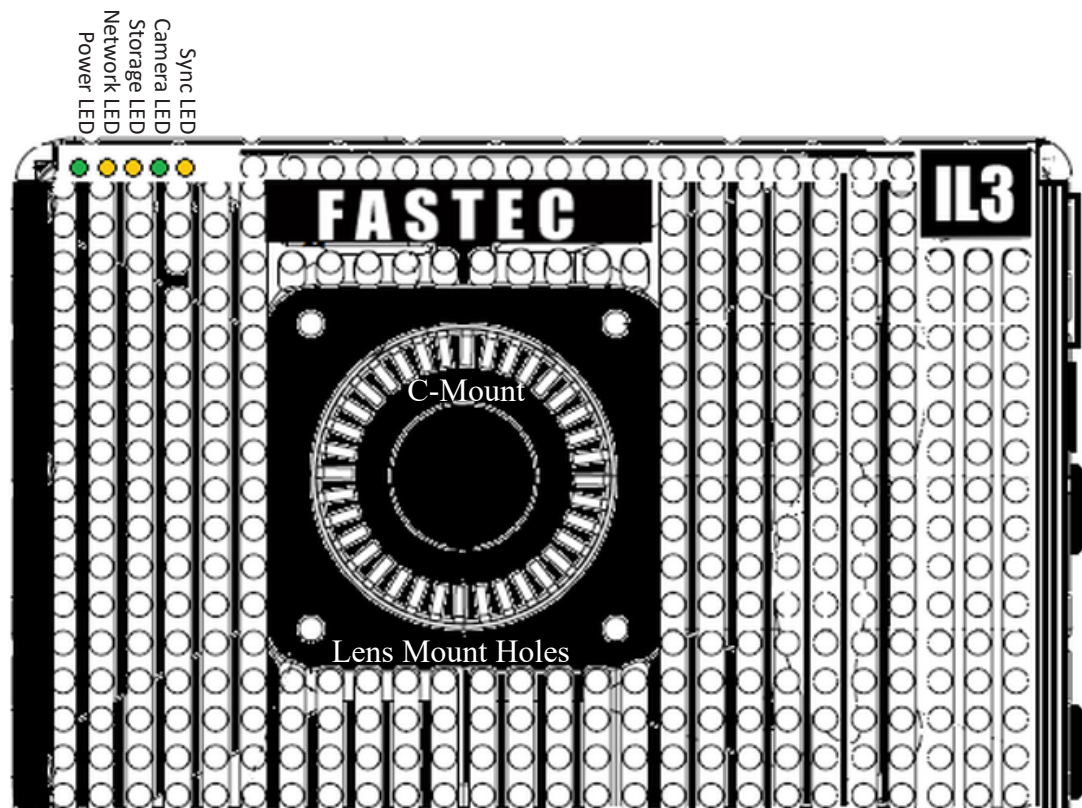


Figure 1-3: ILx Top View

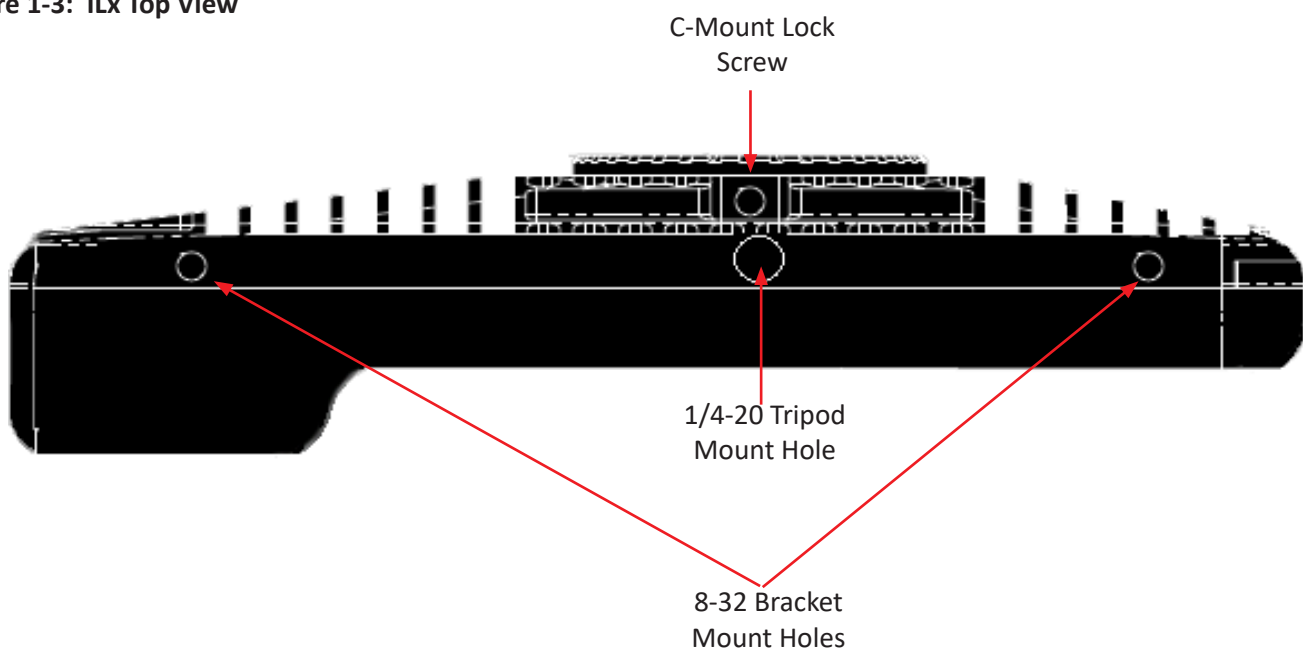




Figure 1-4: ILx Side Views

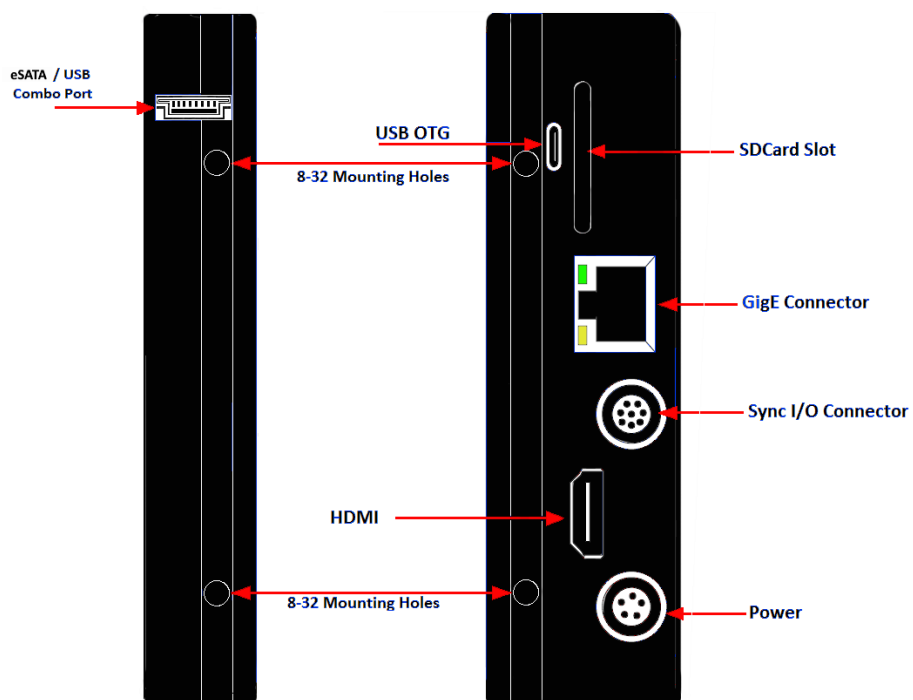
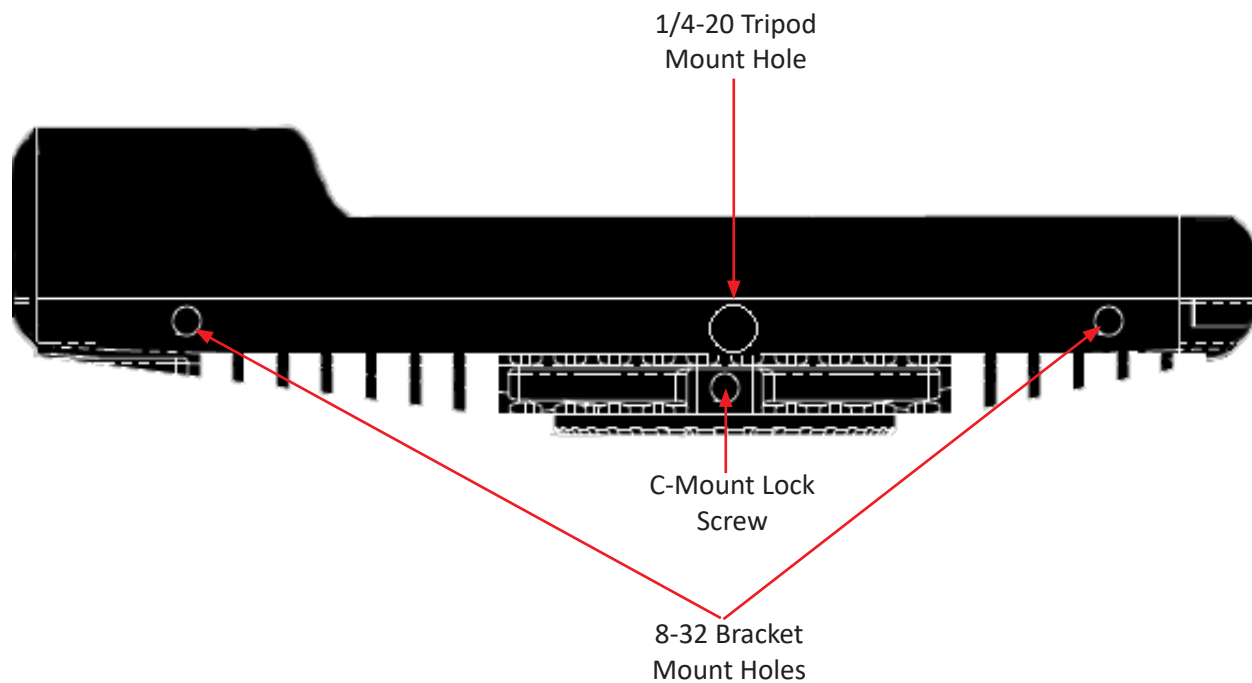


Figure 1-5: ILx Bottom View



## 2 IL3 / IL4 / IL5 Getting Started

### 2-1 Unpacking the Camera

Table 2-1: Package Contents:

Part	STD	OPT	Part #
ILx Camera	X		ILXxxxXXX
C-Mount (factory installed and adjusted on the camera)	X		1105-0026
F-Mount (factory installed and adjusted on the camera)		X	1105-0200
PL-Mount (factory installed and adjusted on the camera)		X	1105-0115
DC Power Supply-- 110/220VAC, 50/60Hz, 12V @ 4.17A, with IEC-320 C8 inlet and 5-pin LEMO connector (no power cord included)	X		1105-0250
16 GB SDHC Card	X		1105-0261
32 GB SDHC Card		X	1105-0262
I/O Cable 18": 8-pin LEMO camera connector to 3 BNC connectors for Sync-In, Sync-Out, and Trigger-In (3 I/O connections)	X		1105-0401
I/O Cable 18": 8-pin LEMO camera connector to 6 BNC connectors for Sync-In, Sync-Out, and Trigger-In, Trigger-Out, Arm-In, Arm-Out (6 I/O connections)		X	1105-0405
Wireless 802.11n USB WiFi Adapter		X	1105-0275
External 12V Li-Ion Battery Pack, 98Wh, w/charger, 4-pin XLR to LEMO cable		X	1105-0253
External 12V Battery Belt, 144Wh, w/charger, LED power gauge, 4-pin XLR to LEMO cable		X	1105-0254
Documentation and Software (on USB thumb drive)	X		

Fastec Imaging retails its cameras through independent distributors. Fastec or its distributors can provide the accessory items required for camera operation according to each customer's particular application needs.

### 2-2 Installing the Lens

The camera is shipped with a C-mount lens adaptor installed and adjusted at the factory. To install a C-mount lens, follow these steps:

1. Select a C-mount lens for use with the camera.

NOTE: There are many C-mount lens formats and focal lengths available. The 22.9mm diagonal sensor of the IL3S / IL4 is larger than the light circle produced by many C-mount lenses. This is especially true for wide angle lenses, but it is dependent on lens design and format. Vignetting (darkening at the corners or edges of the image) will occur when the image on the sensor, the size and location of which is dependent on resolution and image offset, is not covered by the image circle of the lens. (See "Table 2-2: Lens Selection".)

2. Remove the lens receptacle cover from the camera's C-mount. This is a cover that is installed at the factory to protect the camera optics and sensor from dust contamination.

NOTE: Whenever threading lenses on or off the camera, face the camera lens down so that any contamination on the threads will tend to fall away from the camera rather than into it.

3. Thread the C-mount lens into the lens mount located in the front of the camera. DO NOT over-tighten the lens! The lens should be "finger tight" only--just tight enough that you can adjust focus and aperture without unscrewing the lens.

NOTE: Limit the time between removal of the receptacle cover and installation of the lens. Dust could settle on the face of the sensor cover glass and degrade the image quality.

**Table 2-2: Lens Selection**

Resolution	Sensor Diagonal		Required Lens Format to avoid noticeable Vignetting		Field of View From 10M with 50mm Lens	
	IL3/IL4	IL5	IL3/IL4	IL5	IL3/IL4	IL5
1920 x 1080	NA	11.0mm	NA	2/3"	NA	1.9 x 1.1m
1280 x 1024	22.9mm	8.2mm	4/3"	1/2"	3.6 x 2.9m	1.3 x 1.0m
1024 x 1024	17.5mm	7.2mm	4/3"*	1/2"	2.9 x 2.9m	1.0 x 1.0m
1280 x 720	20.5mm	7.35mm	4/3"	1/2"	3.6 x 2.0m	1.3 x .7m
800 x 600	14mm	5mm	1"	1/3"	2.2 x 1.7m	800 x 600cm
640 x 480	11.2mm	4mm	2/3"	1/3"	1.8 x 1.3m	640 x 480cm
320 x 256	5.7mm	2mm	1/3"	1/3"	900 x 700cm	320 x 256cm

\*The 17.5mm diagonal @ 1024 x 1024 is slightly larger than the 16mm specification for 1" C-mount lenses. Many, but not all 1" format lenses will satisfactorily cover this resolution.

This table assumes that the images are centered (no custom offset applied). (See "Offset Control:" on page 29.) It also assumes that no binning or subsampling is used on the IL5.

Note: All F-mount and PL-mount lenses will easily cover the full 22.9m full resolution image plane.

## 2-3 Power

### Attaching the External DC Power Supply

The 12V DC Power Supply operates on 100-240VAC, 50-60Hz. The socket is a standard IEC-320 C8 AC inlet, used worldwide for all types of electronic equipment. The power supply is shipped without power cord so that the user may use one appropriate for local power outlets.

1. Attach a power cord to the power supply and connect it to an AC power outlet.
2. Attach the power supply output cord to the camera via the LEMO connector. Note that the LEMO connector is keyed: the red dot on the connector will face the back of the camera.
3. The camera will automatically begin to boot as soon as power is applied. While powering on, the green camera LED will light up for about 15 seconds and go off, then the green power LED will light up. After about 45 seconds, when both power and camera LEDs are lit, the camera is fully booted. If attached to a network, the amber network LED will blink occasionally.

Note: There is also an ON/OFF button located on the backside of the camera. This can be used to turn the camera on and off while power is applied. It is also used to manually update the camera.

Note: If another power source is used, such as the optional external batteries, there may be no indication or warning before the battery power is low.

## 2-4 ILx Memory and Mass Storage Options

The ILx camera is equipped with 4GB or 8GB of internal high-speed internal memory that can be partitioned for one or more image sequences. Images stored in this memory may be reviewed on the camera, external monitor via HDMI, or PC, then saved to any of four types of mass storage devices:

1. Solid State Drive (optional on the IL3 and IL5) drive (internal SATA SSD or external eSATA SSD).
2. SD-Cards (SDHC) inserted by the operator into the SDHC slot on the side of the ILx.
3. USB devices such as thumb drives or USB external hard drives connected via the USB port.
4. Memory devices on a networked PC using Fastec Camera Control (not Web Browser).

## ILx Solid State Hard Drives (SSDs)

Solid state drives (SSDs) are available on the IL3, IL4 and IL5. (See “Table 1-1: ILx Models” on page 2.) These drives serve as mass storage devices for the camera. Image data from the ILx’s high-speed internal memory may be downloaded to the SSD, thus making room for the next high-speed image capture.

While the SSD does not add to the recording time of the camera operating in Standard mode (not “Long Record” mode), it does allow the user to save large quantities of image data without ever connecting the ILx to a PC or other external device.

### SSDs for Long Record

SSDs are standard equipment on all “Dual Mode” cameras, which include the IL3 and IL5 with the “D” option and the IL4. They may be used as described above, or in Long Record mode whereby the image data is streamed directly to the SSD, thereby greatly adding to the record time.

### SD-Card (SDHC only)

The ILx is shipped with a 16GB SD-Card. (32GB cards are an available option.) This card has two functions:

- It can be used as a mass storage device for downloading and distributing images. SD-Cards and card readers are very commonly used storage devices among PC users and photographers.
- Any field software updates for the ILx from Fastec will be installed via the SD-Card.

Note: An SD-Card when used for a software update must be reformatted before it can be reused as a mass storage device. See “Appendix K: IL3 Updates” on page 122.

**Figure 2-1: ILx Connections**



## USB Port (USB 2.0)

The ILx will act as a **Host** to any USB 2.0 mass storage device connected at the USB port. (See “ILx Side Views” on page 5.) Image data may be saved to these devices.

## USB-On The Go!

The USB-OTG port allows the camera to be connected as a slave to any PC using a USB-A to USB-Micro-B cable. Once connected via the ILx's OTG port, any mass storage device on the camera can be accessed by the PC. This includes an SD-Card, Solid State Drive, or thumb drive in the USB port.

**Note: This is not supported for the SSD when in Long Record mode because the drive cannot be formatted FAT-32 for streaming.**

1. Power up the camera.
2. Install thumb drive and/or SD-Card in the camera. (Any device that is connected to the camera *after* the camera and PC are connected will not be seen by the PC.)
3. Attach the camera to the PC via the camera's USB-OTG port, which is next to the SD-Card slot on the side of the camera. As each device is located by the PC an Autoplay window on the PC will open. This is a very simple way to transfer image data to a PC. This is for file access only--there is no way to control the camera via USB-OTG.

When you are finished, you need to eject the media from the PC. Click on the “Safely Remove Hardware and eject Media” icon on your computer's task bar and select “Eject Fastec Camera.”

Note: Use this method for relatively small image transfers. Much faster and more efficient workflows are available using FasMotion. Please refer to “4-21: Transfers, Batch Transfers and Conversions” on page 58.

**Table 2-3: ILx Mass Storage Functionality**

	Target Drive(s)	Functions
<b>FasMotion Utilities:</b>		
Storage/Explore	PC Drives+SSD/USB/SDHC/eSATA	Move, Copy, Delete, Batch, Convert to AVI, Load CAP, review metadata
Storage/Format	SSD/USB/SDHC/eSATA	Format drive
Review/Save	PC Drives+SSD/USB/SDHC/eSATA	Save image Data from Internal High-Speed Memory, Load CAP file
Record Still	PC Drives+SSD/USB/SDHC/eSATA	Save a single still Image
Autosave	PC Drives+SSD/USB/SDHC/eSATA	Autosave image Data from Internal High-Speed Memory
Stream (Long Record)	SSD/eSATA (proprietary format)	Long Record Basic, Long Record BROCC, Long Record ROC
<b>PC via Gig-E Connection:</b>		
Explore	SSD/USB/SDHC/eSATA	Open, Copy files, multiple files, directories From ILx to PC only
<b>Web Application:</b>		
Storage/Browse	SSD/USB/SDHC/eSATA	Move, Copy, Delete (1 file at a time), review metadata of Image files
Storage/Format	SSD/USB/SDHC/eSATA	Format drive
Review/Save	SSD/USB/SDHC/eSATA	Save image Data from Internal High-Speed Memory
Record Still	PC Drives+SSD/USB/SDHC/eSATA	Save a single still Image
Autosave	PC Drives+SSD/USB/SDHC/eSATA	Autosave image Data from Internal High-Speed Memory
Stream (Long Record)	SSD/eSATA (proprietary format)	Long Record Basic, Long Record BROCC, Long Record ROC
<b>PC via USB-OTG:</b>		
Explore	SSD/USB/SDHC/eSATA	Copy files and directories to and from ILx



## 3 IL3 / IL4 / IL5 Camera Setup

### 3-1 Install FasMotion Control Software on PC or Mac

Before we can begin setting up the ILx, you must first install the Fastec FasMotion Controller software.

The FasMotion install program is available on the Fastec website, [www.fastecimaging.com/Software](http://www.fastecimaging.com/Software) and is also copied onto the USB thumb drive that shipped with your ILx camera.

This software may be used to set up and control ILx and TSx cameras. With it you may configure all recording parameters including Record Mode, Session Length, Resolution, Frame Rate, Exposure, Color Balance, Autosave, Trigger point, and Sync options.

To install FasMotion on a Windows PC:

1. Run the FasMotion install file on your PC. The file will have the format: FasMotion<version>.exe. For example, FasMotion64\_2.0.22.exe would be the install file for version 2.0.22. It is recommended that you copy the install file to the hard drive of your PC for safekeeping.
2. The Windows Account Control will display a message asking if you want to allow the installer to make changes to your computer. Answer "Yes."
3. The Installer Setup window will appear as shown informing you that the install process has begun. Click on "Next."

Figure 3-1: FasMotion Installation



Figure 3-2: FasMotion Install Location

4. The next window allows you to choose a location for the program. Select a location and click on "Next."

Note: FasMotion 2.0x is a 64-bit program and should be installed in \Program Files. If you currently have a previous version installed in \Program Files (x86), use the Browse function to install FasMotion into \Program Files. (The install will create the "FasMotion" folders and necessary sub-folders.)

A 32-bit version is available, but is not recommended. Contact Fastec Support if you plan to run on a 32-bit computer.

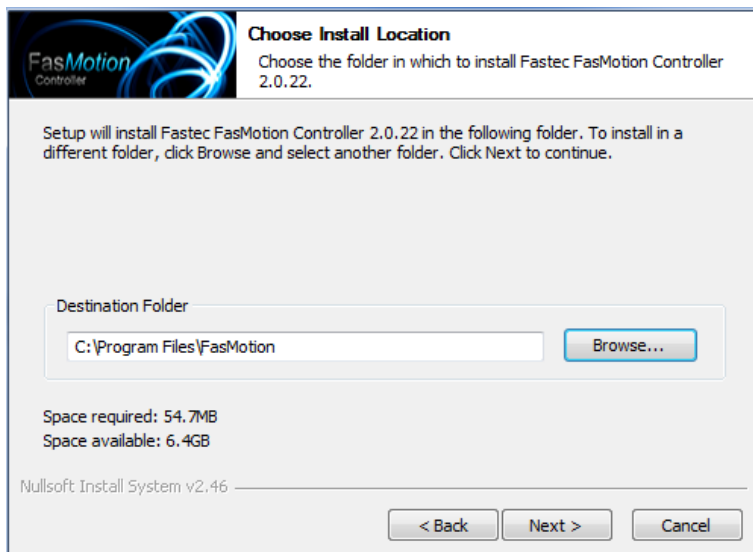
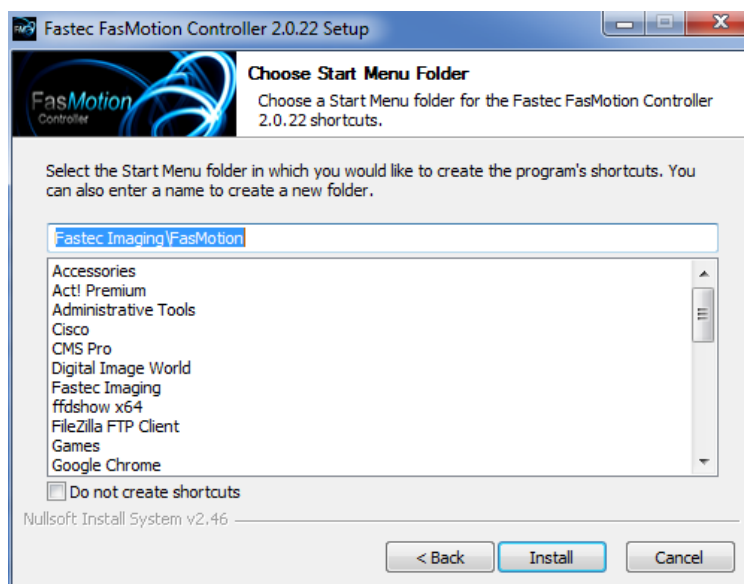
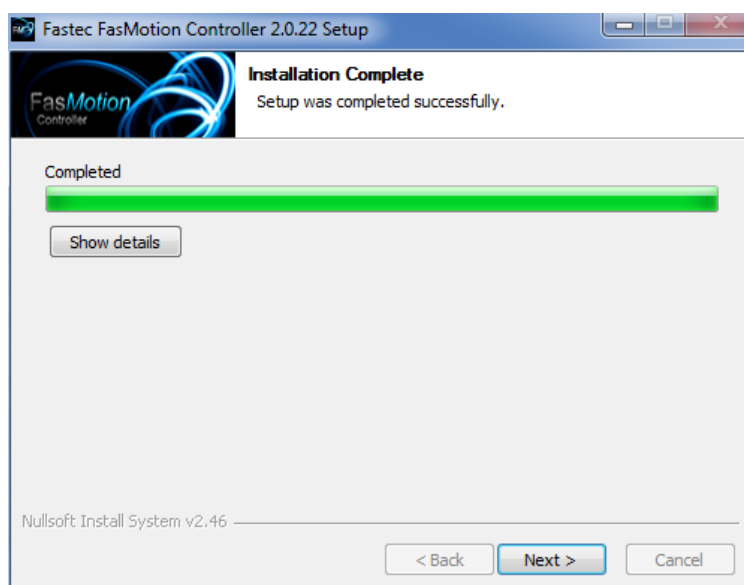


Figure 3-3: FasMotion Start Folder



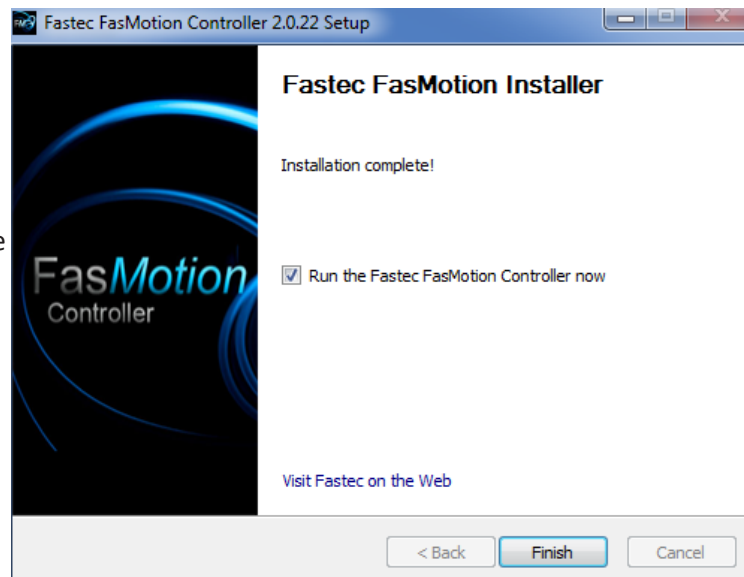
5. The next window gives you the option to create a shortcut for FasMotion in the directory of your choice. Select a directory for a shortcut or click the “Do not create shortcuts” check box. Click on “Install” to continue.

Figure 3-4: FasMotion Install Progress



6. FasMotion will now be installed on the PC. A window with a progress bar will appear and inform you when the install is complete.

Figure 3-5: FasMotion Installation Complete



7. The final install window gives you the option to run FasMotion software and a link to the Fastec web page. Click on “Finish” when done to exit the install program.

FasMotion software has been tested on OS X Mountain Lion, Mavericks, and Yosemite.

Some of the best file transfer performance we have seen has been using a MacBook Pro (2014 model: 8GB RAM, Intel (R) Core(TM) i7-4750HQ) with an SSD, running Mavericks and Windows 7 Professional (BootCamp).

#### To Install FasMotion on your Mac:

1. Copy FasMotion.dmg to your Mac.
2. Double-click on FasMotion.dmg to run. A Window will open with icons for FasMotion and the Applications folder.

3. Drag the FasMotion icon into the Applications window.

4. If you are updating FasMotion, you will get the message in Figure 3-5. It is recommended that you only use the version of FasMotion that matches the camera firmware version. Do not keep the old version of FasMotion unless you need it for cameras that are not on the same version as the FasMotion software you are loading.

Figure 3-6: Install FasMotion for Mac

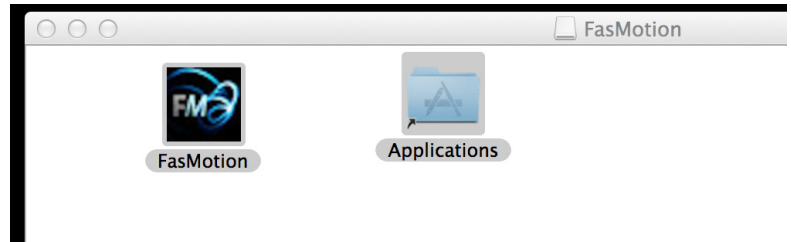
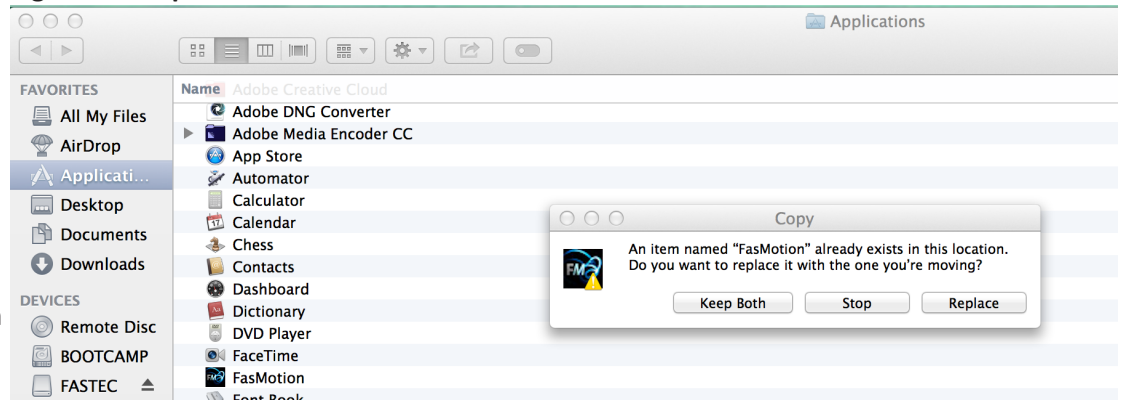


Figure 3-7: Update FasMotion for Mac

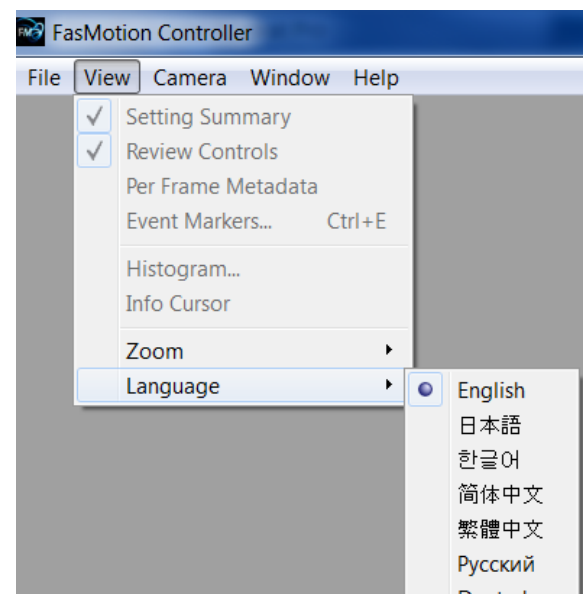


## 3-2 Language Selection in FasMotion

#### To select a language in FasMotion:

1. Open the FasMotion Application
2. Click on View
3. Select Language from the View Menu
4. Make your language selection

Figure 3-8: Language Selection

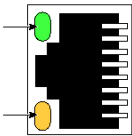



### 3-3 Connect the ILx to a Wired Network

The default network configuration for the ILx is DHCP. If a DHCP host is not found on the network, the ILx will automatically configure itself with a “Local Link” 169.254.xxx.xxx IP address according to Gig-E protocol.

**To attach the ILx to a network:**

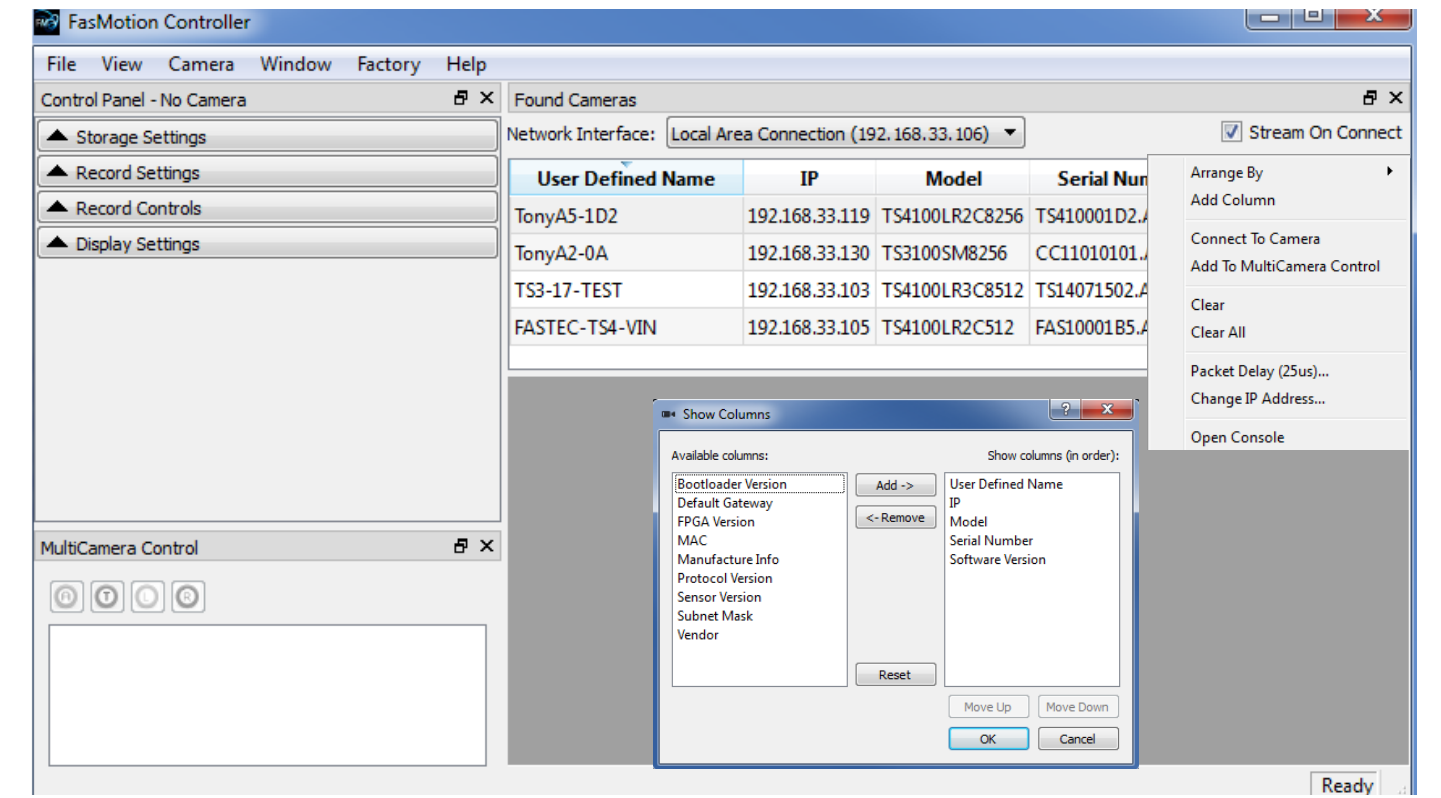
- 1. Before connecting to power, connect the ILx to your network via a switch or router, or directly to your PC using CAT 5E or CAT 6 Ethernet cable.
- 2. Power up the ILx. See “2-3 Power” on page 8.
- 3. Watch the LEDs on the camera’s RJ-45 connector. When the camera connects to the PC or local network the green LED will begin to blink in a pattern depending on connection speed. (See “Table 3-1: ILx Network LEDs” on page 14.)
- 4. Start the FasMotion software application.
- 5. Select a camera from the “Found Cameras” list in FasMotion. Double-click to open.

LEDs on RJ-45 Connector		Camera Networking LED
		
Green (Connection)	Amber (activity)	Amber (activity)
1 Blink = 10Mb	Blinks for all network activity	Blinks for camera network activity only
2 Blinks = 100Mb		
3 Blinks =1Gb		

Note: Figure 3-9 shows the context menu for the “Found Cameras” dialog, which opens with a right click on the list. This menu may be used to arrange or configure the dialog as well as carry out other functions described elsewhere. “Arrange By” sorts the list according to whatever parameter you choose. Also shown here is the “Show Columns” dialog, which opens when you select “Add Column” from the context menu. This is used to add or remove camera parameters from the “Found Cameras” list.

Note: Disable adapters that will not be used with FasMotion. A common cause of connection problems is that the WiFi adapter has been enabled. Please refer to “Application Note 5: Optimizing System for Image Transfers” on page 86 for more details.

Figure 3-9: FasMotion “Find Cameras” Dialog



### 3-4 Managing ILx Network Settings in FasMotion

The default network setting for the ILx is DHCP.

Manually configuring the ILx is not necessary in most installations. The camera will automatically be assigned an IP address by a DHCP host on your network, or it will assign itself a Local Link Address (169.254.xxx.xxx) like any computer.

**The network settings of the ILx may be configured using the Network Configuration dialog in FasMotion:**

1. Follow #s 1-7 in “3-3 Connect the ILx to a Wired Network” on page 14.
2. Click on the camera you wish to manage (do not double-click) to highlight the selection.
3. Right-click on the “Found Cameras” dialog to bring up the context menu, and then select “Change IP Address.” (See Figure 3-9.)

From this dialog you may select DHCP if you wish for the camera to receive an IP address dynamically from your DHCP server or if you wish for the camera to establish a Local Link Address (see “3-3 Connect the ILx to a Wired Network”). Or you may select Static and edit the IP Address, Net Mask, and Gateway to work with your established network.

**If you wish to configure a camera that is not on your subnet (FasMotion will not list it):**

If your TSx is physically attached (via Gigabit Ethernet), but is not reachable in FasMotion via the network because it is not on the same subnet, you may still change its settings using the Network Configuration dialog.

1. Right-click on the “Found Cameras” to bring up the context menu with no cameras selected.
2. Open the Network Configuration dialog.

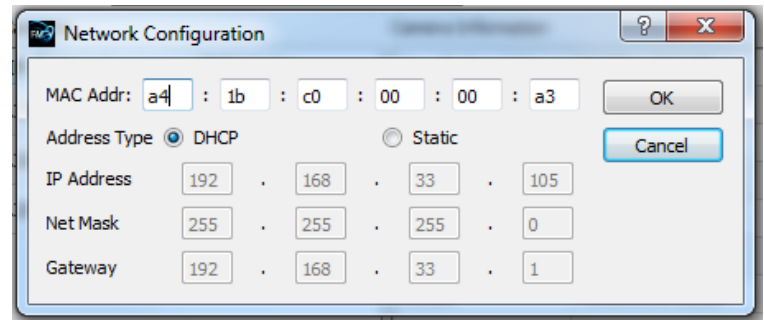
The Network Configuration dialog will open in an unpopulated state as in Figure 3-11.

3. Enter the MAC address of your camera.
4. Enter the Static IP Address, Net Mask, and Gateway for your camera that conforms to your network. (If you wish to use DHCP, you will have to set a compatible static IP address first, and then re-attach to set the camera to DHCP.)

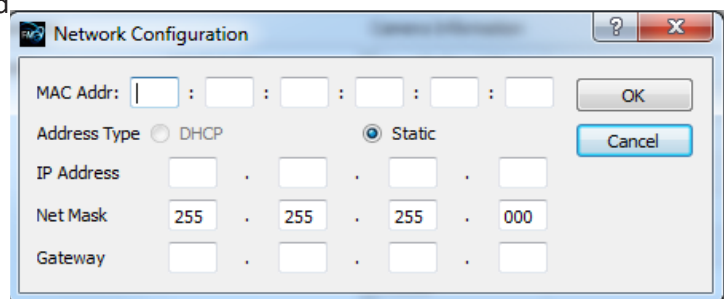
In the example shown in Figure 3-12, settings compatible with the local network are entered.

5. Click on OK.
6. Click on Scan. If the IP address is compatible with the chosen network interface, the camera will now appear on the list.

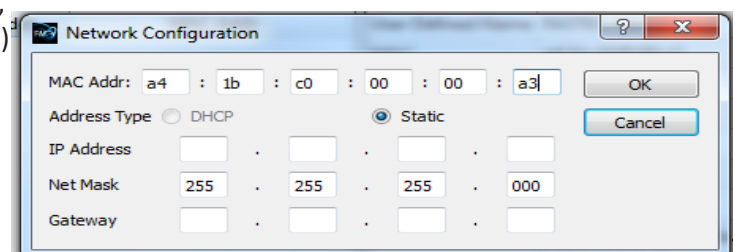
**Figure 3-10: Network Configuration Dialog**



**Figure 3-11: Empty Network Configuration**



**Figure 3-12: New Network Configuration**





## 3-5 WiFi Setup

The “WiFi Config...” element in the FasMotion Configuration menu will only appear if the attached camera is in Live mode and has been factory licensed for WiFi and has its WiFi dongle attached via its USB port.

Note: The camera may not be operated via WiFi in FasMotion.

### WiFi Setup for an Existing Network

1. Select WiFi Config... from the Configuration Menu.
2. Click on the Scan button to see a list of local WiFi networks.
3. Select a network from the “WiFi Scan Results” dialog. You will most likely wish to leave DHCP selected unless you are familiar with the network and wish to supply a valid IP address, net mask, and gateway.
4. Type in the password, if needed and then click on OK. The dialog will close.
5. If you selected DHCP, you can re-open the WiFi configuration dialog after a few minutes and you will see the assigned IP address for the camera.

### WiFi Setup for an Ad Hoc Network

1. Select WiFi Config... from the Configuration Menu.
2. Write a name you wish to use for the SSID, in this example we have used “ginny.”
3. Check the Ad Hoc checkbox and then, leaving the DHCP radio button selected, click on OK.
4. The dialog box will close. If you reopen it in a couple of minutes you will be able to read the IP address assigned to the camera.

### Connecting to the IL3 via WiFi

1. Open the Wireless network settings utility on your computer or mobile device. You will see a list of available wireless networks.
2. From this list, select the wireless network the ILx is using as seen in the WiFi line in the camera's System Menu.
3. Enter the password, if any.

The ILx and your computer or mobile device are now both connected to the same wireless network. Follow the instructions in “3-11 Connect to the ILx Outside FasMotion” on page 22 to use the ILx wirelessly with the Web-App.

Figure 3-13: Configuration Menu with WiFi

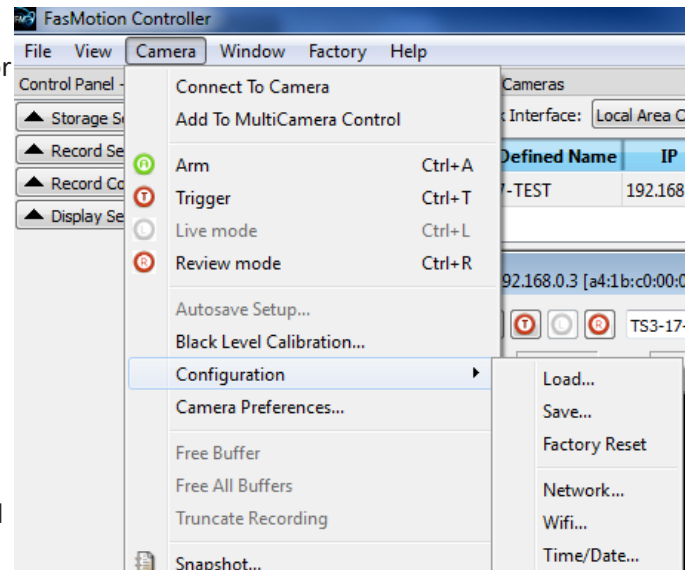


Figure 3-14: WiFi Configuration Dialog

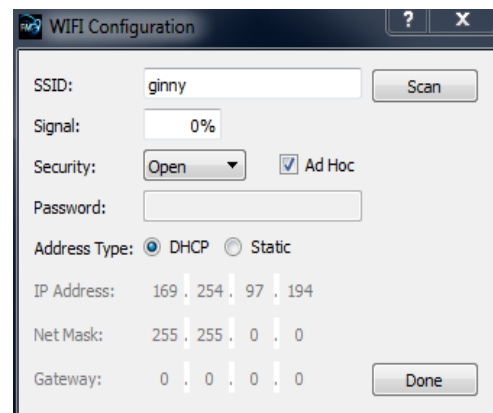
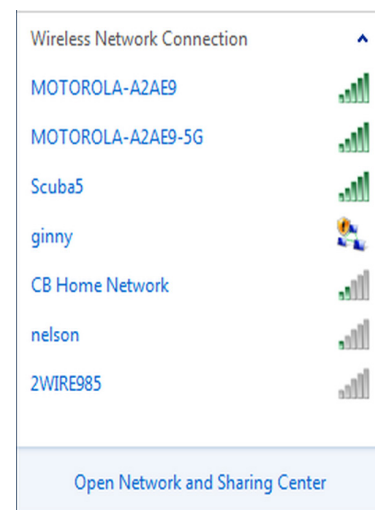


Figure 3-15: WiFi Access Point Scan Dialog



### 3-6 FasMotion Application Window

Figure 3-17 shows the application window with no cameras connected. To the left, is the Control Panel, which has four sub-panels: Storage Settings, Record Settings, Record Controls, and Display Settings. Sub-panels may be opened or closed using the “▼ ▲” buttons, or by selecting the panel in the Window Menu, shown in Figure 3-16.

The MultiCamera Control panel is below the Control Panel, and to the right, is the image window.

The Control Panel and Found Cameras and MultiCamera Control panes may remain docked within the FasMotion application window or be moved outside of the application window to any location on your desktop. If you use two displays, you may wish to move the one or more of them to your extended desktop in order to give yourself a larger image window. They detach by clicking on the gray border at the top in each pane. To return the pane back to the application window, just double-click on that same border.

The **Window menu** gives you some flexibility in what is displayed. For example you may un-check the Found Cameras or MultiCamera Control panes or the control panel if you wish to hide them temporarily. This may be helpful if you wish to have more space for the camera window or if you wish to simplify the controls once the camera(s) are set up.

Figure 3-16: FasMotion Window Menu

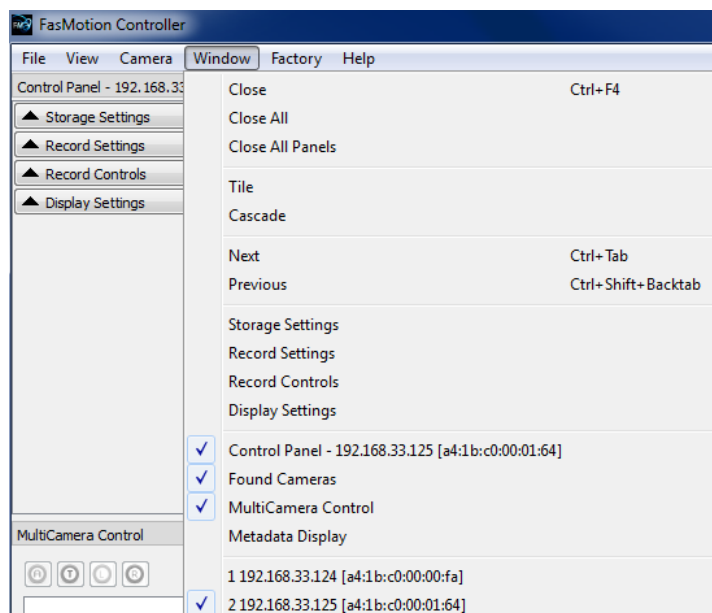
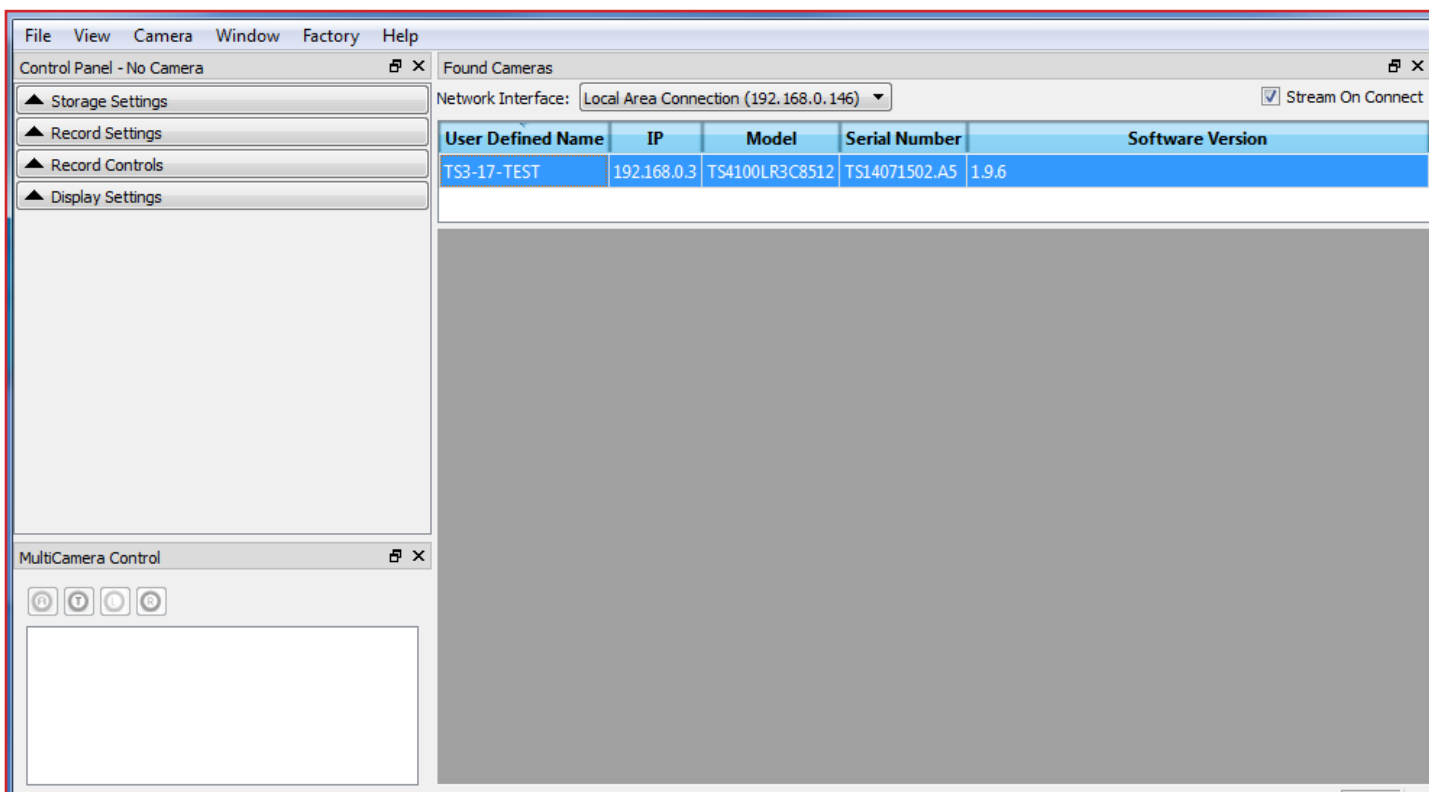


Figure 3-17: FasMotion Application Window



## 3-7 Connecting to Multiple Cameras in FasMotion

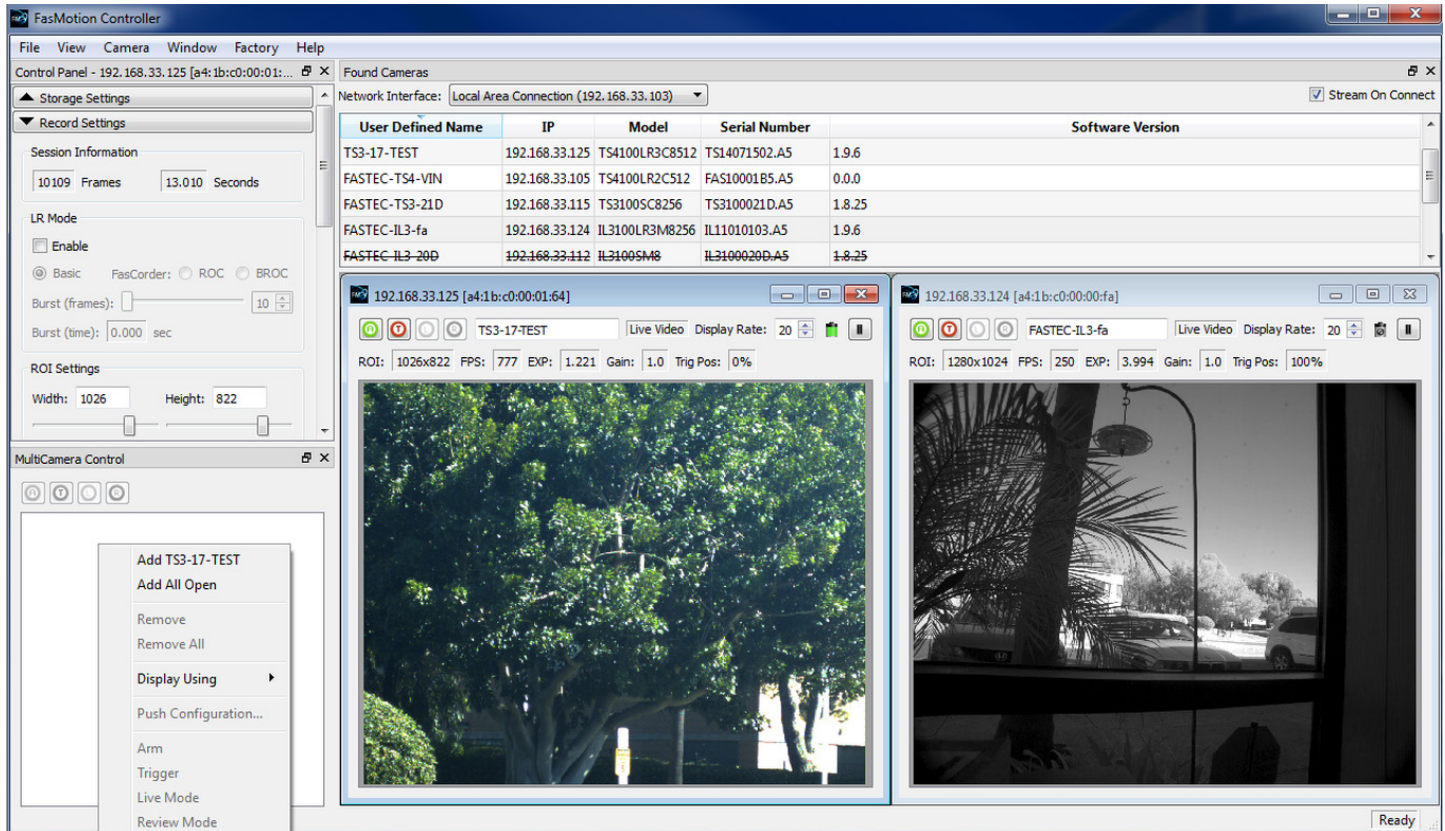
To open multiple cameras in FasMotion, simply double click on each camera you wish to open from the Found Cameras list.

As each camera opens, a camera window will appear within image window. Camera windows will automatically tile themselves to fill the space. Camera windows may be re sized manually by pulling from any of their corners. Use the Tile or Cascade items in the Window menu to automatically re-arrange the windows.

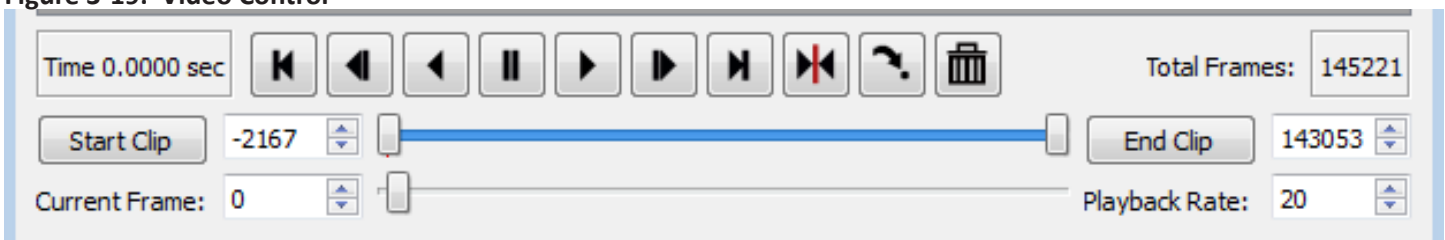
Click on a camera window to select it. When selected, the window border will be a darker shade than the other cameras. See the image window on the left, below. The selected window will always have a faster refresh rate than the others, so live images and video playback will always appear smoother. Camera parameters that are changed via the Control Panel menus pertain only to the selected camera.

Note: As cameras are added in FasMotion, more system memory is required. It is recommended that systems supporting two cameras should have a minimum of 8GB of RAM and that 2GB should be added for each additional camera.

**Figure 3-18: FasMotion with Multiple Camera Views**



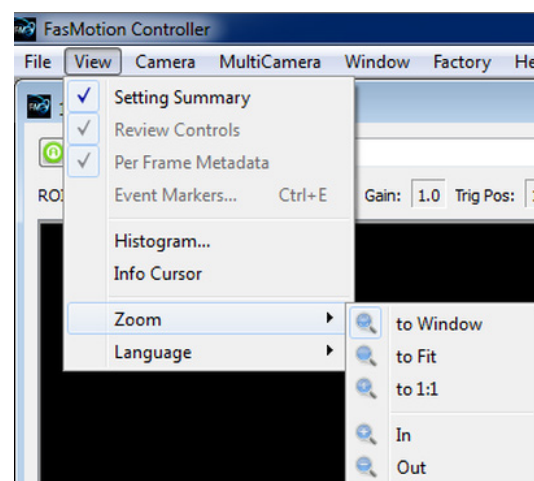
**Figure 3-19: Video Control**



## 3-8 Controlling the Image Displays

Figure 3-20: View Menu

Zoom to Window	The full image is sized to completely fill the image window. The image may be distorted as the aspect ratio is lost.
Zoom to Fit	The image expands proportionally and fills the image window without losing its aspect ratio.
Zoom 1 to 1	The image is represented pixel for pixel on the display. Depending on the display resolution, the image may only fill part of the image window, or the image may be cut off, in which case sliders will appear so that you may access the entire image.
Zoom In	The image is enlarged greater than 1:1 with the first click, then progressively larger with each additional click. When the image exceeds the size of the window, sliders will appear for access.
Zoom Out	If you have Zoomed-In on an image, Zoom-Out allows you to back through the zoom settings down to 1:1.



### Ctrl + Mouse Wheel Zoom Control:

Place the cursor on a point of interest on the image, hold down the Ctrl button, and then turn the mouse wheel. If the image zoom becomes larger than the window, the mouse cursor becomes a “hand” and can be used to reposition the image within the window.

### Setting Default Gamma and JPEG Quality:

**Camera Preferences** is in the Camera menu.

The Default Gamma setting is used to set the default output Gamma for displayed and saved images.

The default Gamma is 1.0 (linear). Many laptop computer displays have a Gamma of 1.0, while most of the larger flat panel LCD monitors have a Gamma of 2.2.

Note that changing the Default Gamma setting does not change the current Gamma of the camera; it sets its reset value. To set the Gamma of the camera to a new default, navigate to the Display Settings tab and select “Reset Light and Color Settings.”

Figure 3-22 on page 20 uses two screen shots of a high-contrast image to demonstrate the difference in appearance between Gamma 1.0 and 2.2. These images were displayed on a monitor with a 2.2 Gamma.

JPEG Quality is set to 80 by default, as a good compromise between quality and image size. For higher-quality Stills, JPEGs, and AVI files, set to 100. For faster live refresh rates (streaming to the display set this lower.

### Auto-playback

The Auto-playback checkbox is also found in the Preferences Dialog.

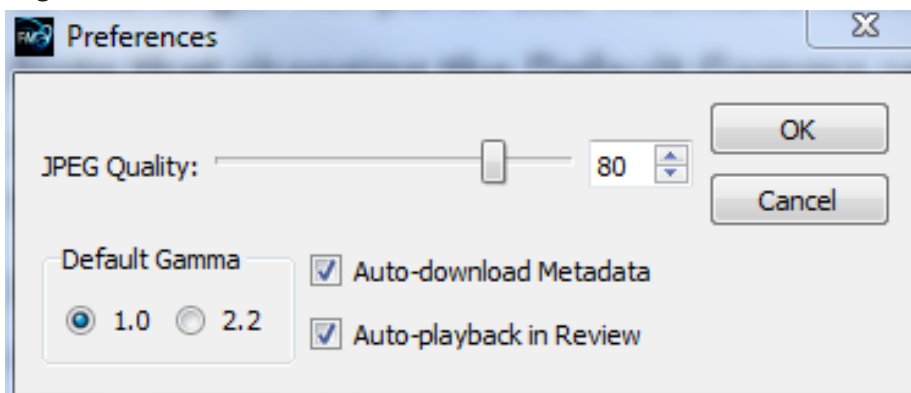
When the Auto-playback box is checked, the camera will playback immediately at whenever a recording is complete in Standard Basic mode. This box becomes unchecked if LR mode is selected on cameras with that option.

### Display Rate for live images:

The display rate for live images in FasMotion may be adjusted using the spinner at the top of the Image Window. (See Figure 3-22 on page 20.) This number will automatically change according to the performance of the network and the PC. The JPEG Quality setting will also affect the display rate as it controls the size of the JPEGs sent via Ethernet to FasMotion.

There is also a pause/play button on the top of the Image Window. This may be used to temporarily start and stop the video stream.

Figure 3-21: Camera Preferences



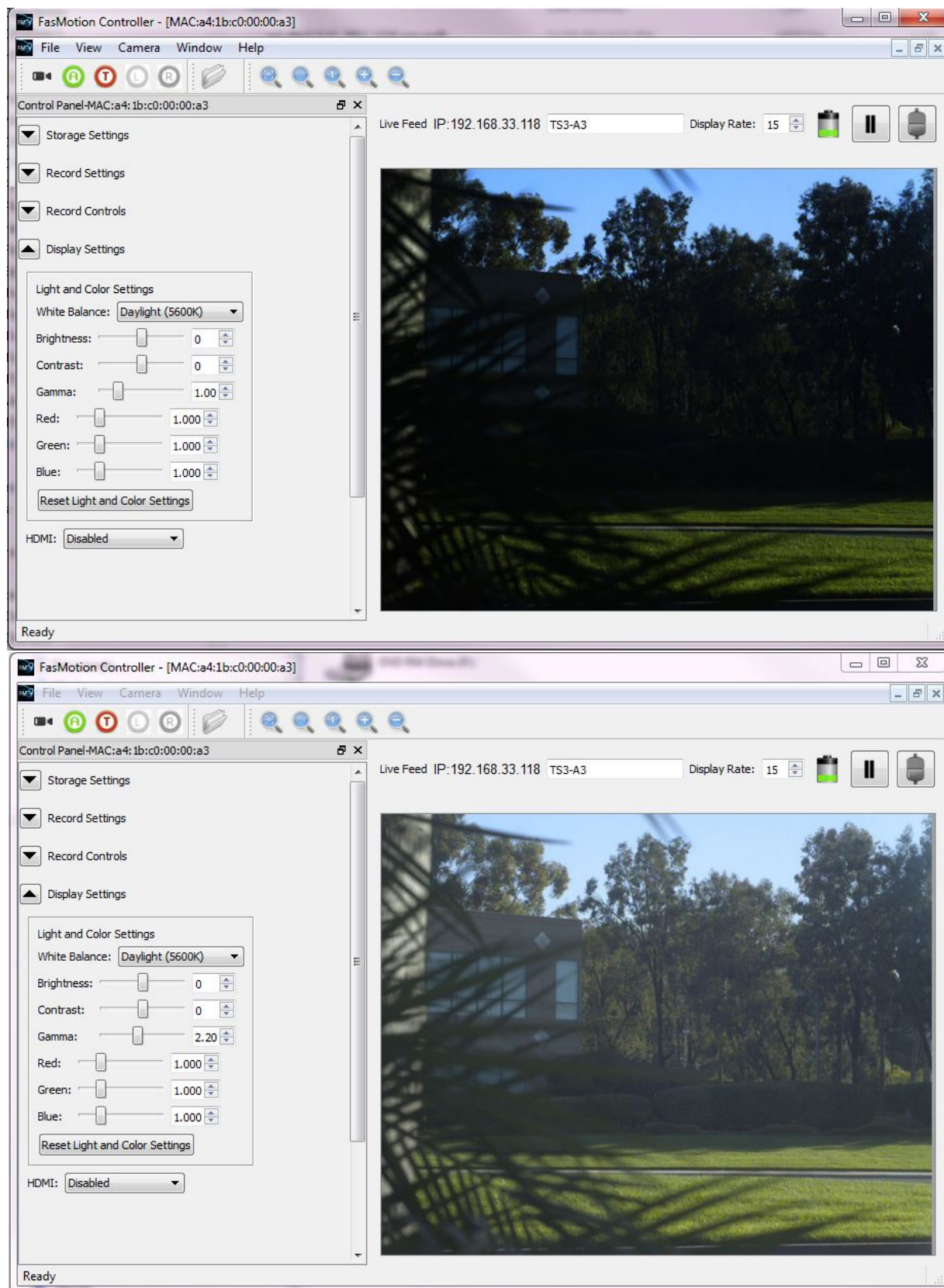


The first image, with Gamma set to 1.0, appears very dark on this display. If the lens is opened or the exposure increased, the dark areas will gain detail, but the brighter areas will saturate.

In the second image, with Gamma set to 2.2 to match the display, the detail in the shadows is evident.

Note: The opposite would happen if the display had a Gamma of 1.0: the first image would have looked good, while the second would have appeared washed out.

**Figure 3-22: Gamma Comparison**



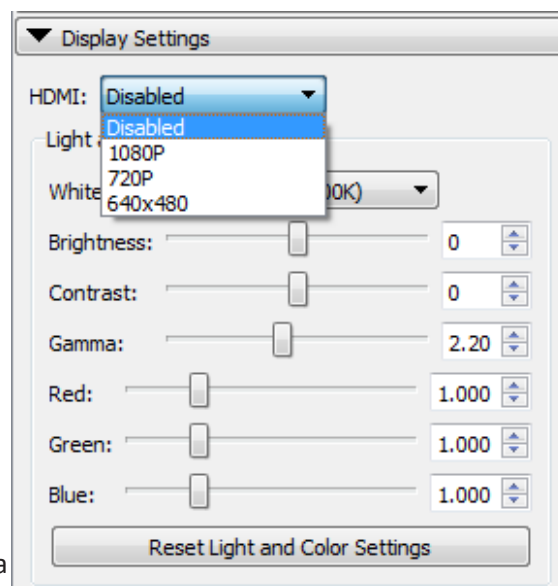
### Setting up the HDMI display:

The ILx has an HDMI output that can be used for displaying both live and recorded images. The HDMI port is located on the side of the camera between the Power and External I/O connectors. See “Figure 1-4: ILx Side Views” on page 5.

To enable the HDMI output click on the HDMI button on the Display Settings Tab and select the resolution you wish to use.

Note: The images from the camera will be scaled to fit the HDMI display screen while maintaining aspect ratio. This means that there may be black borders on the sides or top and bottom of images, depending on aspect ratio and best fit.

Figure 3-23: HDMI Settings



## 3-9 Name the Camera

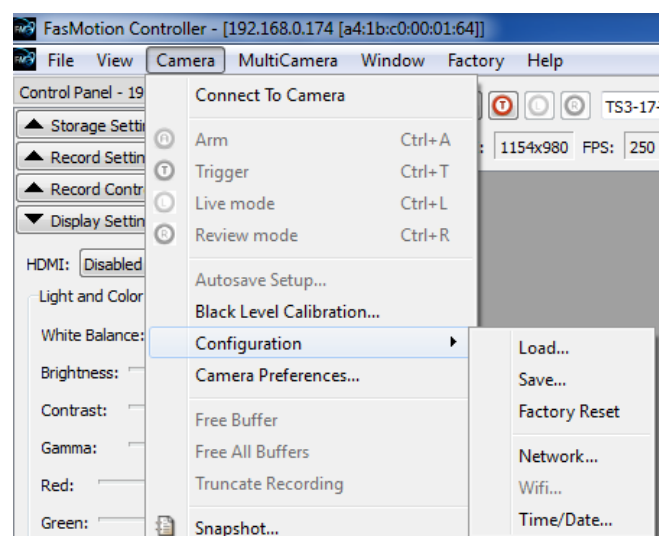
When the ILx leaves the factory its default name is ILx-xx, “xx” being the camera’s serial number. The camera name can be used both for identification on a network and as part of the filename when saving images.

It may be beneficial to rename the camera according to its function, locality, field of view, etc. depending on how the camera is to be deployed.

To change the camera name simply edit the name as it appears in the box above the image window.

There are some limitations in the character set that may be used for the camera name as it must be “legal” both as a filename and network device name. All numbers, and upper- and lower-case numbers may be used. The only punctuation character that may be used is the “-” (not “\_”).

Figure 3-24: Camera Configuration Menu



## 3-10 Camera Time and Date

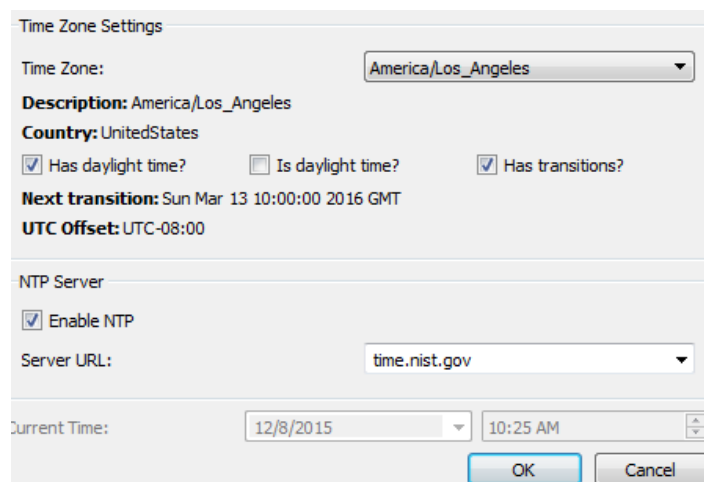
When your ILx is received, the time zone may need to be set to reflect your local time.

Access the Time and Date dialog from the Camera Configuration menu in FasMotion. (The Camera Menu is also available as a context menu, opened with a right-click on the camera window.) The Time Zone pull down menu has an extensive list of cities. If you cannot find a city in the list to reflect your time zone, go to the bottom of the list and select a UTC time offset instead.

If NTP is enabled, the time will be corrected each time the camera boots up when connected to a PC with Internet access.

Note: A rechargeable battery inside the ILx will maintain time while the camera is disconnected from power. If your ILx is not powered up for a few weeks, the time and date may need to be reset.

Figure 3-25: Time and Date Configuration





## 3-11 Connect to the ILx Outside FasMotion

FasMotion software is the primary user interface for the ILx. It is the most flexible and efficient way to use the camera. There may be times, however when you may wish to access the ILx using its built-in Web-Application.

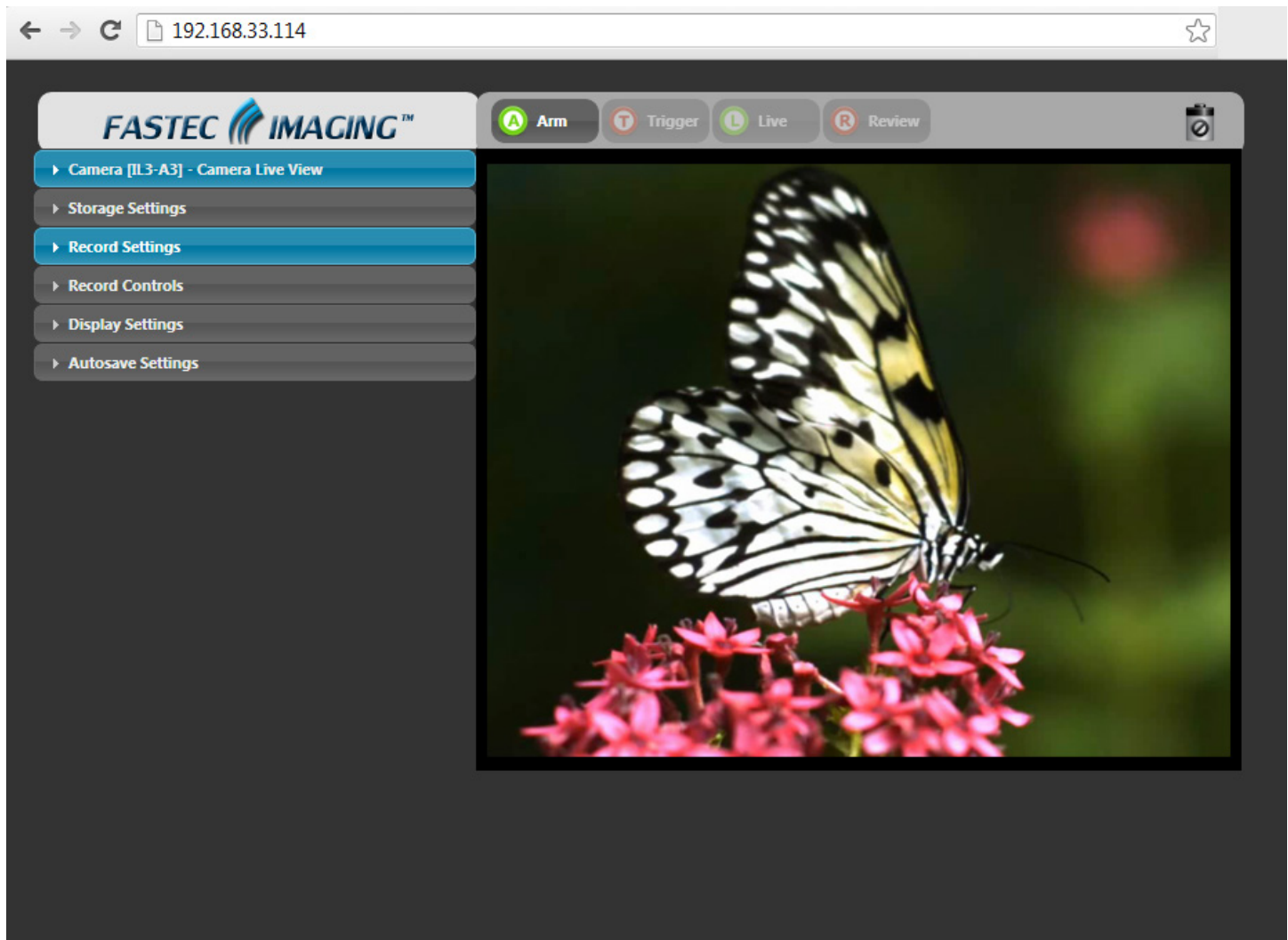
To open the Networked ILx in a Web browser in the **Web-Application**:

The Web-application works with many web browsers, including Google Chrome, Mozilla Firefox, Apple Safari, and Microsoft Internet Explorer. Unlike FasMotion, it does not require a wired Gig-E connection on the host device. It works on most PCs, Smartphones, and tablets:

1. Type the camera's IP address or camera name into the browser's Location bar. For example, using the information from "Figure 3-26: Web-Application" you would type 192.168.33.114 (IP address) or L3-A3 (the camera name) into the browser's Location bar.
2. A camera control application within the camera does the rest. A control menu will appear in your browser that will give a live camera view and complete control over the camera operation. Details on use of the camera's web browser appear in Chapter 6 of this manual.

Note: The Web-Application is useful for setting up and controlling the camera, but it does not have the display performance (refresh rate) of FasMotion and has no utility for saving video or image files on the host device (PC, Tablet, etc.).

Figure 3-26: Web-Application



You may also wish to open the camera in Windows Explorer in order to copy images from one of the cameras drives to your PC or network.

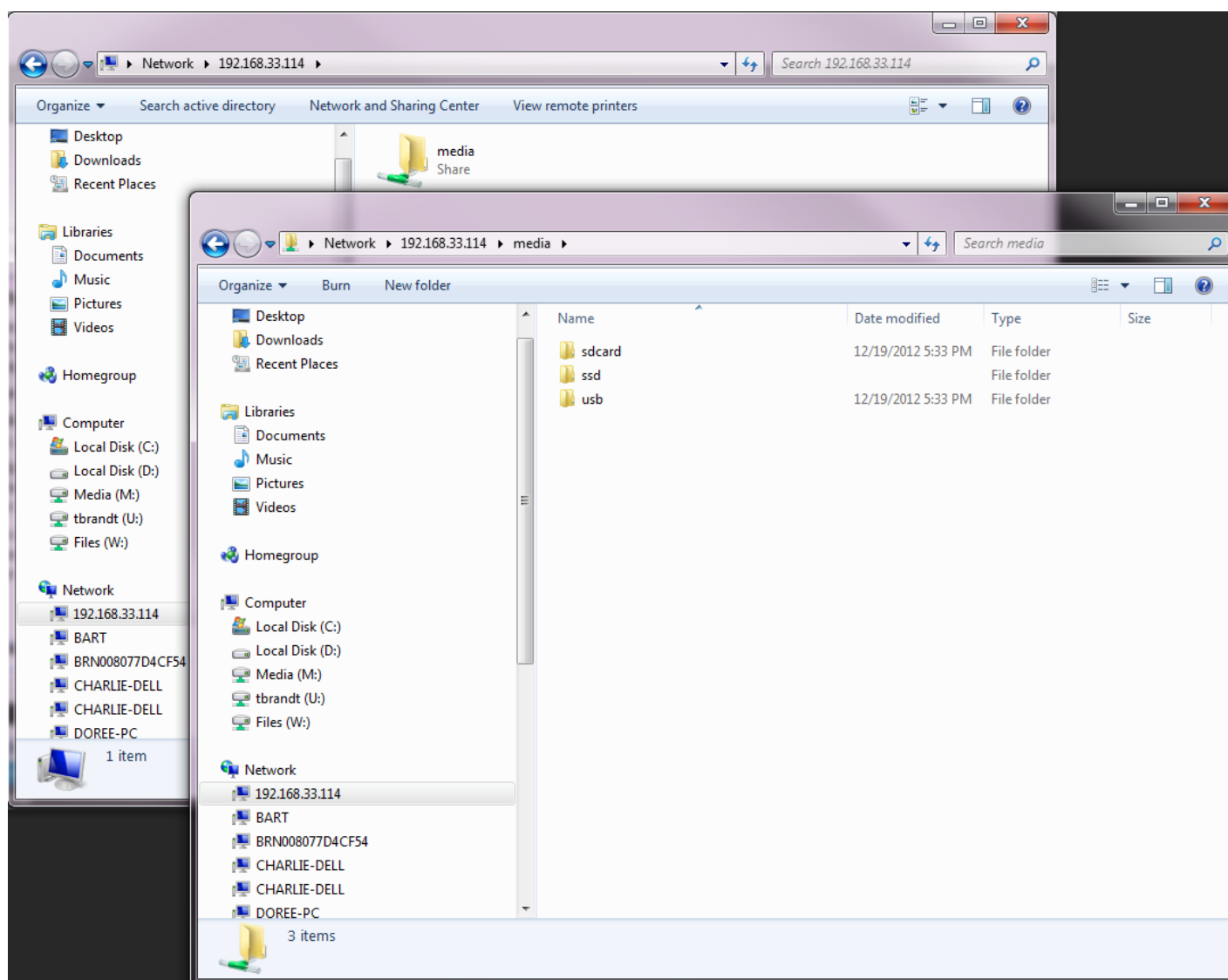
Note: This can be a convenient way to transfer a few files from your camera, but if you wish to transfer large numbers of images or video clips, the Save utility in FasMotion can be many times faster.

**To open the Networked ILx in a Windows Explorer menu:**

Type the camera name or IP address in the Location bar, preceded by \\ . So, using the same information as in the example below, type in either \\192.168.33.114, or \\IL3-A3.

When the camera is viewed in Explorer, you will see the camera name or IP address under Network. Opening that, you will see a directory called “media,” which contains directories for each mass storage device installed on the camera.

**Figure 3-27: Open ILx Media in Windows Explorer**



**USB OTG:**

Another option for connecting to the ILx is via the USB OTG port. Please refer back to “Table 2-3: ILx Mass Storage Functionality” in Chapter 2 for details and a comparison of functionality.

## 3-12 Storage Setup

The FasMotion Storage Settings Tab gives the user access and control of the Camera memory and any installed media, including a Solid State Drive (SSD), SD Card, or USB drive.

The ILx has 4GB, or 8GB of internal high-speed memory used for capturing high-speed imagery (depending on model and option). You can elect to use all of this memory when recording, or a smaller amount. Total record time will depend on resolution, frame rate, and bit depth. For the Dual Mode cameras, the dialog box changes. The Session Recording Capacity slider becomes disabled as it is no longer needed. If SSD is selected, the Explore button is grayed.

### Configure Session (Standard Mode):

Use the Session Recording Capacity slider to select the amount of memory you wish to use to capture video. This slider has a granularity of 250MB.

**Use the Format** utility in the Storage Settings Tab to format any of the camera media. The SSD, SD Card, and USB drives are all accessible for formatting.

### Formatting the SSD:

It is recommended that you format the SSD to delete all recordings and completely clean it off. This should be done often to keep performance as high as possible.

To format the SSD simply select the SSD radio button in the Storage Settings dialog and click on "Format."

When formatting the SSD, you may be given an option of Sanitizing the drive. Sanitization is a low-level process that securely erases all data and renews the SSD for optimal performance.

### Formatting SD Cards and USB drives:

Formatting SD Cards and USB drives is the easiest and most effective way of deleting all recordings. When formatting SD Cards and USB drives, FasMotion will give the option of "Performance" or "Compatibility."

The Compatibility format is FAT32, which is recognized by most computers. The Performance format is EXT2, which is a Linux format and may require a 3rd-party driver or application (such as DiskInternals Linux Reader) on your Mac or PC. EXT2 will improve

file Save times to the SD Card and USB. The improvement is only about 10% for very large images such as full-resolution TIFF and BMP images. The greatest improvement (as much as 6x) is seen when saving large numbers of very small files, such as saving thousands of low-resolution JPEGs.

### Exploring Camera Media:

Open the FasMotion Camera Explore dialog by selecting the radio button for the SD Card, SSD, or USB and clicking on the Explore button.

Figure 3-28: FasMotion Storage Settings Tab

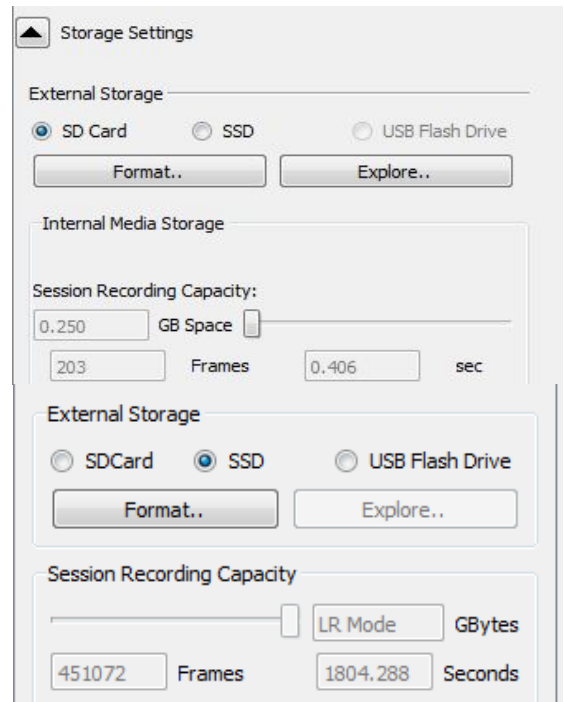
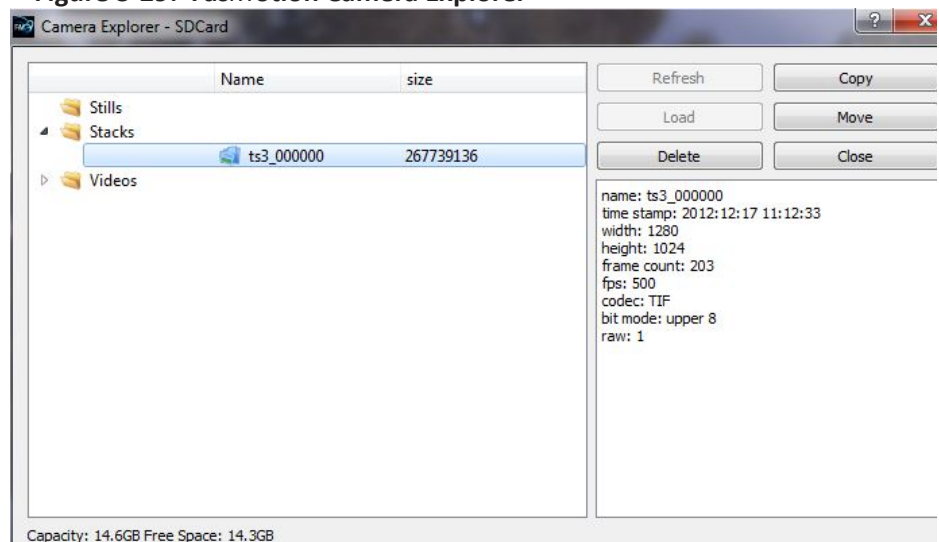


Figure 3-29: FasMotion Camera Explorer



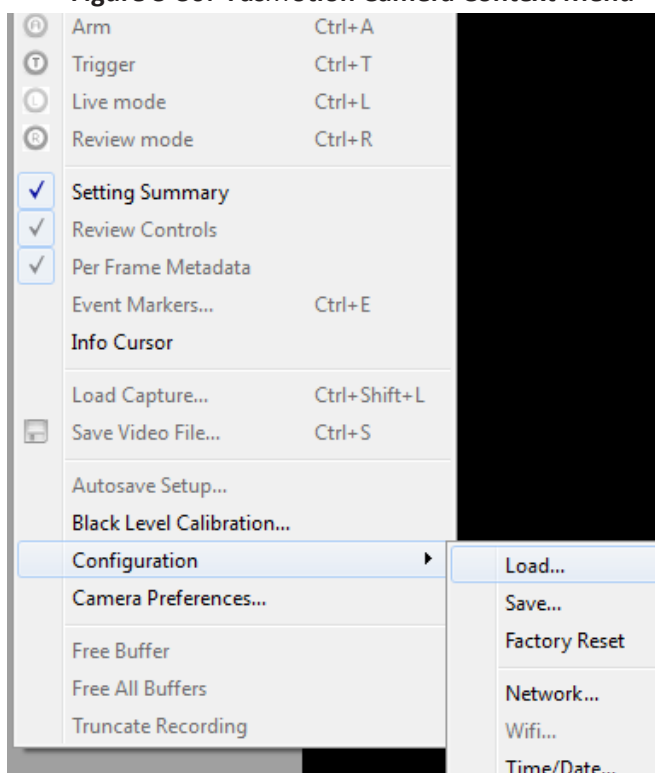
Navigate to the Still, Stack or Video of interest.

You will notice that the information about the clip or still will be displayed, including the time stamp, resolution, frame count, frame rate, and file format.

Any selected still or clip may be copied, moved or deleted From SD Card or USB device, or copied from the SSD (deletions from the SSD are only done via formatting). See “4-18 Saving Images to Mass Storage”

CAP files, which are proprietary Fastec raw image files, can be Loaded back into the camera. When Cap files are loaded back into the camera, the camera may be operated in Review mode, just as when the imagery was originally taken. This will allow you to Save it in any format and to any camera or PC media. See “Appendix N: Partition Capture (CAP) File Format” on page 126.

**Figure 3-30: Fas/Motion Camera Context Menu**



## 3-13 Configurations

ILx Configurations, which include all camera settings (resolution, frame rate, session length, exposure, etc.), can be Saved, Reloaded, or Reset to factory defaults.

### To Save the Current Configuration:

Click on Save... in the Camera Configuration Menu. Camera Configuration may be opened from the Camera Menu (see Figure 3-24 on page 21) or the Camera Context Menu (Figure 3-30), which opens with a right-click to the camera window. This will open an Explore window that allows you to browse to a location where you may save the current configuration.

### To Load a Saved Configuration:

Click on Load... in the Camera Menu. This will open an Explore window, which will allow you to navigate to the folder where you saved .cfg files and select the Configuration you would like to load.

### Loading a Common Configuration to Several Cameras:

Note: Only load common configurations to cameras of the same model!

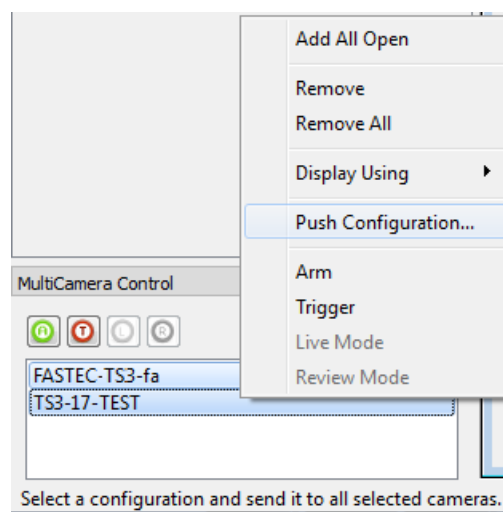
Select the target cameras in the MultiCamera Control window. Right-click to open the MultiCamera Context Menu and select Push Configuration... This will open an Explore window allowing you to browse and select the Configuration you wish to load onto the selected cameras.

### To Load the Factory Configuration:

Click on Factory Config in the Configuration Menu. This will load the factory default settings for the camera.

Note: This is not a routine operation as it rewrites your camera configuration. Always power cycle the camera after loading Factory Configs.

**Figure 3-31: Push Configurations**



## 3-14 Reboot and Power Down

The camera may be Powered Down or Rebooted from the Camera Menu.

If you power the camera down it will turn off completely. To turn it back on, you will need to re-apply power by removing and restoring the power connector, or by pressing the power button on the back of the camera. (See “Figure 1-1: ILx Back View” on page 3.)

If you Reboot the camera, it will do a “warm boot.” That is, it will disconnect from FasMotion, clear its memory, and restart its Operating System. Some of the electronics and logic will not be reset during a warm boot.

Note: Both Power Down and Reboot will erase any imagery in the camera’s High-Speed internal memory, but it will not disturb any image data already saved to SSD, SD Card, or USB drives.

After a Reboot or Power Down, you will need to re-connect the camera to FasMotion by returning to the “Find Cameras” dialog and scanning for the camera after it boots up. See “3-3 Connect the ILx to a Wired Network” on page 14.

## 3-15 Camera Information

Camera information is located in the “Found Cameras” window.

The information shown is selectable via the Add Column Dialog box, which is available through the Found Cameras Context Menu. To select and organize the information on the Found Cameras window:

1. Right-click on the Found Cameras window to open the context menu.
2. Select Add Column
3. From the Add Column Dialog, you may Add or Remove information items, including:
  - Camera Name
  - Model
  - Serial Number
  - Software Version
  - IP address
  - Subnet Mask
  - Default Gateway
  - MAC
  - Vendor
  - Manufacture Info
  - Protocol Version
  - Bootloader Version
  - FPGA Version
  - Sensor Version
4. Use the Move Up and Move Down buttons to change the order that the information will appear.

Figure 3-32: Found Cameras Context Menu

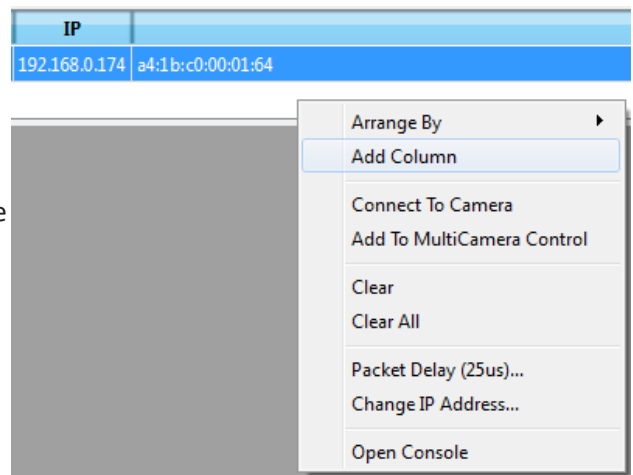
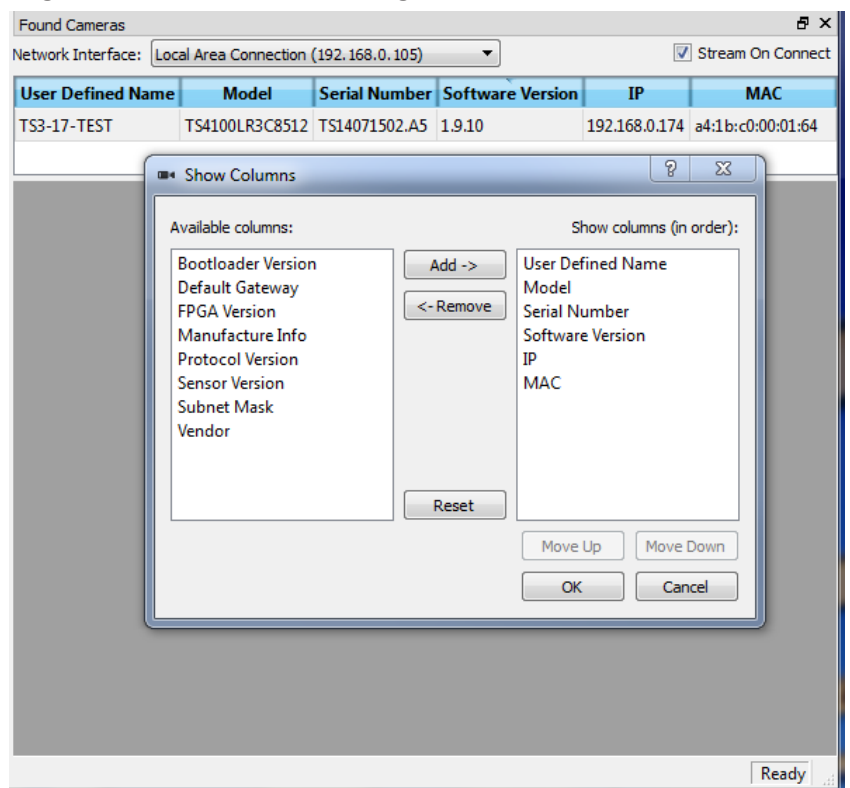


Figure 3-33: Add Column Dialog





## 3-16 Solving Setup Issues

### If the camera is not present in the Found Cameras window:

Any ILx camera connected via Gigabit Ethernet should appear on the FasMotion Found Cameras window as long as:

1. The physical connection is sound (good CAT 5e or CAT 6 cable, etc.).
2. The camera's IP address is on the same subnet as the computer.

It is best to check #1, the physical connection, first.

- Make sure that the cable is marked CAT 5e or CAT 6.
- Connect the computer to another network device with the same cable and confirm that it can connect.
- Connect the camera to the computer via the GigE cable and confirm that the green LED on the camera's Ethernet connector lights in a three-blink pattern. (Three blinks indicate a GigE connection; two indicate 100BaseT.)

The simplest way to ensure #2, above, is to use a direct connection between the camera and computer (no switches or routers between camera and computer).

- If the camera's network configuration is set for DHCP, which is the default setting, Make sure the computer is set to DHCP: the TCP/IPv4 properties of the network adapter are set to obtain an IP address automatically.
- If the camera's network configuration is set to a Static IP address, make sure that the computer is set to a Static IP address on the same subnet.
- If the camera's network configuration is set to a Static IP address, but you do not know what that address is, refer to "3-4 Managing ILx Network Settings in FasMotion" on page 15.

### If you can connect to the camera in FasMotion, but do not get a Live image:

In most cases, all of the control and setup features work in FasMotion, but you cannot get a live image or transfer images to the computer. There are two common causes:

1. WiFi is enabled on the computer.
2. The firewall is not allowing FasMotion to use UDP, which is the protocol for both live view and file transfers.

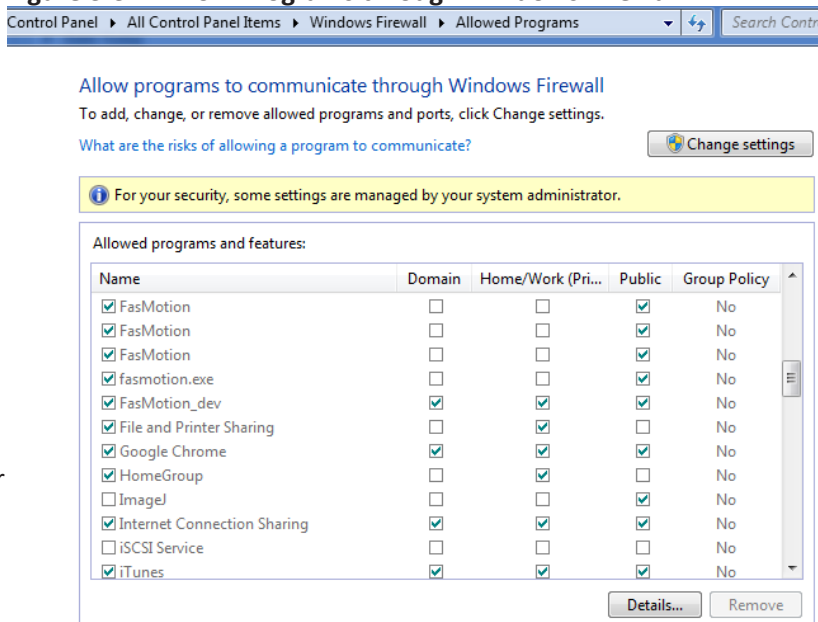
The first thing to do is always to make sure that the GigE interface that the camera is connected to is the only network interfaced active--disable the WiFi adapter and any other NICs present.

Check to see that all instances of FasMotion are allowed through the Windows firewall.

Note that the example shown here is from a Fastec test computer that has had many versions of FasMotion on it. Your computer is not likely to have this many, but there may be more than one.

**If image transfers from camera to computer are slow or fail,** please refer to "Application Note 5: Optimizing System for Image Transfers" on page 86 and make sure your system meets the requirements and is set up properly.

**Figure 3-34: Allow Programs through Windows Firewall**





## 4 Recording with the IL3 / IL4 / IL5

### 4-1 Long Record and Standard Modes in FasMotion

Cameras with the Dual Mode option may be operated in either Standard mode or Long Record mode.

#### Switching from Standard mode to Long Record Mode in FasMotion:

1. With the camera in Live, open the Record Settings tab.
2. Click on the LR Enable check box to place a check mark there.

A Mode Change message box will appear with the warning that Long Recording mode will overwrite data on the SSD.

Note: The format on the SSD will be overwritten as soon as it is accessed for streaming in LR mode. At that time any imagery on the SSD taken in Standard mode will be lost.

3. Click OK to continue. The camera will reboot in Long Recording Mode.

#### Switching Back to Standard Mode:

1. With the camera in Live, open the Record Settings tab.
2. Click on the LR Enable check box to remove the check mark there.

The Mode Change dialog will appear again, but this time the text informs you that you will need to format the SSD before you will be able to write to it in Standard Mode.

3. Click OK to continue. The camera will reboot in Standard Basic mode.

NOTE: Formatting the SSD while in LR mode only formats the drive for Long Record. To use the SSD in Standard Mode, the camera must first reboot out of LR mode before formatting.

Figure 4-1: Record Settings: LR Enabled

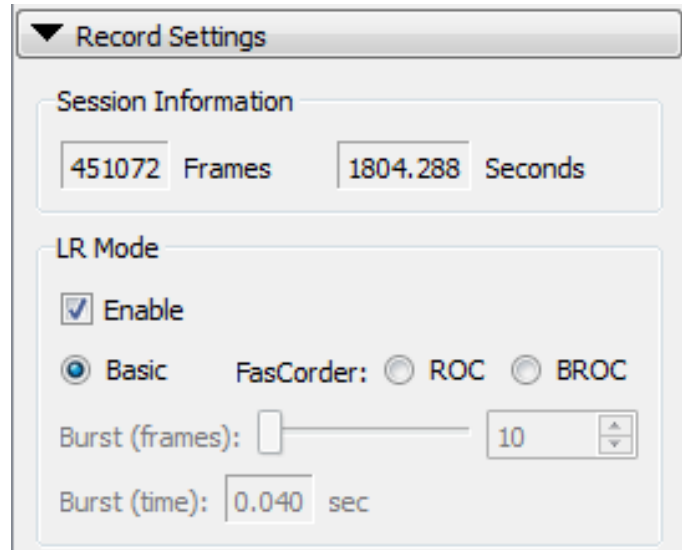


Figure 4-2: User Preferences Dialog

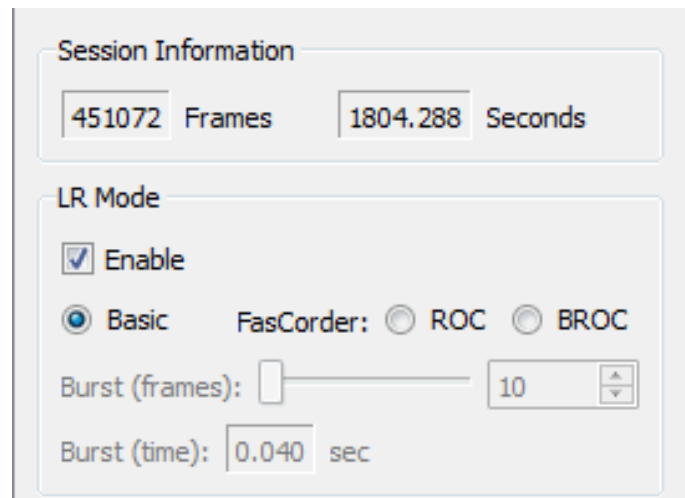
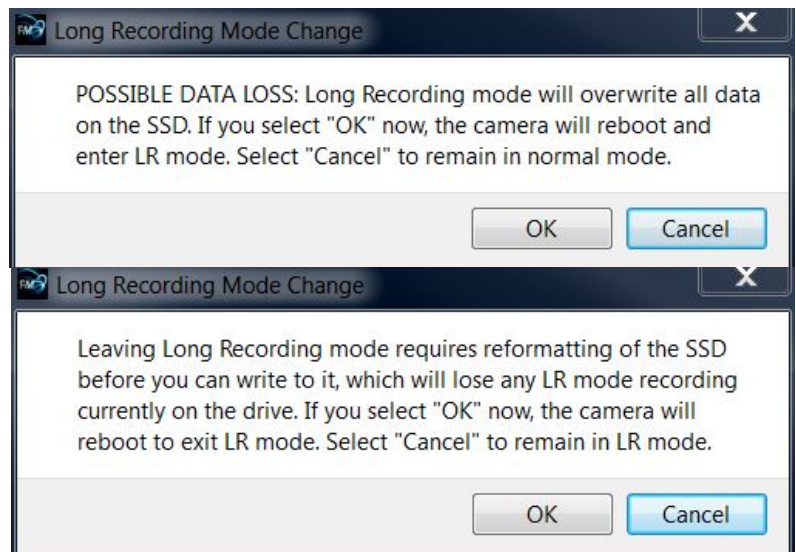


Figure 4-3: Mode Change Messages



## 4-2 Setting Frame Rate and Resolution

### Record Settings are interactive:

- The Resolution you choose will define the maximum Frame Rate and number of frames that can be captured.
- The Frame Rate will define maximum Shutter Speed (exposure time in  $\mu\text{sec}$ ).
- The Frame Rate and number of Frames captured define the duration of the recording (time in seconds).
- If you select Autoset in either Frame Rate or Resolution, that parameter will be selected automatically to its maximum allowable value, dependent on the other current settings

### To set the Resolution of the ILx:

1. Select the Aspect Ratio you wish to use: choices are Custom, 5:4, 4:3, and 16:9.
2. Adjust the image Width (in pixels) you wish to use. This can be done either by editing the number in the Width edit box, or by moving the slider.

Resolutions can be refined to any even-numbered pair from minimum to maximum resolution, depending on camera model. Please refer to "Appendix D: IL3 / IL4 Record / Resolution Tables" on page 101 for details.

Whenever any slider has focus, it turns blue. It may be then controlled by dragging it with the mouse or using the keyboard arrow keys. Often the best way to do this is by dragging it with the mouse until it is close to the value you want, then using the arrow keys to "zero in" on the exact value.

### To set the Frame Rate of the ILx:

Either edit the number in the Frame Rate edit box, or move the Frame Rate slider to the desired position using the mouse and arrow keys.

### Offset Control:

Most of the time, to make use of the best resolving properties of your lens, you will want to center the image at the optical center, which corresponds to the center of the sensor. In this case you would make sure that the "Center" check box is checked.

It is also possible, that you will wish to shift your ROI (Region of Interest) without moving the camera.

Let's say, for example, that you have captured images at 1024 x 1024 @ 500fps and are now interested in capturing a 512 x 512 portion of the scene, let's say the bottom right hand quarter @ 2000fps.

In this case, you would wish to add 512 to both the X and Y offset. For a 1024 x 1024 centered image the offsets will be 128 and 0. The resultant offsets for a 512 x 512 image (lower right quadrant) would be 640 and 512.

Figure 4-4: Record Settings Tab

**Record Settings**

**Session Information**

6517 Frames 13.034 Seconds

**LR Mode**

☐ Enable

☒ Basic FasCorder: ☐ ROC ☐ BROC

Burst (frames): 10

Burst (time): 0.040 sec

**ROI Settings**

Width: 1280 Height: 1024

Frame Aspect Ratio: 5 x 4

☐ Autoset ☐ Center

Offset X: 0 Offset Y: 0

**Frame Time**

☐ Autoset

Frame Rate (FPS) Time: 2 mSec

500

Record Time: 00 : 00 : 13 . 034

**Shutter Settings (uSec)**

Shutter Speed: 1994

358.9°

☐ Low Light 7994

**Advanced Settings**

Bit Depth Upper 8 Bits

FPN Pixel

## 4-3 Setting Shutter Speed

The Shutter Speed is expressed in microseconds of exposure time.

### Minimum Exposure:

Minimum exposure is 2μsec for all IL3 / IL4 models, 3μsec for all IL5 models (regardless of frame rate).

### Maximum Exposure:

**Table 4-1: Maximum Exposure by Model**

IL3 and IL4	IL5
1/(Frame rate) - 6μs Example: At 500 fps the max exposure is: (1/500sec) - 6μs = 2000μsec - 6μsec = 1994μsec	1/(Frame rate) - 12μs Example: At 500 fps the max exposure is: (1/500sec) - 12μs = 2000μsec - 12μsec = 1988μsec

For those accustomed to using shutter angle, to convert that to degrees:

$$(\text{Exposure (in } \mu\text{sec)} / \text{Frame Time}) \times 360^\circ$$

For example, at 500fps, an exposure time of 250μsec is:

$$(250\mu\text{sec} / 1/500 \text{ sec}) \times 360^\circ = (250 / 2000) \times 360^\circ = 45^\circ$$

### Setting the Shutter Speed:

Shutter Speed is set using the slider or edit box in the “Shutter Settings” section of the Record Settings Tab. (See “Figure 4-5: Shutter Settings”.)

### Low Light Mode:

In some special circumstances, the light available for setting up the ILx for a high-speed event is not as bright as what will be used for event itself. You may, for example be using some lights that can only be switched on for a short time and are not available for camera set up.

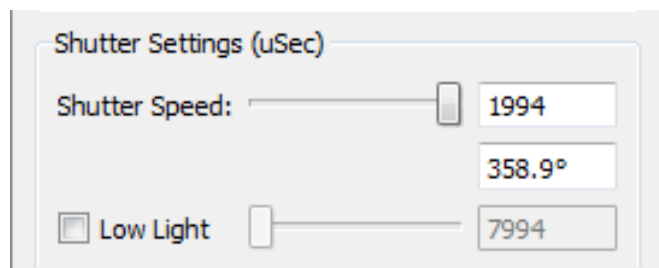
The exposure for Low Light Mode is much longer than would be possible for a high frame rate. The default shutter speed for Low Light mode is 41.666ms, which is the “1X” shutter speed for 24fps. The shutter speed for Low Light may be adjusted via FasMotion by checking the Low Light box and moving the slider or editing the Low Light edit box.

To enter Low Light Mode:

Note: Be careful when using the Low Light feature! **It is very easy to forget that it is on!** Remember to set your exposure for the light that will be present during the image capture.

1. Set the Shutter Speed just as you need it for the high speed event.
2. Click on the Low Light check box. A check mark will appear in the box. The edit box and the slider will become active.
3. Adjust the slider or edit the box for the desired exposure.
4. Press the Arm Button.

**Figure 4-5: Shutter Settings**



The camera will begin recording. You will notice that the image is darker now than in Live Mode.

5. Press Arm again to quit recording. (Click “OK” on the Warning message to Cancel.)

## 4-4 Enabling Auto-Exposure Tracking

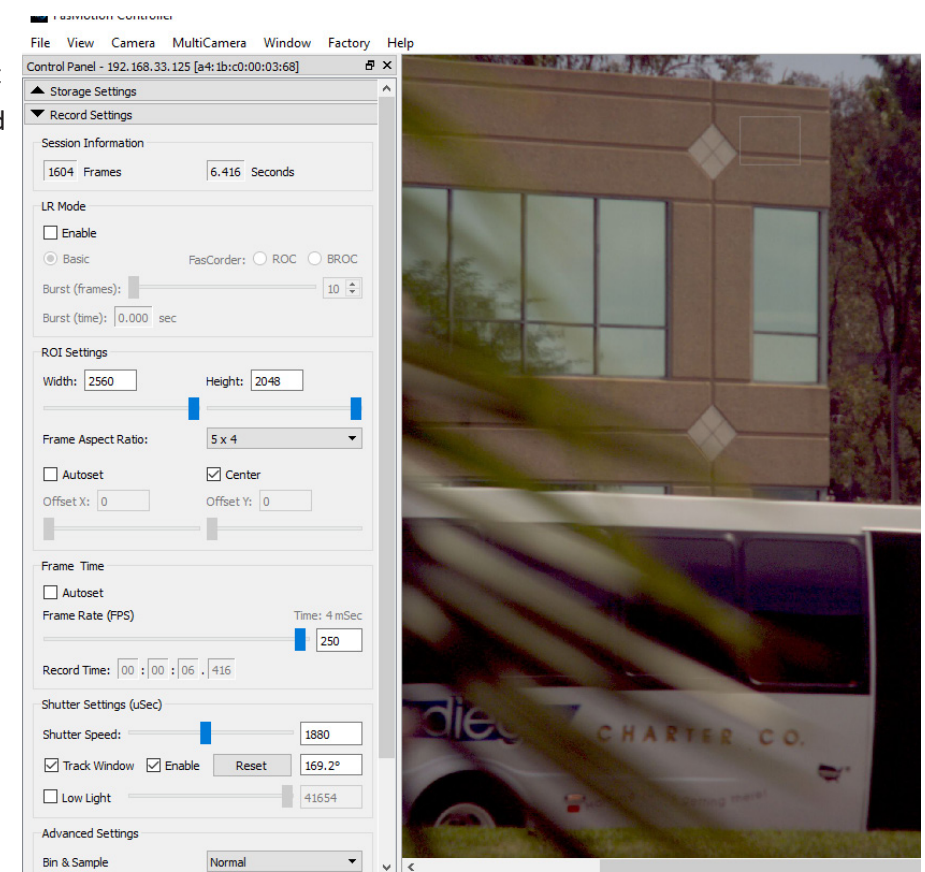
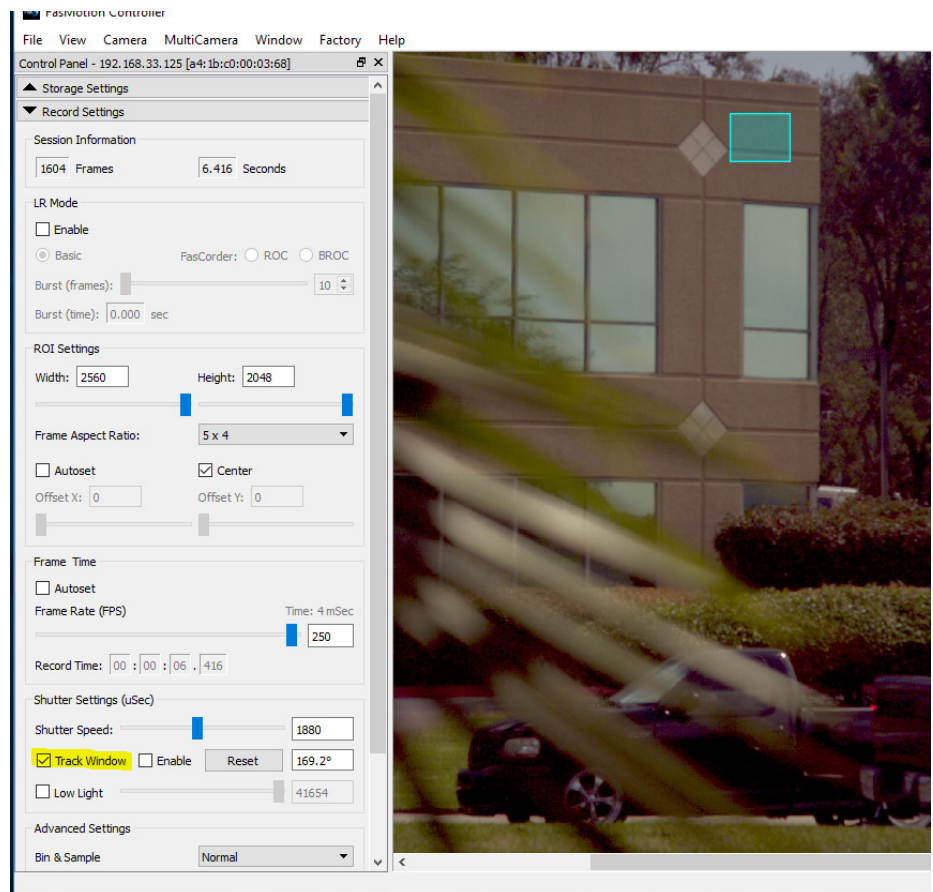
The auto-exposure feature is designed to adjust the shutter setting of a camera to accommodate changes in available light such as changes in sunlight due to moving clouds.

It is not meant to track immediate changes such as flickering light sources, or explosive events.

1. Set your shutter speed to get the best exposure for the present lighting conditions. It is best if the shutter speed is not too close to either the maximum or minimum for the current frame.
2. Click the Track Window check box to begin using the auto-exposure function. A green track window will appear on the image.
3. Move and/or re size the track window to so that it covers an appropriate area of the image. Choose this area carefully:
  - It should be illuminated similarly to the area of interest
  - It should not become obscured by other moving objects
4. Click the Enable check box to begin tracking. The tracking window will now become a thin white border.

Click the Reset button to begin over. This will re-locate and re-size the tracking window and turn it green again, making it easier to locate.

Figure 4-6: Exposure Tracking Window





## 4-5 Setting Bit Depth

The IL3 and IL4 records and saves 8-bit or 10-bit data, while the IL5 records and saves 8- 10- or 12-bit data. The advantage of recording higher bit depths is that it gives more flexibility in post-processing the imagery. The disadvantage is that it takes more memory to record or save 10- or 12-bit data.

When saving 10- or 12-bit data (to a mass storage device) in TIFF (RAW) format, the actual file type is a 16- bit file, so it is substantially larger than an 8-bit mono file. The 10-bit (RAW) color image however is not colorized--it is a RAW Bayer image (not "colorized," which would make it about 3x as large), so it is about 2/3 the size of the 24-bit color file (8 bits per each of 3 color channels).

To choose the recording bit depth:

1. Navigate to the Record Menu.
2. Select Bit Depth. For IL3 / IL4, the choices are: 10-bit, Upper 8 bits, Middle 8 bits, or Lower 8 bits. For the IL5, there are more choices, listed on Table 4-2.
3. Select the desired bits. Note that selection of high bits (default) always presents the cleanest image, while selecting lower bits presents brighter images with added noise. "Application Note 2: Understanding Bit Depth" on page 79.

Table 4-2: IL5 Bit Selection

	Bit:	12	11	10	9	8	7	6	5	4	3	2	1
Selection	10 Bits	x	x	x	x	x	x	x	x	x	x		
	Upper 8 Bits	x	x	x	x	x	x	x	x				
	Middle 8 Bits			x	x	x	x	x	x	x	x		
	Lower 8 Bits					x	x	x	x	x	x	x	x
	12 Bits [12:1]	x	x	x	x	x	x	x	x	x	x	x	x
	10 Bits [12:3]	x	x	x	x	x	x	x	x	x	x		
	8 Bits [12:5]	x	x	x	x	x	x	x	x				
	10 Bits [11:2]		x	x	x	x	x	x	x	x	x	x	
	8 Bits [11:4]		x	x	x	x	x	x	x	x			
	10 Bits [10:1]			x	x	x	x	x	x	x	x	x	x
	8 Bits [10:3]			x	x	x	x	x	x	x	x		
	8 Bits [9:2]				x	x	x	x	x	x	x	x	
	8 Bits [8:1]					x	x	x	x	x	x	x	x

## 4-6 Configuring the Trigger

The ILx records into a fixed, selectable circular buffer, the length of which is determined by the user (see "3-12 Storage Setup" on page 24). This section explains how to set the trigger position within the buffer. See "Application Note 3: Trigger Position and the Circular Buffer" on page 81.

To Set the **Trigger Position** in the ILx:

1. Open the Record Controls Tab.
2. Select either the "Use Percent" or "Use Frames" radio button. The slider and edit box represent the session buffer, which is the camera memory you will be recording into. The trigger position, expressed either in % or frames.
3. Set the position by moving the slider or typing into the edit box or using the spinner buttons.

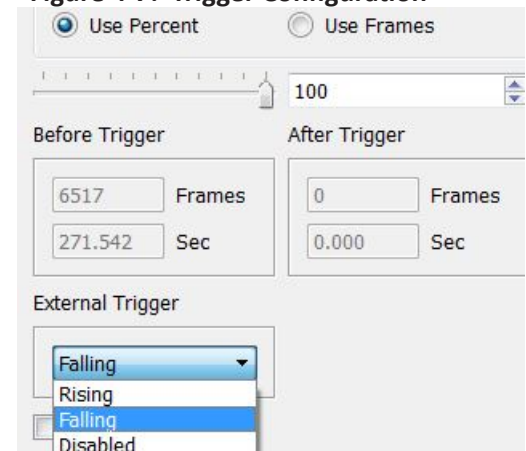
### Enabling the External Trigger

For greater precision, you may activate the trigger electrically.

1. Open the Record Settings Tab.
2. Click on the pull-down in the External Trigger box to expose the choices, which are: Rising, Falling, or Disabled.
3. Choose "Rising" for rising signals or a switch opening and "Falling" for a falling signal or switch closure.

Please refer to "Appendix F: Power and I/O Connections" on page 114 for connection information and warnings.

Figure 4-7: Trigger Configuration



## 4-7 Trigger, Sync and Arm I/O

The I/O portion of the Record Controls tab includes dialogs for each of the I/O signals supported by the ILx. Each of these may be used in either of two ways:

1. As a control I/O signal for the camera.
2. As an input for an external signal for creating Markers. (See “Jumping to Markers” on page 45.)

Note the ILx ships with a three-signal cable that supports Trigger In, Sync In, and Sync Out. A six-signal cable (PN: 1105-0405) is available that supports the Trigger Out, Arm In, and Arm Out signals as well.

Trigger In was covered in the last section. The remaining five I/O dialogs are controlled by a series of tabs. (See Figure 4-8.) Clicking on each tab opens the associated dialog. When enabled, a green circle will appear on the tab. In the figure, External Trigger, Trigger Out, and Sync Out are all enabled.

### Trigger Out

The trigger out dialog includes the options “Pass Thru” and “Invert Signal.” If either of these is selected, Trigger Out will follow whatever the Trigger In signal is, either in its original, or its inverted form. If neither of these is selected, then you may select either “Active Low” or “Active High” and a Pulse Width for the signal.

### Enable Sync In / Sync Out

Sync In and Sync Out functions are used to synchronize the frame timing of a camera with another device or clock. These may include other cameras, strobe lighting, machinery, etc.

Sync In and Sync Out controls are somewhat interactive:

- When Sync In “Per Frame” is enabled, the Master Frame Rate and Rate divisor edit boxes are enabled, allowing you to set the frame rate lower than the Sync input. (Set Rate Divisor to 2 if you want 1/2 the master rate, etc.)
- When Sync In “Per Sec” is enabled, the Delay edit box is enabled, allowing a shift in integration timing from 0 to 1000µsec to fine-tune the phase relationship between cameras and other devices.
- When Sync Out “Per Frame” is enabled, the Shutter and Duty Cycle controls become active. Selecting “Shutter” makes the Sync Out pulse follow the shutter timing. Selecting “Duty Cycle” allows you to select the % of time the Sync Out pulse is “True.” (This may be used in conjunction with polarity choices to establish the phase relationship between devices.)

For timing diagrams and a more detailed description of how these signals may be used for camera synchronization, please refer to “5 Synchronizing Cameras” on page 60.

Figure 4-8: I/O Dialog in Record Controls

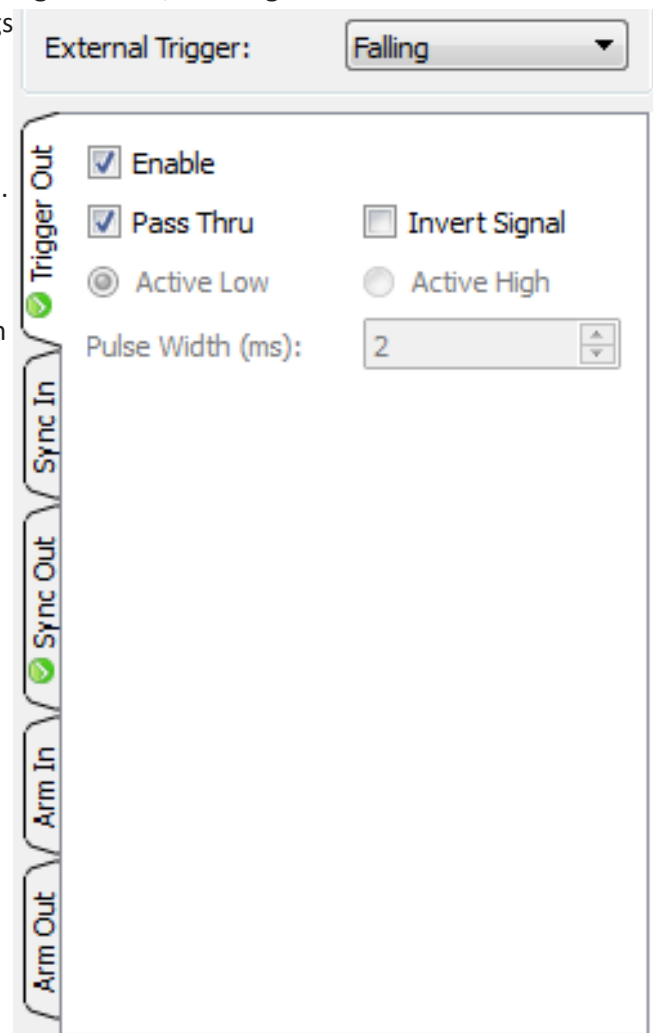
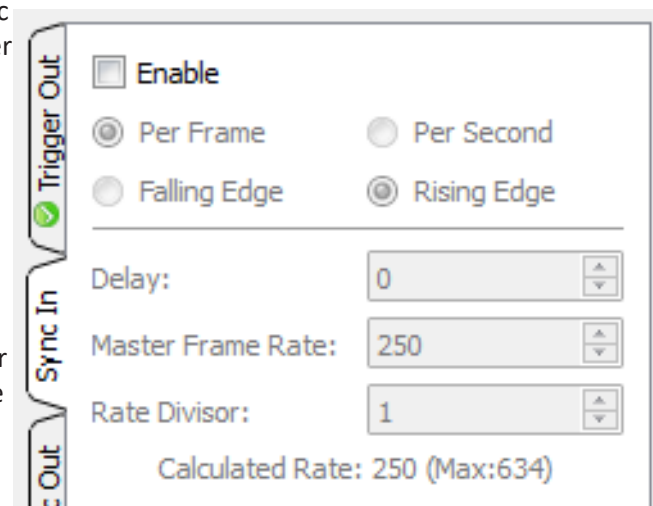


Figure 4-9: Sync In Tab Dialog





## Enable Arm In / Arm Out

The ILx may be Armed using the Fas/Motion Arm button (see “4-9 Record: Arm and Trigger” on page 35), or using an “Arm In” signal via the camera’s I/O cable.

In the Case of Arm In, the signal may be either an “Edge” or a “Level.”

If Edge is selected, the camera will Arm and begin recording as soon as it sees an edge. Whether this happens on a High to Low transition (Active Low) or a Low to High transition (Active High) is selectable. Once Armed, the camera will not change its recording state as a result of any activity on this input until the present recording ends.

If Level is selected, the camera will only remain in an “Armed” state while Arm In is held low: The camera will begin recording as soon as the Arm In goes Low. If the signal goes away before the camera receives a trigger, the camera will disarm and nothing will have been saved. If the signal goes low again, the camera will Arm and begin recording.

Note the “Discard Unsaved Images” box. If this is checked and the camera has images in its buffer (in Review) when the camera receives an Arm In signal, they will be discarded without any additional user intervention. If this box is not checked, the I/O signal would be ignored if the camera has images in the buffer.

The Arm Out signal is used to pass the Arm signal to another camera or device, or to light an external LED to inform a user that the camera is Armed.

The Arm Out Signal can either follow the armed/unarmed state of the camera, or be a Pass Thru signal from “Arm In.”

Figure 4-10: Sync Out Tab Dialog

Figure 4-11: Arm In Tab Dialog

Figure 4-12: Arm Out Tab Dialog

## 4-8 Black Level Calibration

Black level calibration does two things:

1. It sets the black level of the camera to ensure that, in the absence of all light, there is no offset or clipping (the “blackest” pixel will have a value of 0).
2. Dark frame data is saved for correcting Fixed Pattern Noise (FPN).

### Calibrate Black Level:

To be assured that you are getting the best possible images, perform a calibration:

- When you first boot the camera up.
- If you change Shutter Speed, bit depth, Frame Rate, Resolution, or Offset.

In the Advanced Settings section of the Record Settings Tab (see Figure 4-4 on page 29) you will see an FPN selection dropdown menu. The items include Disabled, Column, or Pixel. Click on that button and select the FPN setting you wish to use, based on the following:

- **Pixel FPN** is a per-pixel image correction that is done in the ILx's image processor engine. It provides the cleanest images available. This is the setting that is most highly recommended.

**Note: if you see an \* next to Pixel in Advanced Settings on the Record Settings tab, it means that the current black calibration is not valid because of a change in settings.**

- **Column FPN** is an image correction done on the ILx's sensor. It does not do as good a job cleaning up the images as Pixel FPN.
- **FPN Off** means that there is no noise correction being used.

### To Calibrate the Camera:

1. Set the camera to Live.
2. Shut out all light to the sensor: close the f-stop down all the way and put a lens cap on it or cover it securely.
3. Select Black Level Calibration from the Camera Menu. For information on Advanced Calibration, refer to “Application Note 7: Advanced Calibration” on page 94.

Figure 4-13: Black Level Calibration Dialog

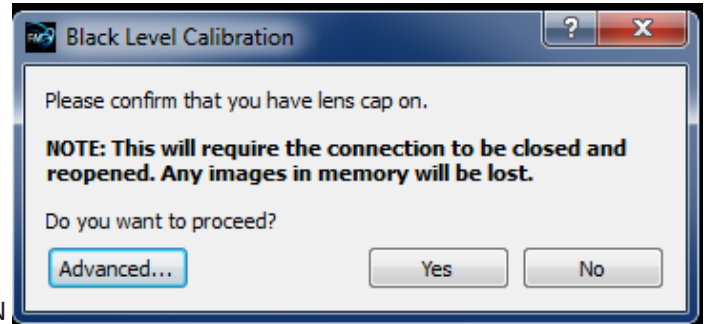
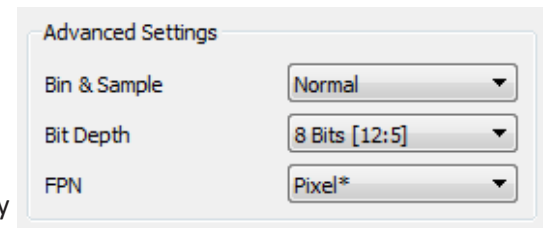


Figure 4-14: Advanced Settings



## 4-9 Record: Arm and Trigger

Table 4-3: Camera Control Buttons

	Live Mode	<b>A</b> (Arm) and <b>T</b> (Trigger) buttons active: Camera in Live mode, waiting to Arm
	Recording: Armed	<b>A</b> (Arm) and <b>T</b> (Trigger) buttons active: Camera is Armed, waiting for the trigger
	Recording: Triggered	No buttons active: Camera has been triggered and is continuing to record
	Review Mode	<b>L</b> (Go to Live) button active: Camera has been armed and triggered, in Review
	Live Images in Buffer	<b>A</b> (Arm), <b>T</b> (Trigger) and <b>R</b> (Review) buttons active: Camera in Live mode, has a recording in the buffer

**Lights Camera Action!**

- The Resolution and Frame rate are set
- The scene is framed and focused
- The Shutter Speed is set
- The Bit Depth is set
- The Trigger Point and Trigger Type is set
- Black Level Calibration has been done

**Take a Still JPEG**

It is optional, but recommended, to take a reference still of the scene:

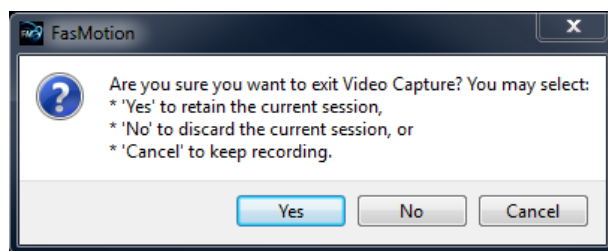
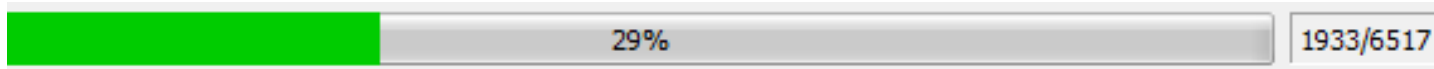
With the ILx in Live Mode (not Recording or Reviewing a recording) either click on the Trigger Button or click on "Snapshot..." in the Camera menu.

A dialog box will appear asking where to store the image. Select the storage media you wish to use. (The image will be saved in <storage device>/dcim/100fastc.)

**Standard Basic Mode Recording**

**Click the Arm Button.** The Arm Button will turn from green to brown (see "Table 4-2: IL5 Bit Selection") and the camera begins recording into its circular buffer (see "Application Note 3: Trigger Position and the Circular Buffer" on page 81 for an explanation of the circular buffer). The Camera LED will change from Green (Live) to slowly flashing Red. It will record for an indefinite period of time until it gets a Trigger. (See "4-6 Configuring the Trigger" on page 32.)

If the Arm Button is pressed a second time, the Recording will abort. The button and the LED will return to green. The Cancel Recording dialog gives the option to retain the images already recorded, discard them, or to continue recording.

**Figure 4-15: Cancel Recording Dialog****Figure 4-16: Record Progress Bar: Armed**

The recording state is indicated by a progress bar at the bottom of the image window. Numbers to the right of the progress bar represent the number of recorded / post-trigger / total frames.

When all of the pre-trigger frames have been recorded, the progress bar stops and turns Yellow.

Note: If the ILx is triggered before the pre-trigger portion of the buffer is full, it will immediately cease taking pre-trigger frames, record frame "0" and progress to the post-trigger portion of the recording. When complete, the recording will have contiguous frames, with the full complement of post-trigger frames, but fewer pre-trigger frames. (See "4-6 Configuring the Trigger" on page 32.)

**Figure 4-17: Record Progress Bar: Triggered**

### To end Recording, Click the Trigger Button:

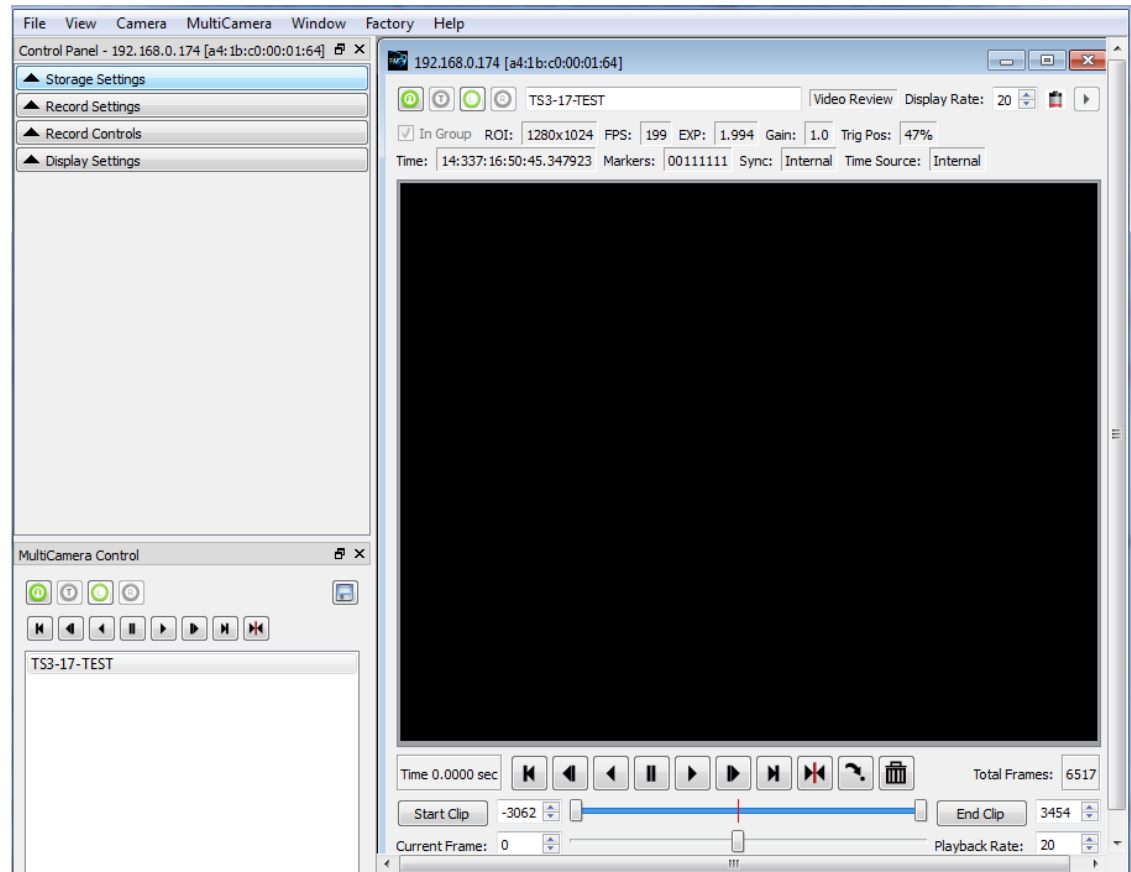
Click on the Trigger button, (see “Table 4-2: IL5 Bit Selection” on page 32) or send an electrical trigger signal (see “Appendix F: Power and I/O Connections”).

When triggered, the ILx will capture frame “0” and the post-trigger frames. When the recording is complete, the progress bar will disappear and the Playback Controls will appear.

**Figure 4-18: Camera Window with Playback Controls**

Note: If one or more cameras have been added to the MultiCamera Control Window, Playback controls will appear there as well so that all selected cameras may play back together.

The refresh rate is the highest for the camera window with focus (it will have a darker border). This view will have smoother-looking playback, but the rates for all of the views will be the same.



## 4-10 Image Trigger

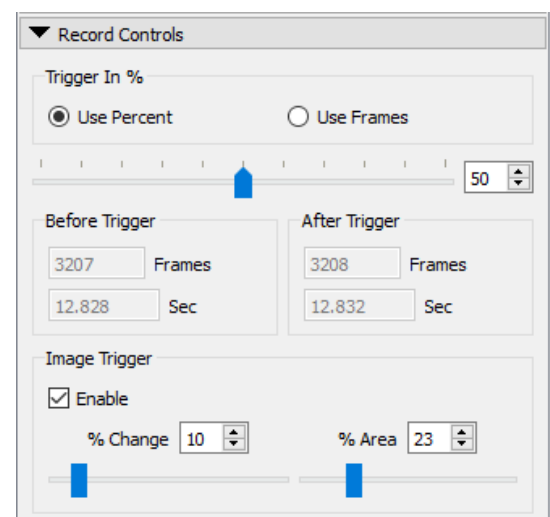
The Image Trigger feature in FasMotion triggers a camera automatically based on the content of a user-defined region.

NOTE: When the Image Trigger feature is enabled, the camera will continue to accept triggers from any other source, including the I/O trigger input, the trigger button on the camera, and software triggers from FasMotion.

To set up the Image Trigger:

1. Click the Enable check box in the Image Trigger dialog on the Record Controls tab.
2. A rectangular reticle will appear. Re-size and locate this on the location on which you wish to trigger. In Figure 4-20 the reticle has been placed just in front of the bird feeder in order to trigger on any birds flying in front of it.
3. Disable / enable the check box to re-sample the background image in the reticle area. The reticle will turn white while taking sample images and return green when done.

**Figure 4-19: Image Trigger Dialog**



The reticle will turn red whenever the image changes enough to trip a trigger.

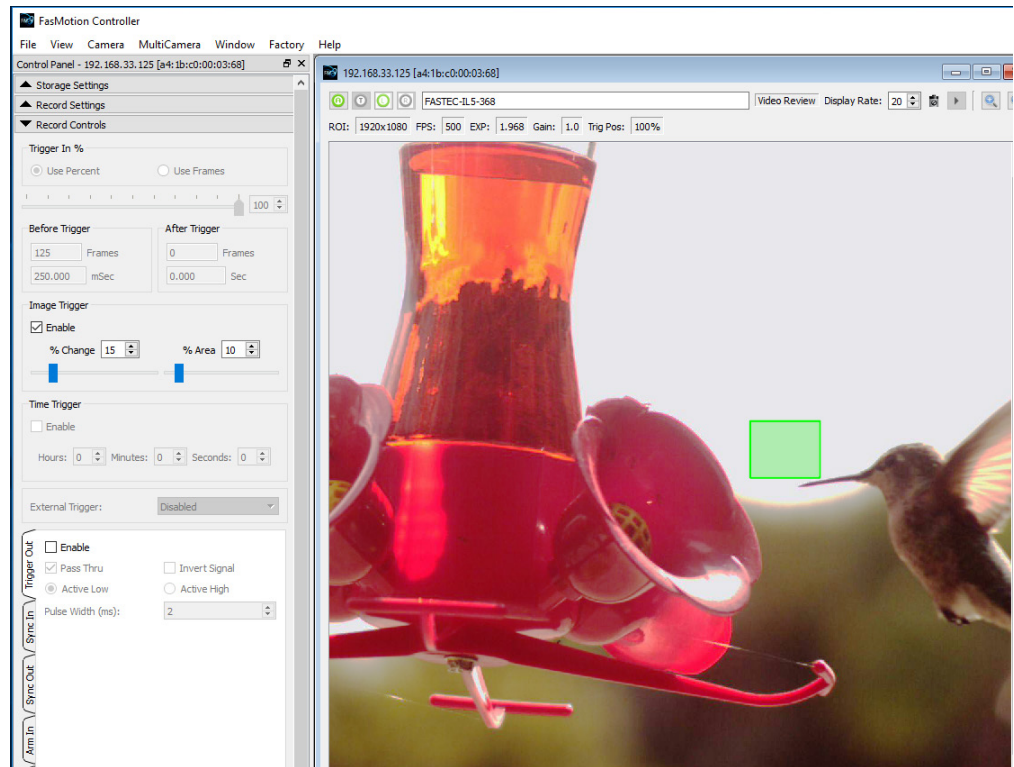
#### Tuning the target:

FasMotion will send a trigger to the camera whenever it sees a change in the image data within the reticle.

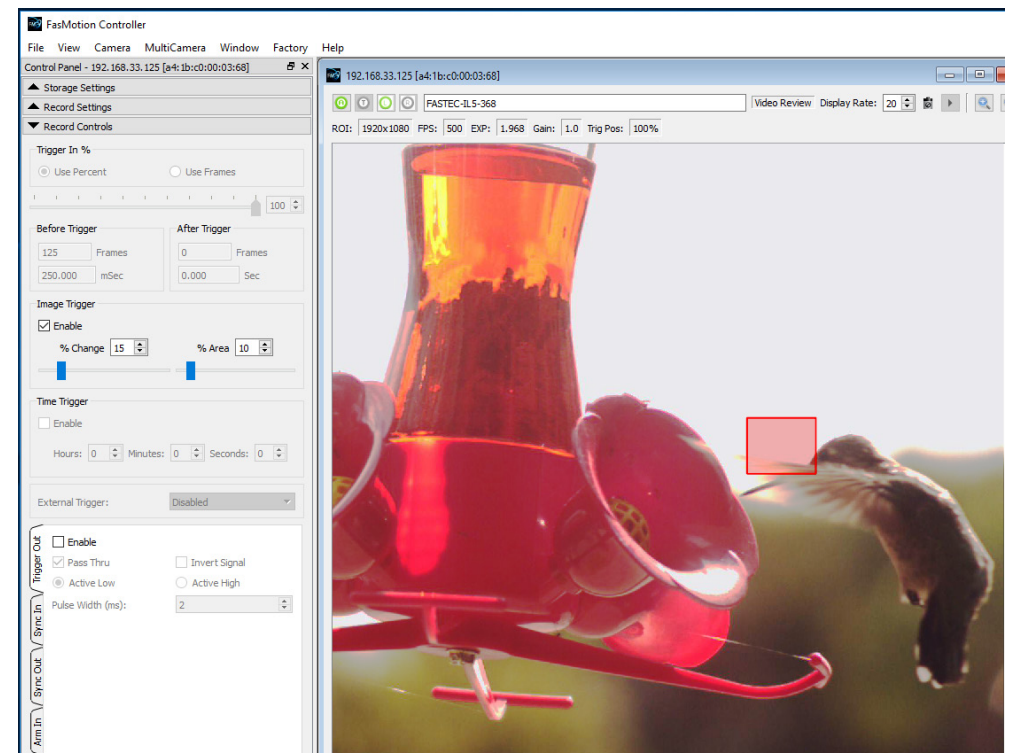
Use the % Change and % Size parameters to adjust the sensitivity of the reticle such that it will trigger on the desired change and not give spurious triggers upon incidental changes within the box.

Note: be sure to disable / enable the image trigger after moving or re-sizing the reticle.

**Figure 4-20: Image Trigger Setup**



**Figure 4-21: Image Trigger-Triggered**



The image trigger reticle and all controls remain active in Live, Armed, and Review. Although the reticle is seen in Review, it is not included in saved images.

It is often helpful to test and tune the trigger in Review (playback).

Latencies due to PC and network response are inevitable. It is best to anticipate these and set your trigger point a little earlier (.1 to .2 seconds) than you normally would.



## 4-11 Time Trigger

The FasMotion Time Trigger sends a software trigger to the camera at user-specified intervals of from 1 second to more than 24 hours.

While the time trigger is enabled, all other triggers, including the Image Trigger are also accepted by the camera.

For example, you may wish the camera to be triggered via external I/O to record fault conditions or some other event being monitored. At the same time, you may wish to take a context recording every hour using the AutoSave feature.

To use the Time Trigger

1. Click the Enable checkbox in the Time Trigger dialog on the record tab.
2. Set the time interval using the edit boxes / spinners provided.

The timer is reset whenever the timing parameters are changed:

- Whenever the Enable checkbox is deselected/selected
- Whenever the timing interval is changed

Note: The time trigger is sent via Ethernet from the PC, thus there is a latency involved that will diminish the accuracy of the timing. Also, the timed trigger will not persist when the camera is disconnected from FasMotion.

Figure 4-22: Time Trigger Dialog

## 4-12 Autosave

The ILx may be used to capture many consecutive events. Using Autosave, this can be done unattended, that is, the camera may be left at a location to automatically Trigger, Save captured imagery, and then re-Arm itself indefinitely--constrained only by the mass storage space available.

Consider that an ILx with an optional 256GB SSD installed, depending on the resolution and download file format, could record and save hundreds or even thousands of events in a completely unattended mode! Even if using an SDHC, many events may be captured.

Advantages of using Autosave:

- Autosave is a good choice for **multiple rapid events**. When you are planning to save every capture and review later, the fastest way to get the job done is to use Autosave. .
- Autosave is also useful for **production environments** or in any scenario where it is used for multiple consecutive tests without any setup changes. Here it is preferred because it limits human intervention, thereby limiting both human effort and the possibility of human error.
- In an **unattended event**, especially in a **remote location** or when there is no easy access to the camera, Autosave is recommended because it is the quickest way to secure the image data. Saving the data to nonvolatile memory can be important if there is a possibility of power loss.



- Use Autosave for any unattended event where there is a possibility of a spurious trigger where the camera might trigger prematurely. If Autosave is used, there is a good chance that the camera will have returned back to Record mode in time to capture the planned event.

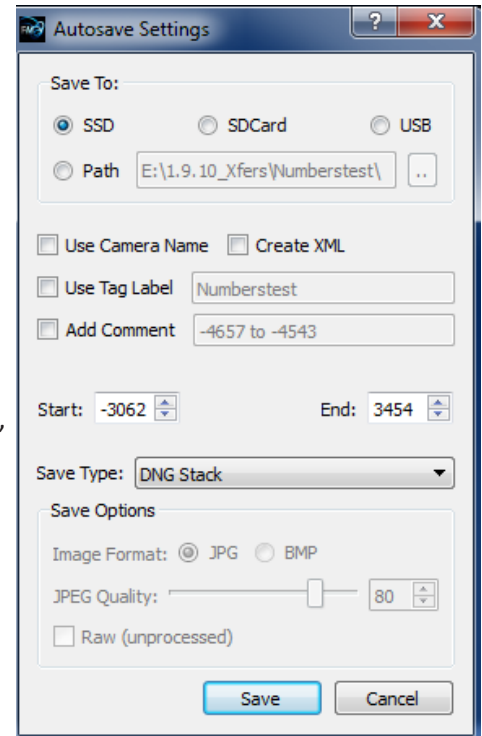
To set up **Autosave**:

Select Autosave Setup from the Camera Menu or Camera Window context menu.

1. Select a target drive using the “Save to Camera / Path” radio buttons. If you select “Path” the target drive and folder will be a folder on a drive accessible by the PC. The Path to that folder is shown at the bottom of the dialog. If you would like to change the path, click on the “..” button and navigate to and/or create the folder you wish to save to.
2. Select a file type from the “Save Type:” pull-down list. File type choices may change depending on the target drive. If you wish to save CAP files, you must save to the SSD. If you wish to save AVI files, you must save to a location other than SSD. See “Application Note 6: Choosing an Image File Format” on page 92.
3. Set start and end points for your saved clips (only if you wish to save less than the full session).
4. Select any desired options for file naming, etc. (See “4-18 Saving Images to Mass Storage” on page 52.)
5. Arm and trigger the camera. Autosave will continue re-arming itself, capturing images and downloading them until the target drive runs out of space. At this time it will progress to Review mode so the user can download manually to a different drive or clear space.

Note: Autosave must be re-enabled after exiting the recording.

**Figure 4-23: Autosave Settings Dialog**



## 4-13 FasFire

The ILx is capable of recording images to one memory partition while saving images from another partition to non-volatile media such as an SSD, SD card, or USB device. Depending on the amount of high-speed DRAM memory (4GB or 8GB) on your camera and the Session Length (partition size) you set (see “3-12 Storage Setup” on page 24), the FasFire feature lets you capture up to 16 clips in quick succession without ever waiting for the camera to finish saving the last.

You will usually find that the camera has saved one or more partition before you get to the last one. Depending on the session size, the speed of the media, and the interval between events, you will often find that you will be able to keep recording clips at will until the space in the save media is exhausted.

For example, if you have 4GB of DRAM in your camera, and you set the Session Length to 0.50GB. You have divided the memory into 8 partitions. The camera will reserve one of these for buffering and open the remaining 7 for FasFire.

### Entering FasFire via FasMotion

The camera will operate in FasFire mode whenever there are at least two FasFire partitions, the camera is set to AutoSave, and the target drive is on the camera (the SSD, SD card, or USB device--not a drive on or connected to the PC). (Refer to “4-10 Image Trigger” on page 37.) With Autosave active, as soon as the camera receives an Arm signal, FasFire will commence.

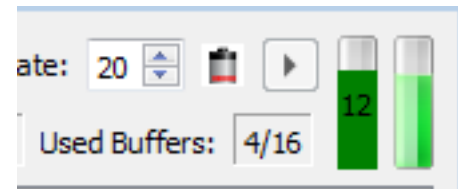
Note: there is no live streaming video in FasMotion while the camera is saving. If you need to see a Live image, you may connect the camera to an HDMI display.

## Using the Gas Gauges in FasMotion

Two gas gauges appear in the upper right corner of the image window during FasFire operation. The gas gauge on the left in Figure 4-24 indicates the number of available partitions for recording into. The gas gauge on the right shows the progress of the current save.

As DRAM memory is filled the gauge on the left decrements its counter and the green level recedes. As partitions become available again, after video clips are saved to the target drive, the number will increment and the green level will grow upwards. If all but one of the partitions become full, the last segment of the gas gauge will turn red. And when the very last segment is used, you will see the normal Autosave progress bar until one partition is saved and the gauge begins to be restored again.

Figure 4-24: FasFire Gas Gauges



## Cancelling FasFire

If you press the Arm button while recording, you will get a warning message asking if you wish to cancel. If you click on "OK," the camera will continue to save images.

If you click on Arm and Trigger, the camera will make one more capture and go into Review/Playback.

The last recording will be available for Review/Playback and Save, as will any other recordings still in DRAM.

**Reminder:** Once the camera has exited the recording state, Autosave must be re-enabled if you wish to commence recording again in FasFire mode.

## Video Review with Multiple Partitions

When there are multiple partitions with unsaved clips in DRAM, the FasMotion Video Review Tab will show the number of available clips. See Figure 4-26.

In this example there are 8 clips available for review. They are always presented with the newest first. You may review the present clip and save it, and then to

see the next, you click on "Free," which will free up the present partition for recording and allow you to review and save the next.

Figure 4-25: FasFire with one Partition Left

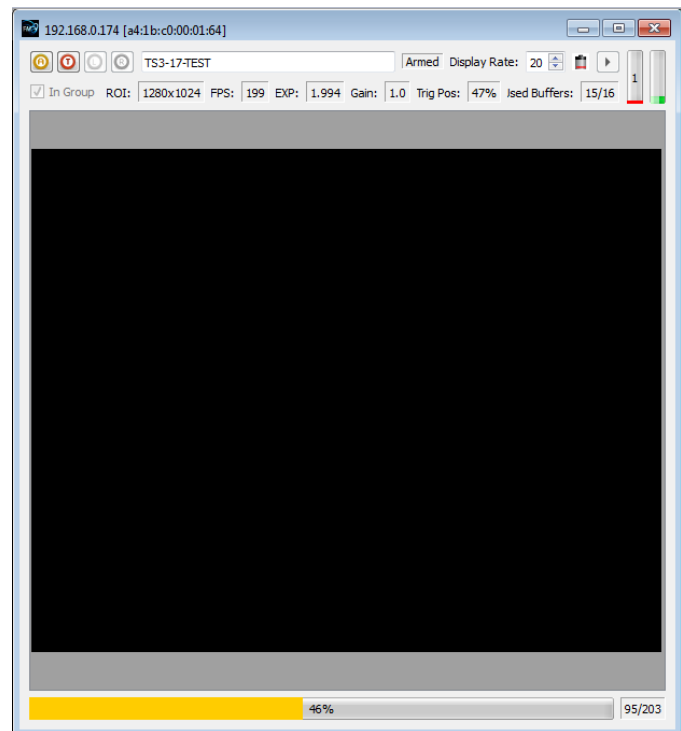
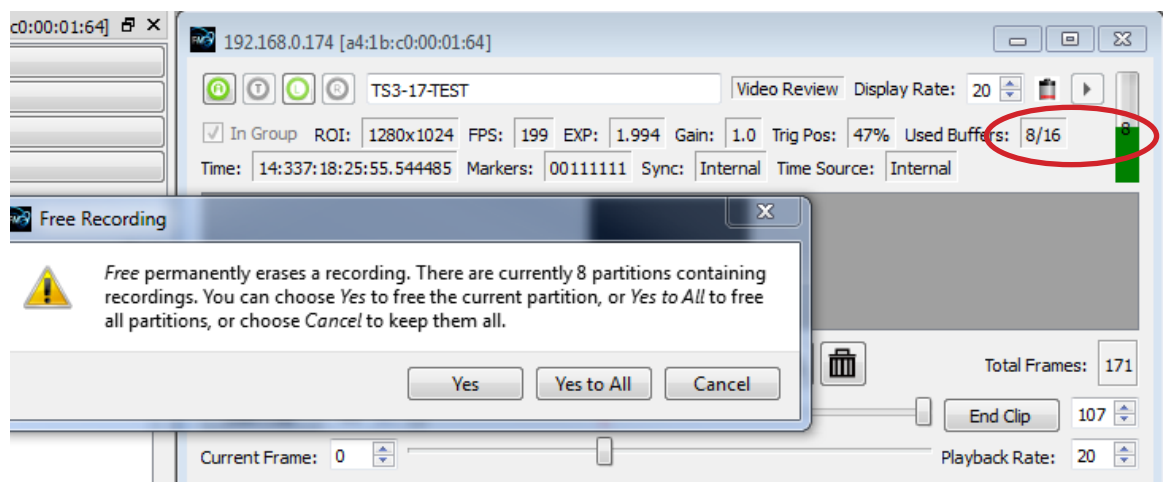


Figure 4-26: Video Review with Multiple Partitions



## 4-14 Long Recording Modes

**Long Record Basic** mode works much like Standard Basic mode, which is described in “4-9 Record: Arm and Trigger” on page 35:

1. Click on the Arm button to begin streaming pre-trigger frames into a circular buffer on the SSD.
  2. Trigger the camera at the appropriate time. The trigger point may be set anywhere on the timeline. See “To Set the Trigger Position in the ILx:” on page 32.
- When triggered, the camera will record the trigger frame, plus all post-trigger frames on the onboard SSD, then proceed into Playback.
  - The progress of the recording is displayed on the timeline very much as it is with Standard Basic mode. Please refer to “Figure 4-16: Record Progress Bar: Armed” on page 36.

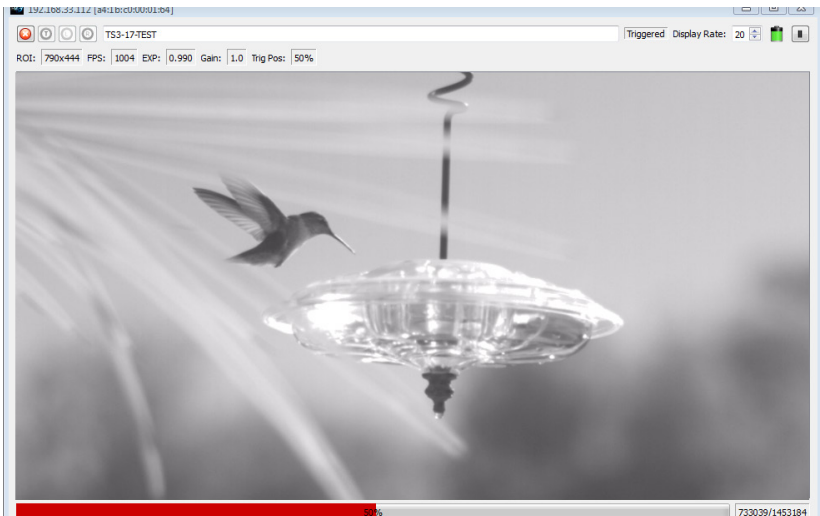
Note: If you wish to stop recording before all of the post-Trigger frames are recorded, you may cancel the recording by clicking the Arm button, then select “Yes” to retain the current session in the Cancel Record dialog. See “Figure 4-14: Advanced Settings” on page 35.

- The basic performance specifications vary depending on model, but generally Long Record allows for much longer recordings at slightly slower frame rates than Standard mode.
- Autosave is available in Standard, but not in Long Record Modes.
- Long Record mode recordings are written to the SSD, which is non-volatile media. The recording is not lost when the camera powers down.

**FasCorder ROC mode** is convenient if multiple recordings of various durations will be made or if there are pauses in the action that need not be recorded. **FasCorder BROC mode** records a specified number of frames with each trigger. See “4-1 Long Record and Standard Modes in FasMotion” on page 28.

**Figure 4-27: FasCorder Mode**

1. Once the camera is set to ROC or BROC mode, click on the Arm button. You will now see the recording timeline and a live image in the Camera Window.
2. Click on the Trigger button. The TSx is now recording and streaming images directly to the onboard SSD. The position indicator is solid red. The Arm button will become a white “X” on red, while the Trigger button remains red.
3. ROC mode: Click on the trigger button again. The recording will now pause and the position indicator will alternate blue and red and the Arm button will turn brown as in Figure 4-25. Repeated triggering will cause the camera to alternate between recording and paused states.



BROC mode: A specified number of frames will be recorded with each trigger, and then the recording will pause. The buttons and position indicators will be the same as for ROC mode. If the camera is triggered before the specified numbers of frames have been recorded, the additional frames are appended to whatever numbers have frames have already been recorded.

4. Press the Arm button. A message will appear giving you the options of exiting to Review and Save, or to continue recording.

Note: Appending to ROC and BROC recordings upon returning from Playback or a Power cycle will cause a number of black frames (up to 128) to be inserted in the recording timeline.

It is possible to alternate FasCorder ROC and BROC recordings in any combination as they are compatible formats. Long Record basic recordings, however, are not compatible with FasCorder and cannot coexist on the SSD.

## 4-15 Reviewing Captured Imagery: Playback

Once the recording is complete, if Autosave is not enabled, the ILx will open the recording in Review Mode with the playback window open (paused).

Note: in Standard Basic mode, with the “Auto-playback” box checked in Camera Preferences, the playback window will open with the video playing. (See “Auto-playback” on page 19.

There are several things to do in Review:

- **Play** the video--play it forward, backward, frame by frame, adjust the cut-in and cut-out points (find the interesting portion of the clip), etc.
- **Adjust** the image brightness, contrast, gamma, bit depth, color, etc. (See “4-16 Image Processing” on page 48.)
- **Save** video to a mass storage device. (See “4-18 Saving Images to Mass Storage” on page 52.)
- **Load** a CAP file from SSD to memory for Review.
- **Rotate** the image (for playback only), use Ctrl + > or <.

Figure 4-28: FasMotion Playback Window

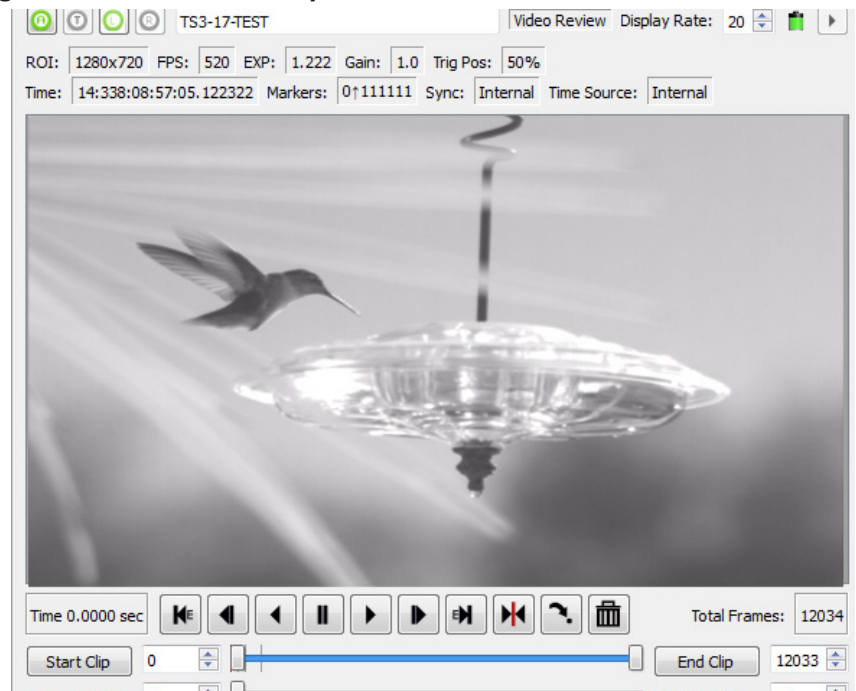


Table 4-4: Playback Control

	Jump to previous Marker (only present when Event Markers are enabled).
	Go to beginning of clip--goes to Cut-In point. Click a second time and it goes to the very beginning of the video.
	Move one frame backward. When highlighted, hold OK button on D-Pad to skip backward.
	Play backward. Use up and down buttons on D-Pad to adjust speed.
	Pause play.
	Play forward. Use up and down buttons on D-Pad to adjust speed.
	Move one frame forward. When highlighted, hold OK button on D-Pad to skip forward.
	Move to end of clip--goes to Cut-Out point. Click a second time to go to the end of the video.
	Jump to next Marker (only present when Event Markers are enabled)
	Jump to Trigger frame.
	Jump to Time.
	Truncate / Delete. In LR ROC or BROCC mode, use this to delete any amount of image data from some selected point to the end of the recording. In other modes, use to delete the present partition.

### Searching for Interesting Parts:

Very often the first thing you will wish to do when reviewing a clip is to “scrub” through it using the playback slider looking for the most interesting moments.

1. Click on the Pause Play button. (Only necessary if you have already clicked on another of the playback buttons.) This will enable all of the playback buttons (they become black). (If any of the buttons become gray (inactive) you will not be able to scrub through the clip.)
2. Move the Start Clip bumper all the way to the left (beginning of segment) and the End Clip bumper all the way to the end. (This is the default position when you enter Review.)
3. Click and hold the Playback Bug and move it along the progress bar. This will allow you to move to any point in the video that might be of interest.

### Using the Slider

When selected, the Playback Bug will turn blue. There are several mouse and keyboard strokes available when the bug is selected:

- Click on the slider bar to the left of the Playback bug to move 10 frames backward
- Click on the slider bar to the right of the Playback bug to move 10 frames forward
- Click on the left or down arrow on the keyboard to move 1 frame backward
- Click on the right or up arrow on the keyboard to move 1 frame forward
- Click on Page down to move 10 frames backward
- Click on Page up to move 10 frames forward
- Click on End to move to the end
- Click on Home to move to the beginning

**Figure 4-29: Playback Bug Selected**



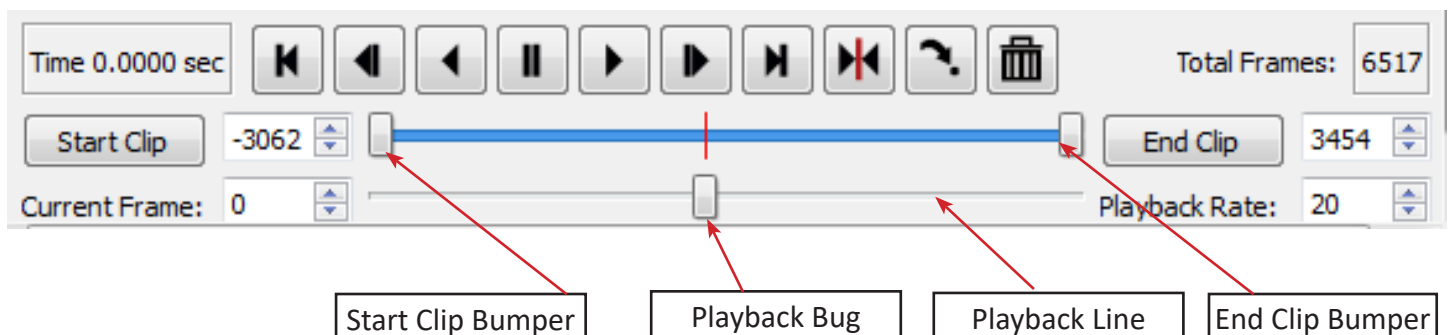
### Setting the Start Clip and End Clip points:

1. Click on the Pause play button. All buttons should now be active (black).
2. Click and drag the Playback Bug to the frame you wish to be the starting point. You can use the Current Frame edit box and/or spinner, or your PC keyboard <- and -> keys to zero-in on the correct frame.
3. Click on the Start Clip button. The Start Clip Bumper will move to that frame.
4. Move the Playback Bug to the frame you wish to be the ending point (as in #2, above).
5. Click on the End Clip button.

When playing, the video will start and end between the Start Clip and End Clip bumpers.

The Start and End Clips also define the range of frames that will be Saved. (See “4-18 Saving Images to Mass Storage” on page 52.

**Figure 4-30: Video Controls (Playback)**





## Jumping to a Frame by Time

Click on the “Jump to Time” button in FasMotion to find a frame based on its time. See “Table 4-4: Playback Control” on page 43.

- Select the “Relative” radio button if you wish to jump to a frame based on the time relative to the trigger time.
- Select the “Absolute” radio button if you wish to jump to a frame based on the “time of day” clock, which is used for timestamps in the metadata.

Note that the Year, Day, Hour, Minute fields only become active according to the length of the captured video. For example, in Absolute mode, if you have a recording that begins at 6:56 am and ends at 7:01 am, the Hour, Minute and second fields will be active. In Relative Mode only the Minute and second fields will be active.

## Jumping to Markers

ILx cameras have six LVTTTL I/O ports that may be used for camera control or as event marker inputs, or some combination of the two. Note that the signal level for each I/O port is recorded in the per frame metadata independent of their use.

When used for camera control, these ports are defined as Trigger-in, Trigger-out, Sync-in, Sync-out, Arm-in, and Arm-out.

When used as markers we refer to the same ports as T-I, T-O, S-I, S-O, A-I, and A-O, respectively. Please refer to “5-5 IL3 / IL4 / IL5 Timestamps and Markers” on page 66.

**Rec Start** marks the beginning of an LR ROC or BROCC recording. This is a very useful marker to be used whenever FasCorder mode is used.

When playing captured video on the ILx, event marker locations may be made visible as hatch marks on the timeline.

## Setting up Event Markers

1. Open the Event Marker Control dialog: (in Review mode) click on the Events... button in the Video Review tab.
2. To make markers appear on the timeline, select the Enable Markers checkbox.
3. For each I/O signal you wish to use click on the associated button and select the state for which that signal will be defined as “true” according to Table 4-5.
4. If you wish to create a mark whenever **any** of the signals are “true” select the “Or” radio button. If you wish to create a mark only when **all** of the signals are “true” select “And.”
5. Click on “OK” to accept the Event Marker controls.

Example: In Figure 4-36 there are two markers on the timeline. Note that the signals SO and TO (used in this case as I/O inputs and not for Sync-out or Trigger-out), each go low for a short time. In this example, the Marker Control dialog was set for Or logic with down-arrows for both SO and TO. When SO OR TO go low (High to low transition), a marker will appear on the timeline.

Note: The Event Marker setup is not associated or saved with the captured video, but it is saved in FasMotion settings and is saved along with the configuration using Configuration/Save Config...

## Using the I/O Graph Display

I/O channel signal activity may be viewed in graphical form using the I/O Graph Display.

Figure 4-31: Jump to Time Relative

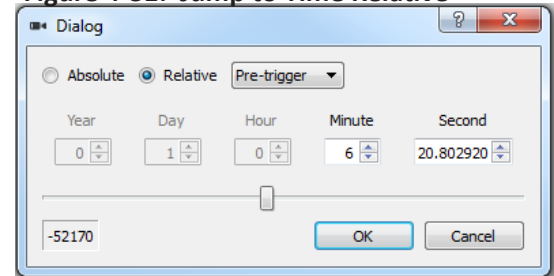


Figure 4-32: Jump to Time Absolute

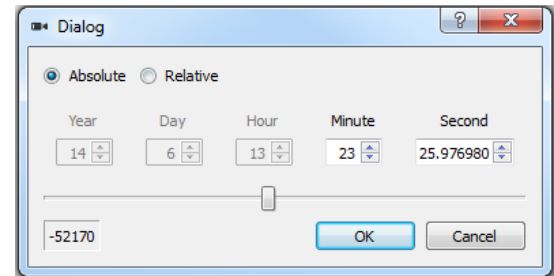


Figure 4-33: Event Marker Control Dialog

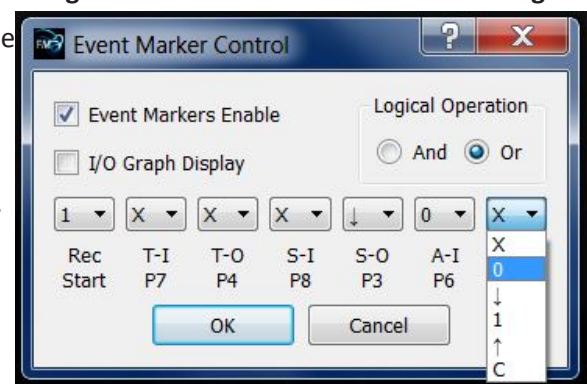


Table 4-5: Marker Logic

X = Ignore
O = Low
↓ = High to Low transition
1 = High
↑ = Low to High transition
C = Transition
G = Glitch (edges / no transition)

1. Click on the I/O Graph Display check box in the Event Marker Control dialog. An I/O graph will appear beneath the timeline in the Video Controls window. See Figure 4-34.
2. Use the u/down arrows in the spinner box to the left of the I/O Graph Display to select the I/O channel you wish to view.
3. Additional charts may be added by clicking on the “Add Chart” button to the left of the bottom-most I/O chart.

### Zooming in on the Timeline

The timeline in the Video Controls window may span many thousands of images in a “Normal Mode” recording, and hundreds of thousands of images in “Long Recording Mode.” The timeline Zoom feature allows you to reduce the number of frames viewable across the timeline, making the task of finding specific events in the video much easier.

#### To Zoom In:

Double click on the timeline to zoom to 2x.

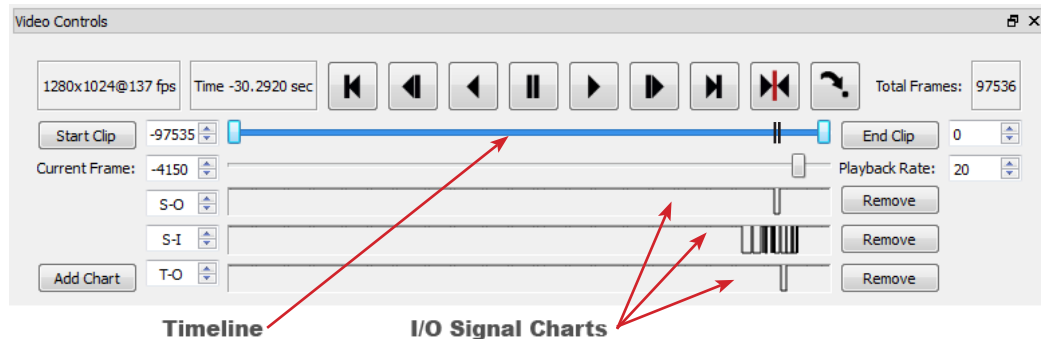
A highlight mark will appear over the zoomed area of the Timeline and a “Zoomed Playback Line” that spans the highlighted area will appear below the Playback Line.

The highlighted portion of the Timeline may be moved by clicking and dragging it, so that any portion of the captured video may be accessed.

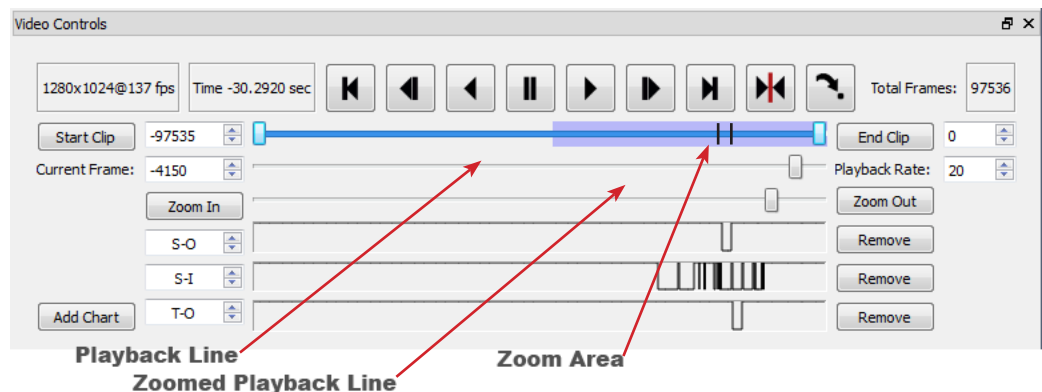
Zoom In and Zoom Out buttons appear at either end of the Zoomed Playback Line. Clicking on the Zoom-In button increases the Zoom 2x: to 4x, 8x, 16x, etc. to the maximum zoom of 4 frames.

Note that the I/O signal charts also expand when zoomed in. If there is a lot of activity on these channels, as in the examples shown here, zooming in is advantageous for seeing the signals clearly.

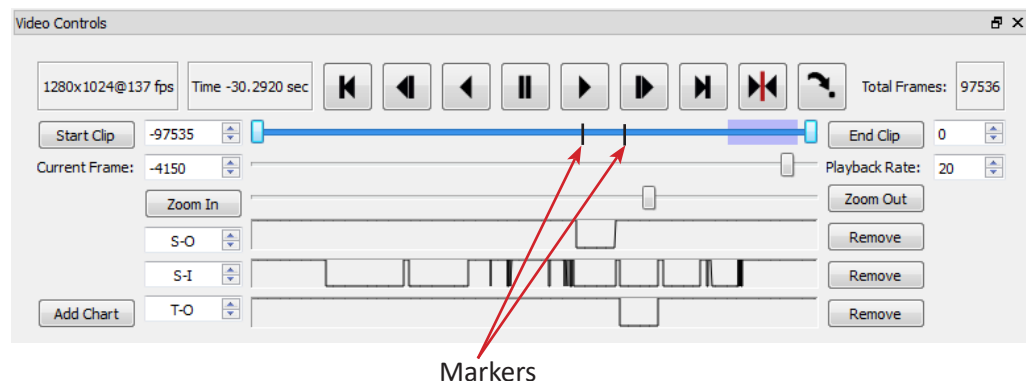
**Figure 4-34: Video Controls with I/O Charts**



**Figure 4-35: Video Controls with 2x Zoom**



**Figure 4-36: Video Controls with 8x Zoom**



## Viewing Per Frame Metadata in FasMotion

Whenever the ILx records imagery, it also records a timestamp for each frame. This timestamp may be displayed during playback and may also be saved to an XML file (See “Appendix J: Contents of <Capture>.XML File” on page 121 and “4-18 Saving Images to Mass Storage” on page 52).

Per Frame Metadata may always be viewed while playing unsaved images in camera memory and also may be viewed when playing back saved image files if they were saved with the XML file. (See “Save Dialog” on page 53.)

### To View Per Frame Metadata:

Right-click on the Camera window when in Playback and click on Per Frame Metadata.

The Per Frame Metadata includes a Timestamp, Marker information, IRIG status, Sync status, and Time source.

### Timestamp Format

Time: YY:DDD:HH:MM:SS.xxxxxx

For the example shown in Figure 4-38 this is:

YY = Year: 14 = 2014

DDD = Day: 338 = Dec 3 (See “Appendix O: Day Number Calendar Conversion” on page 128.)

HH:MM= Hour: Minute: 08:57 = 8:57 am

SS.xxxxxx = Seconds: = 31.281870 (granularity to  $\mu$ sec)

Note: the Timestamp line is always available during playback from camera memory or from CAP files loaded into camera memory from an SSD. It is also seen in saved files played back via FasMotion, but only if they are accompanied by an XML file.

Markers: 00111111

The Timestamp line includes event markers. In the example shown in Figure 4-38, all of the I/O pins were “high” for the duration of the displayed image frame. (See “5-5 IL3 / IL4 / IL5 Timestamps and Markers” on page 66.)

IRIG: 0

In the example IRIG is not enabled (0). (IRIG is not currently an option for the ILx. If you have an application that requires IRIG on the ILx, please contact Fastec.)

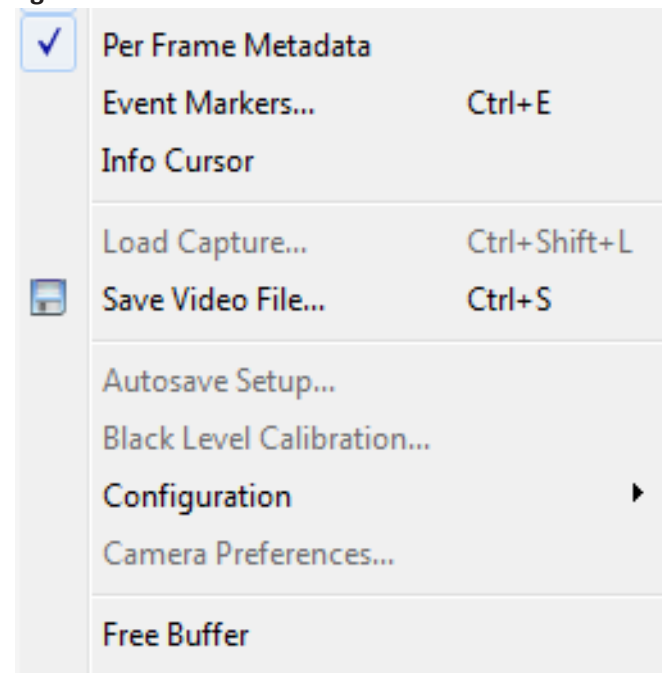
Sync: Internal

The Sync term can be Internal (internal camera clock used for frame timing), PPF (Sync-In pulse used for per-frame timing), or PPS (1Hz clock input at Sync in used to derive the camera frame timing). See “5-1 Sync In” on page 60.

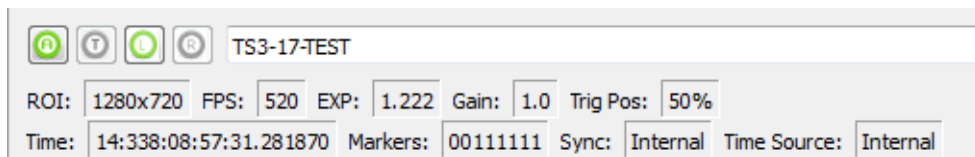
Time: Internal

The Time is always set to Internal for the ILx.

**Figure 4-37: Select Per Frame Metadata in View Menu**



**Figure 4-38: Per Frame Metadata in FasMotion**

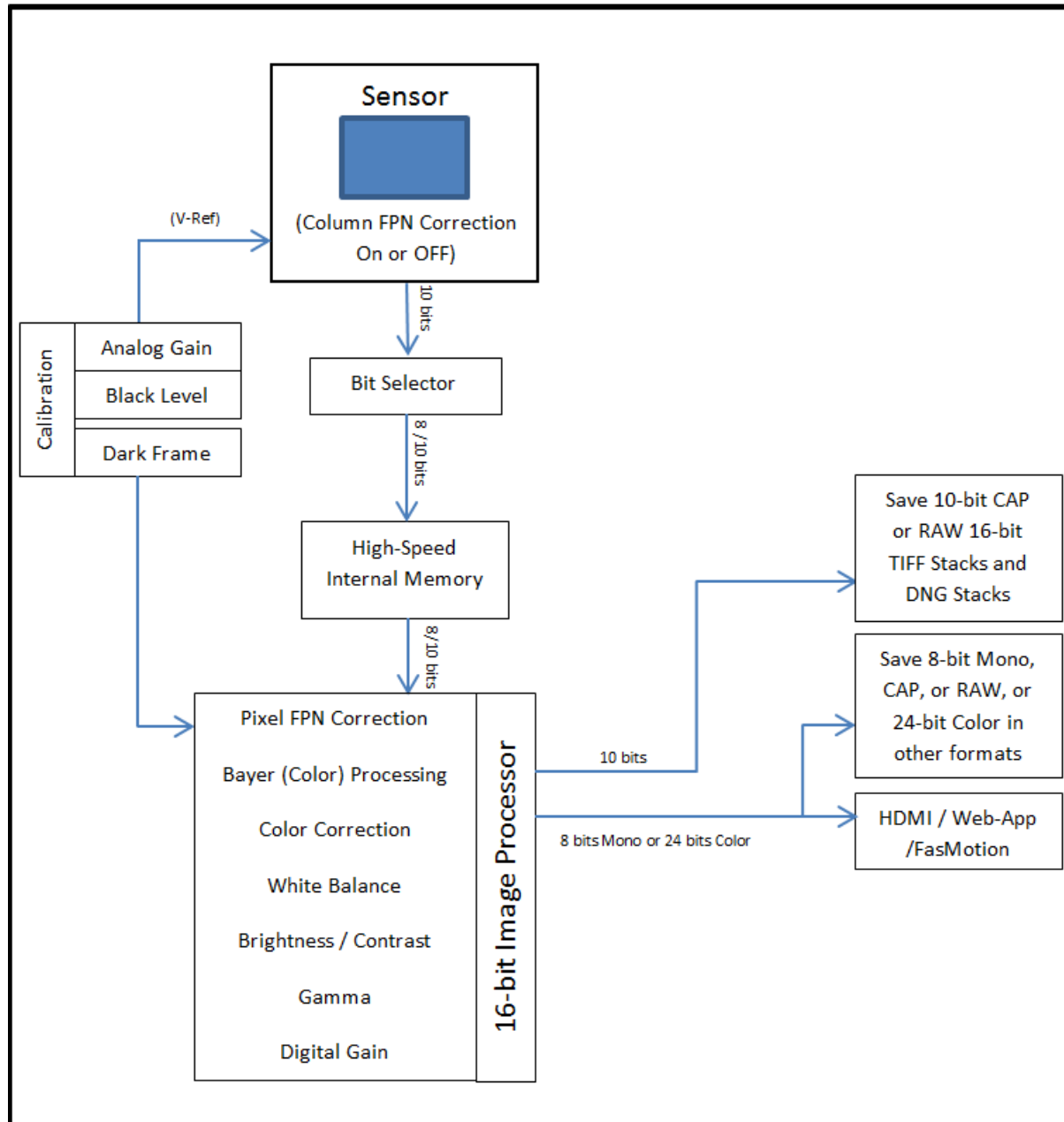


## 4-16 Image Processing

### IL3 / IL4 Image Processing Pipeline.

The IL3 / IL4 image processing begins in the LUPA1300-2 sensor, where on-chip column FPN corrections occur (if enabled) and the Black level is set using data collected during calibration. Pixel data, also collected during calibration is used for Pixel FPN correction (if enabled). (See “4-8 Black Level Calibration” on page 35.) The ILx does more image processing internally, some of which can be controlled by the operator. To better understand how this works, please refer to Figure 4-39.

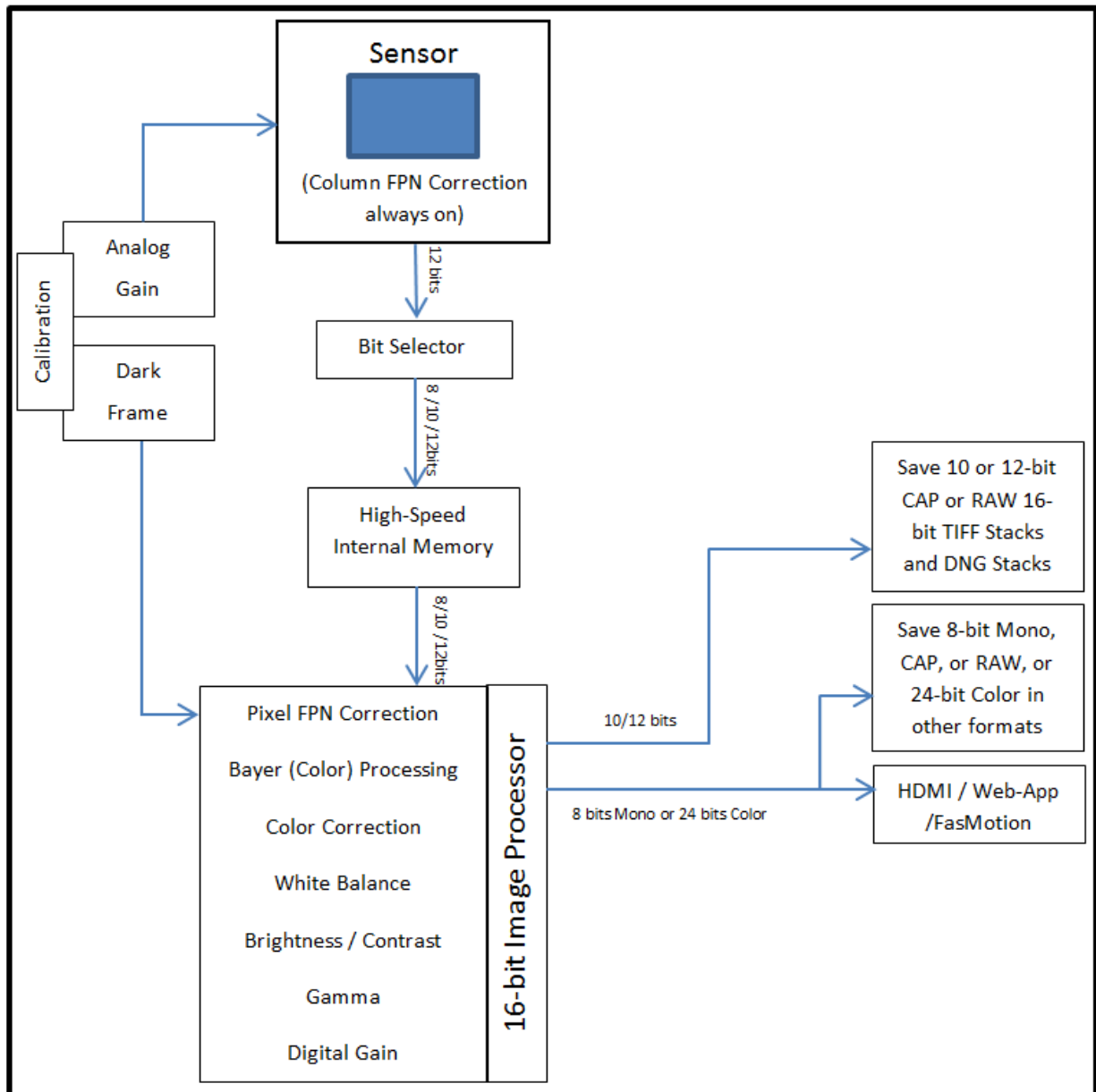
Figure 4-39: IL3 / IL4 Image Pipeline



### IL5 Image Processing Pipeline:

The IL5 image processing begins in the Lince5M sensor, where on-chip Column and Row FPN corrections occur and black level is tracked using masked pixels. (Refer to “Figure 4-40: IL5 Image Pipeline” on page 49.) These features are always enabled unless the user specifically selects FPN Off. Analog Gain is set and Pixel data is collected during calibration for use when Pixel FPN correction is enabled.

Figure 4-40: IL5 Image Pipeline



### Bit Selection

The 10-bit or 12-bit sensor output goes to the Bit Selector, then to internal high-speed memory. This selection is made by the user when bit depth is selected. (See "4-5 Setting Bit Depth" on page 32.)

The path for all images and the input to the histogram is: Sensor, to Bit Selector, to Image Processor, to Display / Histogram. It is always 8-bit Mono or 24-bit Color. Live images pass through from high-speed memory to the image processor immediately. Captured images are saved in high-speed memory until the camera powers down or the images are written over.

- Images in the internal high-speed memory have not yet gone through the image processor. This means that the image processing settings have NO effect on the images in high-speed memory-- they only affect the images as they are saved or displayed.



- Images in high-speed memory may be viewed or saved multiple times with different settings.
- Live images seen on the display ALWAYS go through the image processor.

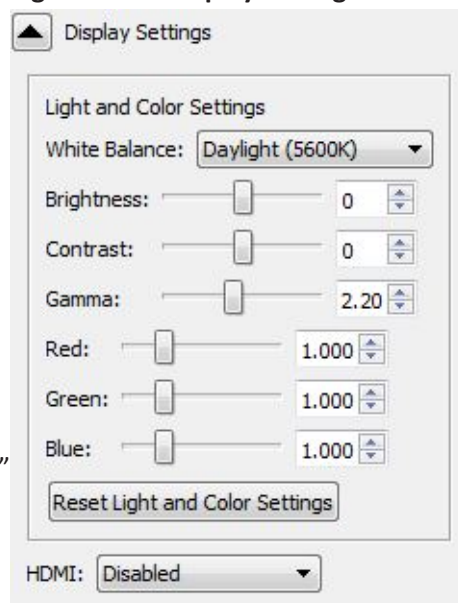
#### User Control of Image Processor

- Bayer (Color) processing (color cameras only) is done in order to display a color image. The user may elect to save images that have not gone through Bayer colorization by choosing to download a RAW format (See “4-18 Saving Images to Mass Storage”.)
- Color Correction is controlled via “White Balance” in the Display tab. You may choose from several color temperatures: Daylight (5600K), Tungsten (3200K), and Fluorescent (4100K) and Normal setting 1:1:1 (all channels at nominal gain). There is also a “Custom” setting used to white balance using a gray target and an RGB gain dialog for further manual adjustment. See “4-17 Custom Color Correction”.
- Brightness and Contrast are controlled via sliders and spinners. Users select levels from -100 to +100 (default = 0).
- Gamma is also adjusted in this dialog. Levels range from 0.20 to 5.00. Gamma 2.2 is the default as it is the most common display gamma for monitors. For a linear display choose a gamma of 1.00.

Note: Making a selection from this menu only affects the Displayed image and any (non-RAW) images saved to mass storage devices. It does not affect either the 8-bit or 10-bit images as they are recorded into the ILx's high-speed internal memory. **Adjustments made here may be done before and/or after the imagery is captured.**

**Note: All image processing is done using 16-bit math. If 8 bits are recorded, they will be used as the upper 8 bits of the 16-bit calculations by the image processor. The upper 8 bits of the results are then used as an output. Similarly, if 10 bits are recorded, they will be used as the upper 10 bits of the 16-bit calculations. This is true regardless of the output bit depth, thus the lower two bits of the 10 bits recorded are used when computing color corrections and image adjustments, even if you are viewing or downloading 8/24-bit formats.**

**Figure 4-41: Display Settings**



## 4-17 Custom Color Correction

When the preset White Balance options, Daylight, Tungsten, and Fluorescent, do not give you the color reproduction you need, there are a couple of other options available:

The Custom item in the Display/White Balance menu allows you to set the color correction via a gray card or neutral gray object.

#### To use Custom White Balance:

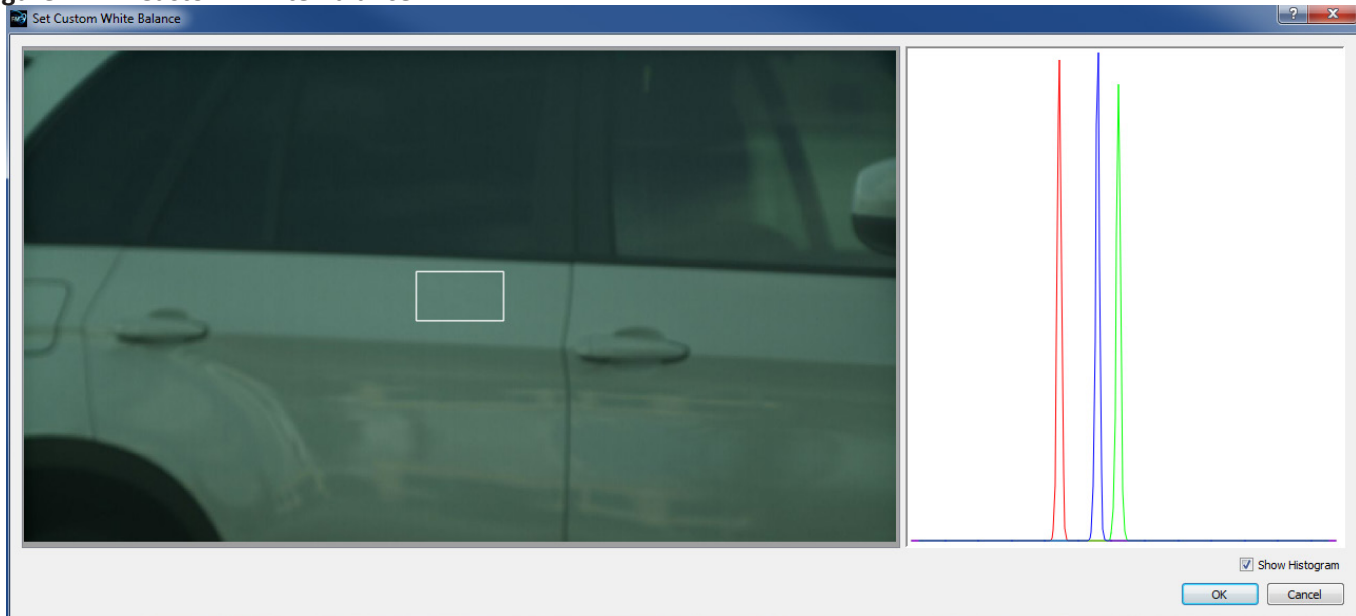
1. Click on the “Custom” button in the White Balance menu. A rectangular reticle will appear in the middle of the image window and a special histogram will appear (See “Figure 4-42: Custom White Balance” on page 51.)
2. Center the reticle (the white box in the center of the image) on a neutral gray object in the field of view. In this instance we are using an 18% gray card, which is the recommended target. Most often the card will only fill a portion of the field of view--it only needs to fill the reticle. It is important that the card or other neutral gray object is located close to the objects of interest and is exposed to the same light as the objects you are going to image.

3. Adjust the lens aperture so that the histogram shows midrange pixel values with no saturation. (It is important that the high pixel value is less than 255.) Notice on the example here, that the RGB peaks are not well aligned and that the Red peak is farthest to the left. This means that the color is skewed slightly towards the Green, the complement to Red.

Note: The histogram used with Custom White Balance represents only the area of the reticle, not the whole image. For more information regarding ILx Histograms please refer to "Application Note 1: Histograms" on page 77.

4. Click on "OK." You will immediately notice a difference in the color.

**Figure 4-42: Custom White Balance**



### Using RGB Gain Controls

Another option for addressing color correction is via RGB Gains. It is recommended that you use the RGB gains sparingly and as a final "tweak" to make subtle changes to the color. The best use of this is to get the color as close as possible using the White Balance presets or Custom options before adjusting the RGB gains.

To use RGB Gain:

1. Open the Display Settings Tab. You will notice sliders with edit boxes and spinners for Red, Green, and Blue.
2. For any color gain you wish to increase, move the slider to the desired position. Remember to use the D-Pad for fine adjustment.

Note: Remember that in the Bayer pattern, 1/2 of the pixels are green, 1/4 are blue and 1/4 are red. Whenever you change gain values you will be adding some noise to the image. It is best to avoid using any more gain than you need to, and to take special care with the green channel as it represents half of the pixels in the image.

## 4-18 Saving Images to Mass Storage

Image sequences may be saved as CAP files (proprietary raw format, see “Appendix J: Contents of <Capture>.XML File” on page 121), as AVI videos, in which one file contains all the frames of the sequence, or TIFF, JPEG, or BMP stacks, which are collections of files, one file per frame of imagery. The file save options change depending on whether 8-bit or 10-bit image data has been written to internal high-speed memory:

**Table 4-6: Image File Save Options**

10 or 12 bits recorded	8 bits recorded
TIFF (8-bit M /24-bit C) or RAW TIFF (16-bit)	TIFF (8-bit M / 24-bit C) or RAW TIFF (8-bit)
DNG (16-bit raw format)	DNG (8-bit Raw format)
BMP (8-bit M /24-bit C)	BMP (8-bit M/ 24-bit C)
AVI (8-bit M /24-bit C)	AVI (8-bit M / 24-bit C)
JPEG (8-bit M /24-bit C)	JPEG (8-bit M / 24-bit C)
CAP (10- or 12-bit raw format)	CAP (8-bit Raw format)

Calculating file sizes for TIFF and BMP images is very simple:

$$\text{Resolution} \times \text{Bit depth} / 8 = \text{approximate BMP or TIFF file size in Bytes}$$

(to convert Bytes to KB divide by 1024)

For example a 1280 x 1024 Mono BMP or TIFF is:

$$1280 \times 1024 \times 8 / 8 = 1,310,720 \text{ bytes} = 1,280\text{K}$$

A 1280 x 1024 16-bit RAW TIFF/DNG is:

$$1280 \times 1024 \times 16 / 8 = 2,621,440 \text{ bytes} = 2,560\text{K}$$

CAP files are always the size of the current buffer (session size).

The actual file size of a 1280 x 1024 mono BMP or TIFF is about 1281K (the additional 1K for the file header). The actual size of 16-bit RAW TIFF is 2561K (again add an additional 1K for the header).

Note: The RAW 16-bit TIFF saved from the camera actually has 10 bits of image data. The 16-bit format is used for compatibility reasons.

Calculating file sizes for AVI and JPEG images is much more difficult. The compression is often approximately 10x to 20x, but it can be much greater for images with little content, and it can be much less for very complex images.

RAW images are not colorized, so Mono and Color images are the same size. Colorization increases file size 3x because 8 bits are saved for each of red, green, and blue channels.

To **Save** a recording to a connected mass storage device on the ILx:

1. Make a recording and establish the Start Clip and End Clip points you wish to use (see “4-15 Reviewing Captured Imagery: Playback” on page 43).

Note that the frame numbers initially shown in the dialog box will be the actual start and stop frames for the entire capture *unless* the Start Clip and End Clip bumpers have been moved. If you are not sure what the actual beginning and end frame numbers for the clip are, you can find them on the far left / far right sides of the Clip bar.

1. Select a target drive using the “Save to Camera / Path radio buttons. If you select “Path” the target drive and folder will be a folder on a drive accessible by the computer.
  2. Select a file type from the “Save Type:” pull-down list. File type choices may change depending on the target drive. If you wish to save CAP files, you must save to the SSD. If you wish to save AVI files, you must save to a location other than SSD. See “Application Note 6: Choosing an Image File Format” on page 92.
- The default folder name format for the image stacks is ts3\_000000. If you would like the name to include the camera name, Select Use Name in the dialog. The resulting folder name format for the example would become ILx-11\_000000. File names for images in stacks are 0000000.<ext>, 0000001.<ext>, etc.
  - If you would like to add a tag to the folder name, select Tag. The Tag may be edited. Using the Tag in the example, the file name becomes 2011-10-11\_000000.
  - Both the Name and the Tag may be used, in which case the file name becomes ILx-11\_2011-10-11\_000000 in the example.
  - If AVI files are saved, the default file name is ts3\_000000.AVI. The Use Name and Use Tag options are also valid for AVI files, in which case the resulting file names are ILx-11\_000000.AVI, or 2011-10-11\_000000.AVI, etc. If the file size exceeds the 4GB limit for 32-bit file systems, the ILx will make a second file for the remainder of the imagery. (MiDAS and other players will play the video as one.)
  - If CAP files are saved, they will not use either the camera name or the tag. CAP files are saved only to the SSD. They must be loaded back into high-speed memory in the camera to be reviewed, and then converted into a downloadable file format.

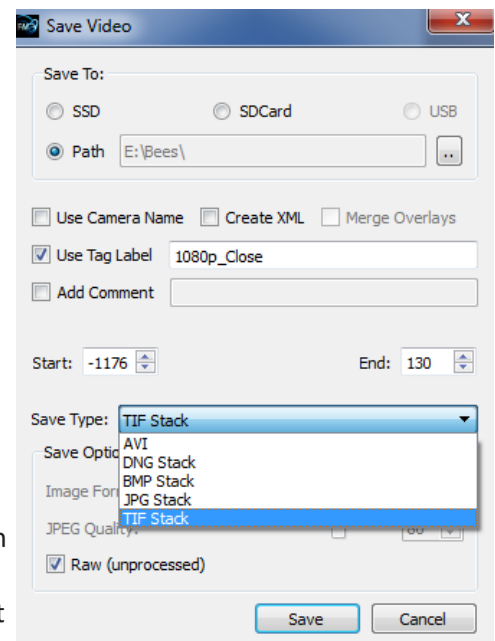
Note: CAP files load back into memory much faster than they are saved, taking approximately 45 seconds for a full 8GB load and proportionately shorter times for smaller ones.

When the ILx saves imagery to mass storage it creates the following:

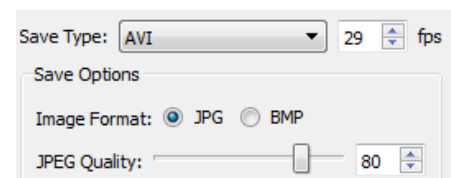
- DCIM. This is an industry standard directory name for Digital Camera Images.
- 100fastc. This is a sub-directory under DCIM.
- ts3\_000000. This is the first sub-directory under DCIM/100fastc, used for storing image stacks.
- hs-video. This is the directory that all AVI files are written to.
- <filename>.txt. For each download, the camera creates this text file. In it are the camera setup values, including resolution, frame rate, camera name, time stamp for the capture, image processing values, color processing values, etc. (See “Appendix I: Contents of Frame.txt file”.)
- <filename>.cfg files. This is a binary file used for MiDAS player so that it can properly play them

Note: Image files may be saved multiple times using different formats, different start and stop points, and different image processing options (brightness, contrast, gamma, color, etc.). If 10-bit images have been captured, imagery may be saved multiple times using different bit-depths.

**Figure 4-43: Save Dialog**



**Figure 4-44: AVI Selected**



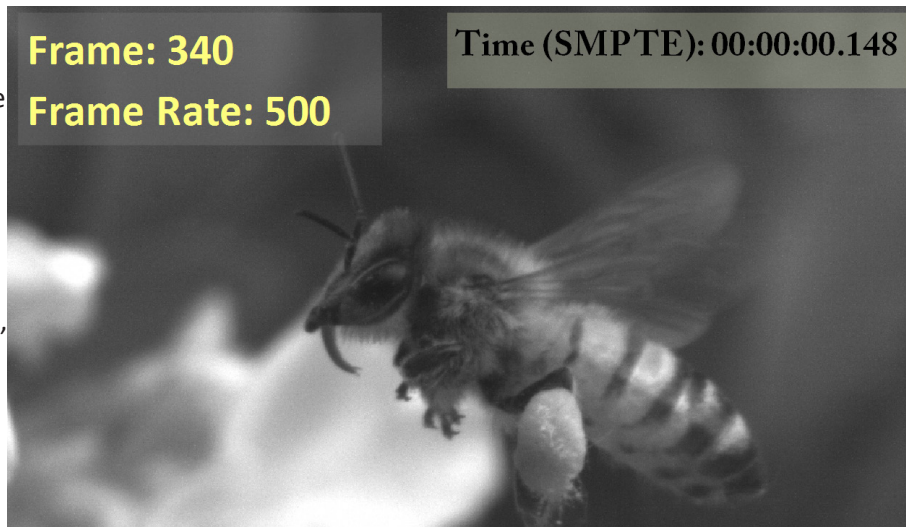
## 4-19 Adding Overlay Metadata

Overlay metadata and custom text may be added to image stacks and video files in FasMotion, either as text boxes within the image frame or pinned above or below the image frame, or positioned on either side.

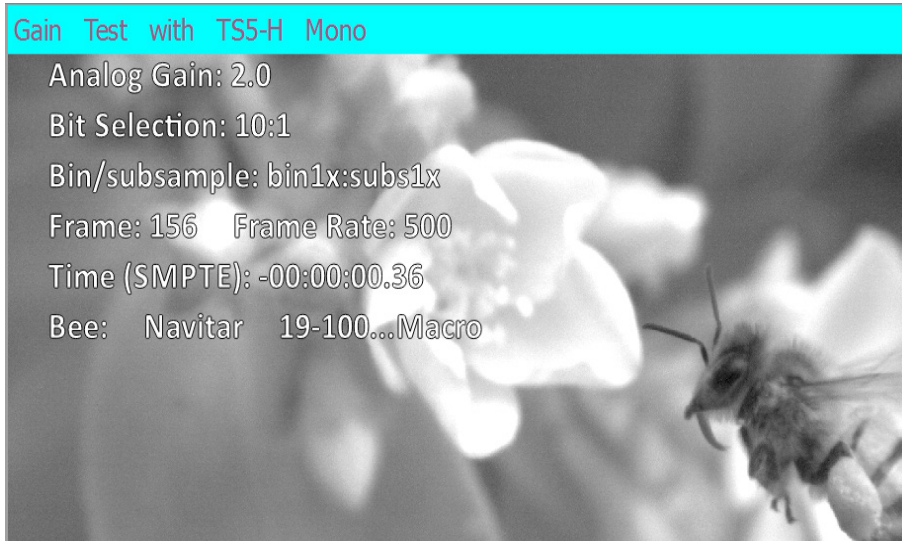
The overlays may be added as images are Saved from the TSx to the computer, or may be added when videos or stacks on the computer are opened by FasMotion, and then re-saved (transcoded) back to the computer.)

As Seen in the Example 1, multiple overlays may be used. Each may have its own shape, font, and color scheme.

**Figure 4-45: Metadata Overlay Example 1**



**Figure 4-46: Metadata Overlay Example 2**



Example 2 uses white text with black outline and a transparent background allowing the characters to be easily readable regardless of the changing image beneath. It illustrates the use of two overlays on the same video. The overlay at the top of the image, magenta text over a turquoise background, which demonstrates that you may use color overlays even if the image is mono. Note that this text box adds to the vertical size of the saved image.

If very narrow resolutions are used, there may not be a lot of room for text without forcing it to wrap in undesired ways, so if the chosen overlay shape is wider than the original image, the saved images will have added black horizontal space.

For example 3, a transparent background was used with white text so that it shows up nicely against both the dark roof and the added black space.

**Figure 4-47: Metadata Overlay Example 3**

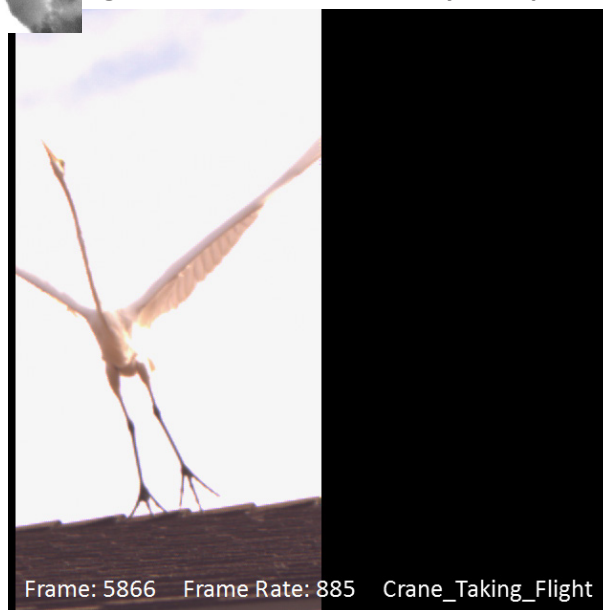
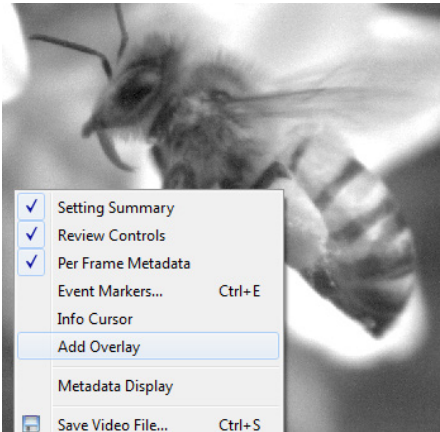




Figure 4-48: Playback Context Menu

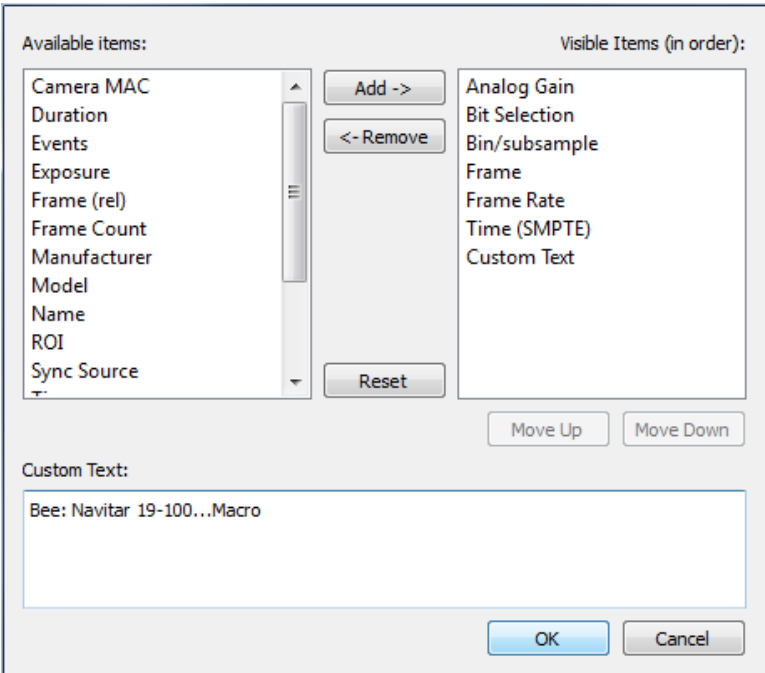


Setting up the Overlay:

1. Right-click on the image in Playback to open the context menu.
  2. Select “Add Overlay” to bring up the Overlay Item Selection Dialog.
- Note that overlays persist in FasMotion and that the “Merge Overlay” check box in the Save Menu is always checked by default if an overlay is present.
3. Select the metadata items you wish to use in your overlay from the Overlay Item Selection Dialog.
  4. Add any custom text you wish to use.

Note: Remember that you can have multiple overlays!

Figure 4-49: Overlay Item Selection Dialog



5. Adjust the position of the overlay by placing the mouse cursor inside the overlay left-click and drag with your mouse.
6. To shape the overlay, place the mouse cursor on a corner until you see the red dot on it, then left-click and drag.
7. Right-click on the Overlay to open the Overlay Context Menu.
8. Select Change Item Font and select your font and Size. You may also select “Outline Text” from the context menu. (The outline is black)

Figure 4-50: Overlay Context Menu

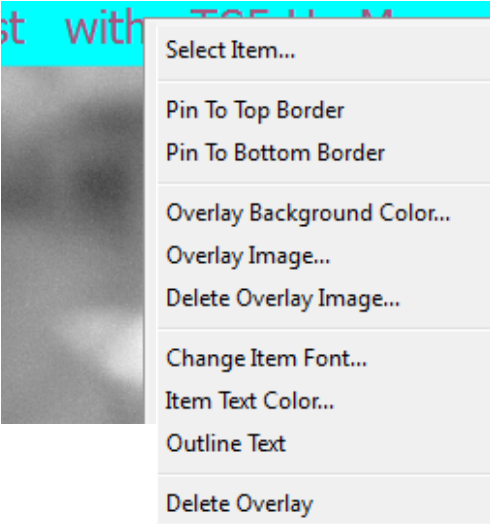
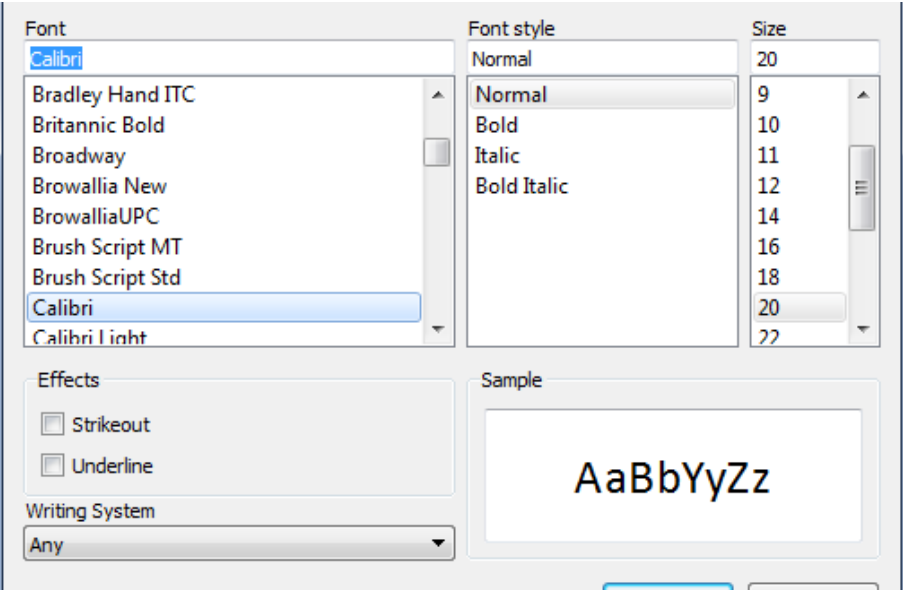


Figure 4-51: Overlay Font Dialog



9. Select "Item Text Color..." from the context menu to select the color for the text. (This dialog is identical to the Background Color Dialog.)
10. Select "Overlay Background Color..." to change the color of the overlay background. The Alpha channel is used for transparency: 0 = totally transparent, 255=totally opaque.
11. Save the image data with the overlay as an AVI or Stack (any type except DNG) to a Path. Remember that the Merge Overlay check box must be checked.

Figure 4-52: Overlay Background Color

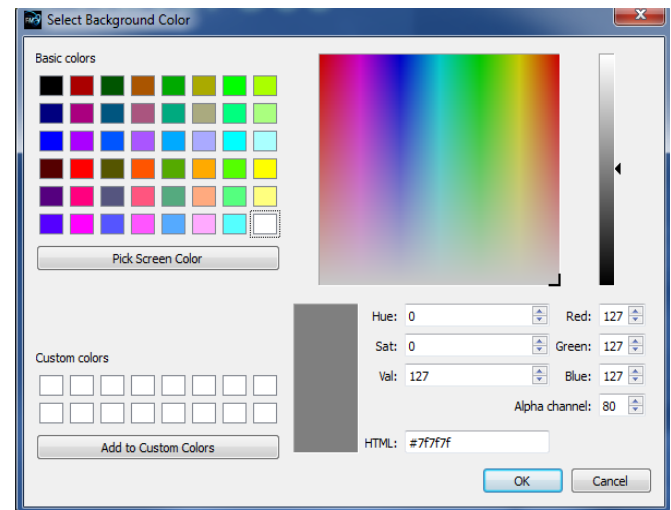


Figure 4-53: Image Overlay Example



Setting up an Image Overlay:

Image overlays may be added to any recording in much the same way as text overlays:

1. Right-click on the image window in Playback to bring up the context menu (see Figure 4-48).
2. Select "Add Overlay."
3. The Overlay Item Selection Dialog will open. Click on "Cancel."
4. You will now have an overlay at the top of the image with the text "<add items>"
5. Right-click on the overlay box to bring up the Overlay Context Menu and select "Overlay Image..."
6. A browser will open which will allow you to select a .jpg, .png, .bmp, or .tif image.
7. Size the overlay by grabbing it by a corner and stretching or shrinking it to fit.

Note: If you wish to use an image with a transparency (alpha) channel, use a png image.

## 4-20: Playback from File and Transcoding

FasMotion is capable of playing back and transcoding AVI videos and image stacks recorded by ILx cameras and stored on a computer drive.

To open a video or stack, select “Open Video File...” from the File Menu in FasMotion.

This will open a Windows Explore window that will allow you to browse the media connected to your computer. In the lower right corner of the window you will see the list of Image file types FasMotion can open: jpg, jpeg, bmp, tif, tiff, dng and avi.

You may also click on the down arrow to select cap files.

You may open multiple files for playback, although only one file may be either played or saved at a time.

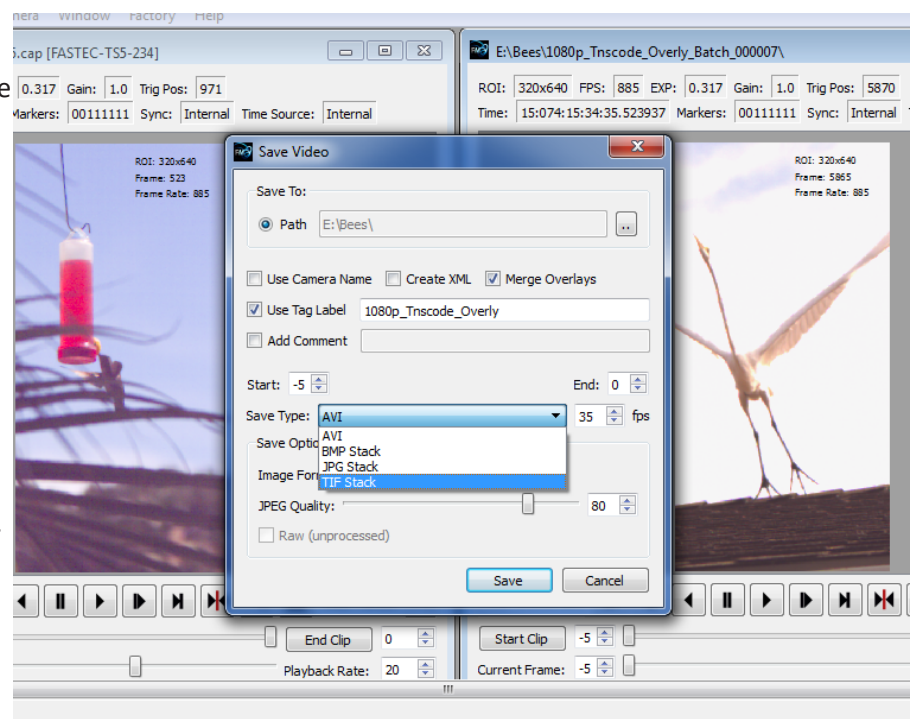
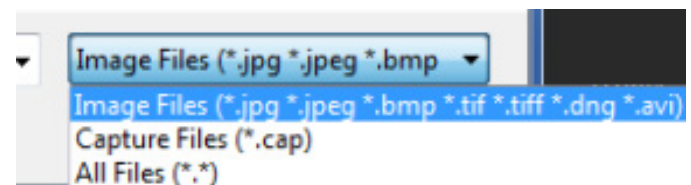
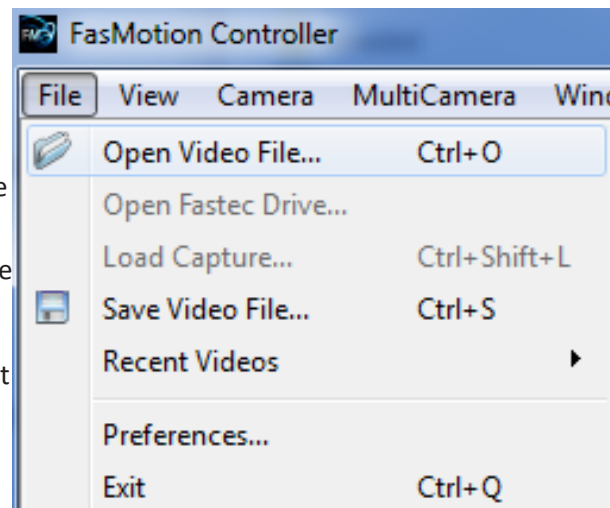
To Transcode a video, that is, to re-save it, right-click on the image window (or Ctrl+S) and select “Save Video File...”

This will open the familiar Save Video dialog box. This is a slightly different version of the dialog than you would see if saving video from the camera. It allows only saves to a Path (not to any camera media).

This dialog supports:

- Transcoding from any saved stack or CAP file (not AVI).
- Adjusting Start and End points.
- Adjust JPEG Quality. (When transcoding from JPEG to JPEG or JPEG to AVI, there will always some loss of fidelity even if JPEG Quality is set to 100. If the original JPEG was saved with JPEG Quality set to 80, setting it to 100 for the second generation will not make the second generation better than the first. )
- Adding overlays (cannot remove original overlays).
- Save to AVI, BMP, JPG, or TIF. Save to DNG only from CAP file.

Figure 4-54: Open Video File



## 4-21: Transfers, Batch Transfers and Conversions

Stills, stacks, videos, and capture files (CAP), saved on camera media may be managed via Explore on the FasMotion Storage Settings tab.

### Copy / Batch Copy

Stills, videos, and stacks may be copied from any camera media (SD card, SSD, or USB device) to any other camera media or to a Path accessible via your computer (any media attached to your computer or networked drive, etc.).

1. Select the camera media you wish to copy from using the radio buttons in External Storage box on the Storage Settings tab.
2. Click on the Explore button. The media on the camera will be accessed and read at this point, which may take a minute or two, depending on the number of files and folders present.
3. Select the type of image data you wish to copy, (Stills, Stacks, Video or Capture).
4. You will be presented with a list of available files or folders to pick from. Pick one or more from this list. You may click on one, or Ctrl/click on multiple files, or Shift/click on the first and last of a sequence for a **Batch Copy**.
5. Once you have made your selection, click on Copy. A little dialog box will open that allows you to choose a destination.
6. Select from the list of available camera media to copy to another drive on the camera, or Path to copy to media attached to your computer.

### Move

Move works exactly like Copy, except that the source files are deleted after they are copied.

**Note:** *Move is not enabled for the SSD.*

Figure 4-55: FasMotion Explore Menu

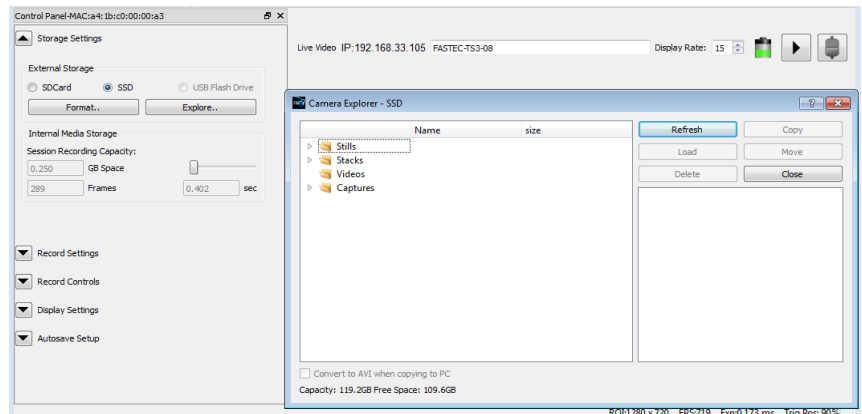


Figure 4-56: Copy: Choose Destination

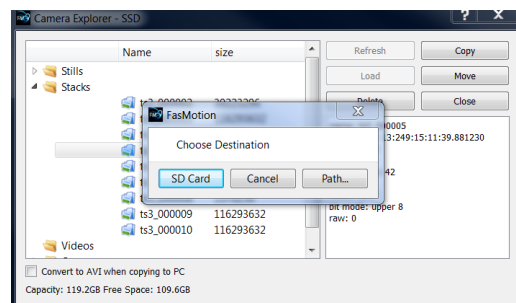
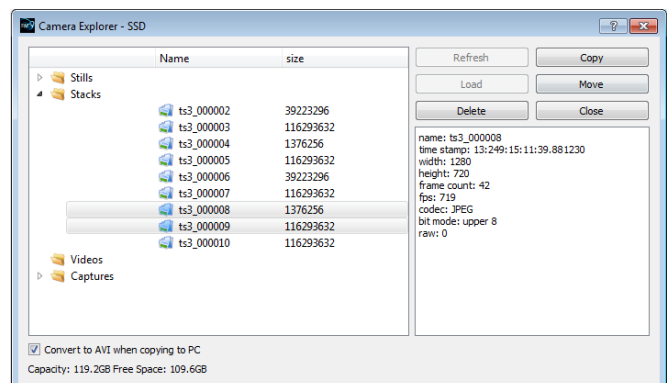


Figure 4-57: Batch Copy Convert: JPEG or BMP to AVI





### Convert JPEG or BMP Stacks to AVIs

JPEG and BMP stacks will be converted to AVI videos during transfers (copy or move) if the “Convert to AVI” box in the lower left corner of the explore window is checked. Refer to Figure 4-57 on page 58.

There is no additional compression used when converting JPEGs or BMPs to AVIs. Compression for JPEG/AVI files will be the same as the original JPEG, which was selected via JPEG Qfactor in camera Preferences when the JPEG was saved.

BMP/AVI files are uncompressed and may very large. Be aware that very large AVI files may take extra time to load and play on your computer.

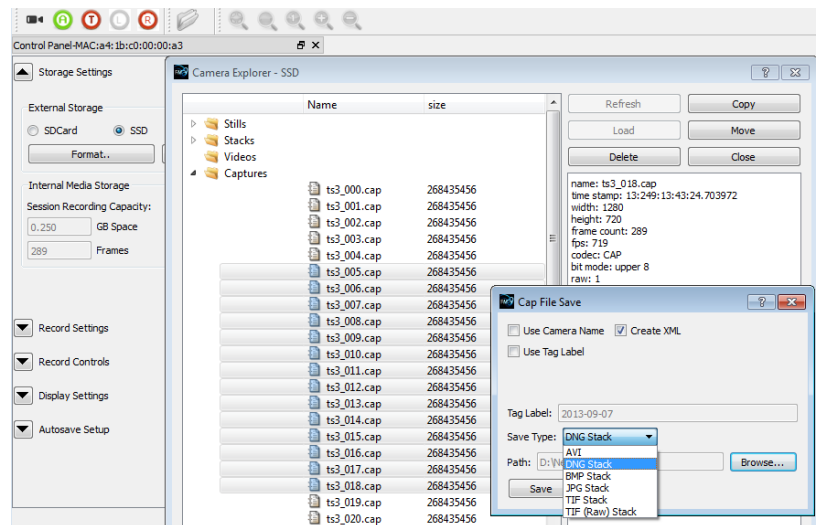
### Batch Copy and Convert CAP Files

Note: CAP files are only present on cameras with SSDs. If you have an ILx without an SSD and would like to add this functionality, please contact your Fastec distributor and inquire about an upgrade.

When one or more CAP (Partition Capture) files are selected for Copy or Move, an additional dialog box will appear that will give you all the available options for naming the saved images, inclusion of the per frame metadata XML file, file type and Path.

Note: the display properties, including color balance, gamma, etc. of the saved imagery will be those set in the camera when the CAP files were captured. If you would like to make any changes, you will want to load the CAP files individually and save them via the Review/Save Tab after making any changes.

Figure 4-58: Batch Copy Convert: CAP files





## 5 Synchronizing Cameras

**Note:** Please refer to “Appendix F: Power and I/O Connections” on page 114 for electrical specifications. Do not experiment with these connections if you are unsure of compatibility with your source as they are very sensitive to over voltage and can be easily damaged.

### 5-1 Sync In

#### Per Frame:

The ILx is easily synchronized to an external device such as another camera, or a precision timing generator. The “Per Frame” option is used when you wish the camera to capture at a rate of one sync-pulse per frame or fewer.

#### To set up Sync-In:

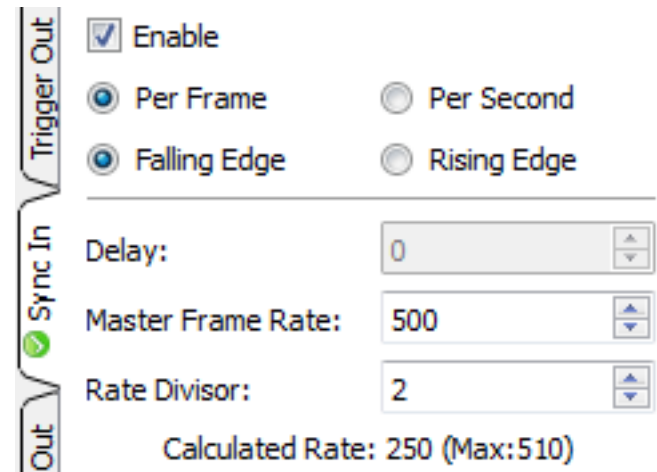
1. Open the Record Controls tab in FasMotion.
2. Click on the “Enable Sync In” check box to enable Sync In.

**Note:** As soon as Sync In is enabled, the camera needs a sync pulse in order to continue taking Live frames. You may not notice this immediately because FasMotion will continue to display the last frame it captured.

3. Select Rising Edge or falling edge depending on your preference.
4. Select Per Frame. (Per Second Synchronization will be covered in the next section.)
5. Set the master frame rate. This is the speed in Hertz of the input signal. It is important that the input signal does not exceed this because this is the number the camera will use to calculate integration timing.
6. Set the rate divisor. In the example shown in “Figure 5-1: Sync In Settings Dialog”, the desired frame rate is 250, while the Master Frame rate is 500, so a divisor of 2 is used.
7. The camera’s frame rate will now be set at 250 and all of the shutter settings are adjusted accordingly.

In this example, the Max (frame rate) is 510. The camera’s resolution was set at 1280 x 1024 for which 510 is the maximum frame rate. If you wish to change your maximum frame rate, you must change the resolution in the Record/Settings menu.

Figure 5-1: Sync In Settings Dialog



**Figure 5-2: Sync: Per Frame Timing**

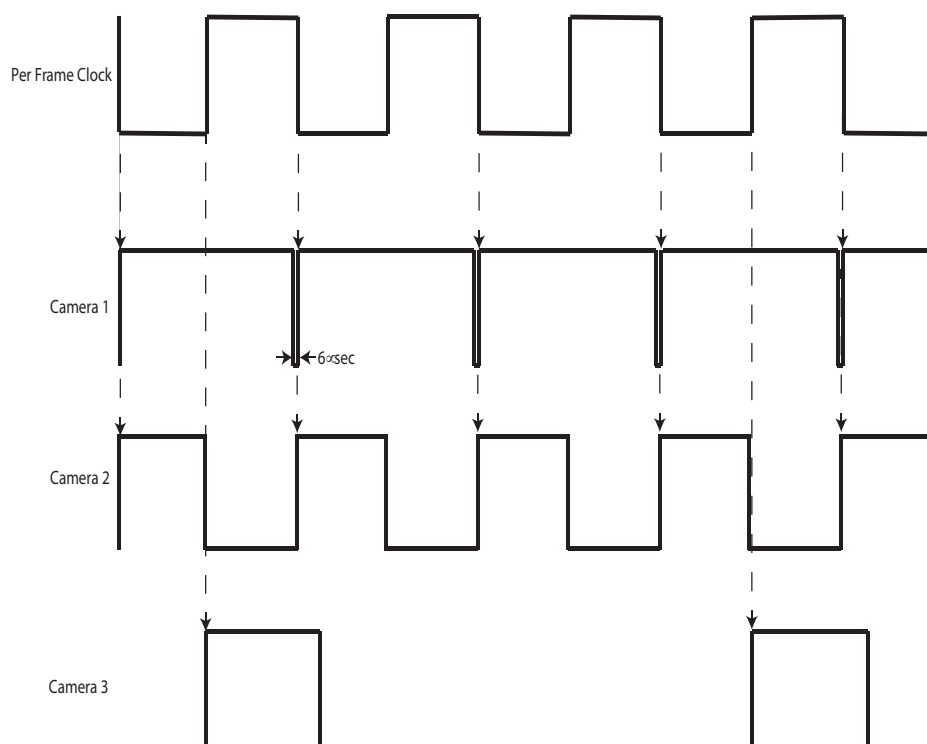
The Frame Clock may be from another Camera (See “5-3 Master/Slave Setup” on page 63) or some other external clock.

Note: for each camera, the signal shown represents the exposure (high = shutter “open”)

Camera 1 is set for Falling Edge, at a 1x shutter. Note that there is a 6μsec inter-frame time.

Camera 2 is set for Falling Edge, at a 2x shutter. Note that exposures for Camera 1 and Camera 2 begin at the same time.

Camera 3 is set for Rising Edge, a 4x shutter and has a rate divisor of 3.



### Per Second:

Many commonly available sync sources have a precision 1 Hz output. IRIG and GPS are two that are very often used with high-speed data capture.

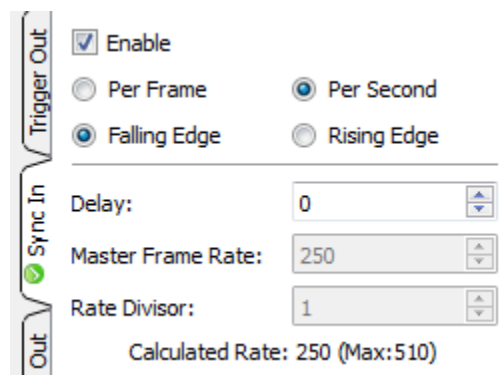
The ILx is able to utilize these signals for synchronization of cameras at any frame rate.

### To use Per Second Synchronization:

1. Open the Record Controls tab and locate the Sync In controls.
2. Click on the check box to enable Sync In.
3. Select “Per Second” in the dialog box. The Master Frame rate and Rate Divisor fields will gray-out.

The camera will now record at whatever rate has been selected in the Record Settings tab, in this case it is 250 fps. It will multiply the 1Hz Sync In pulse by 250 to clock the camera. In this manner it is possible to synchronize several cameras, operating at different frame rates to one 1Hz signal.

The Delay control may be used to fine-tune the sync or, if multiple cameras are used, to force a phase relationship between synchronized cameras.

**Figure 5-3: Sync In Per Second**

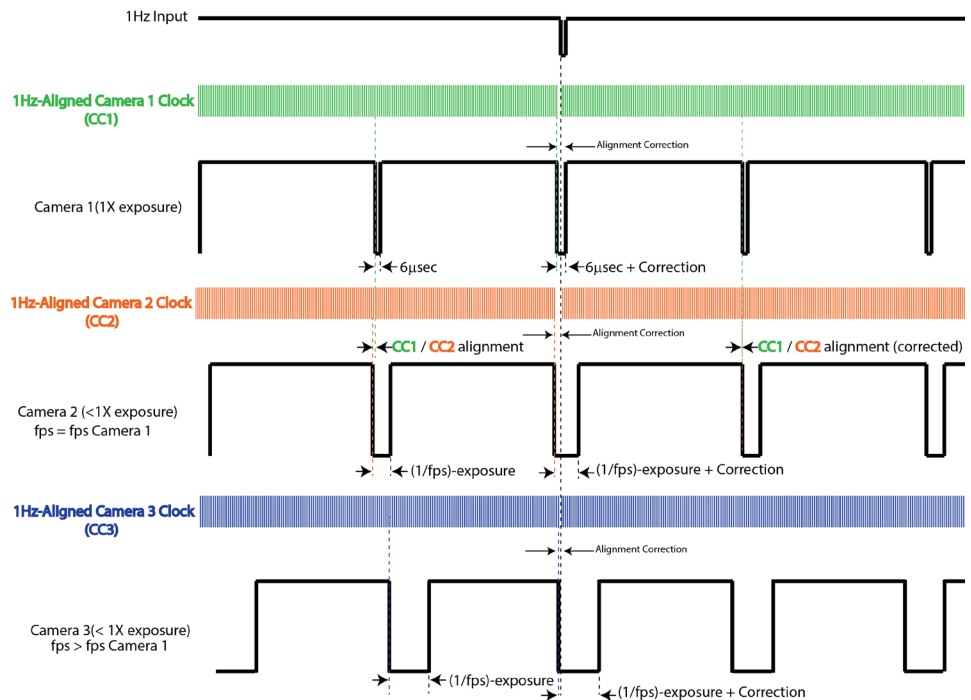
Each Camera derives an internal clock from the 1Hz “Per Second” input signal, (from either the Sync-In or IRIG inputs), which it can use to run at any desired rate, as in normal operation. A small correction may be done at the inter-frame time of the last frame in any given second (see the “alignment correction” on the diagram).

Camera 1 is set with a 1x shutter. The exposure time is  $1/\text{fps} - 6\mu\text{sec}$ .

Camera 2 is set at the same frame rate as Camera 1, but with a shorter exposure. Note that the frame alignment is at the end of each exposure, not the beginning as with per-frame sync.

Camera 3 is set at a slightly faster frame rate than cameras 1 and 2. Note that the end of the exposure of the last frame of the second will be aligned with cameras (slightly skewed) 1 and 2. Sync timing between camera 3 and the other two cameras will phase in and out depending on the frame rates.

**Figure 5-4: Sync: Per Second Timing**



## 5-2 Sync Out

### Per Frame

External devices such as additional cameras, strobe lights, and test instruments may be synchronized via Sync Out pulses from the. The “Per Frame” option output is one pulse per frame--the sync pulse rate is equal to the recording frame rate.

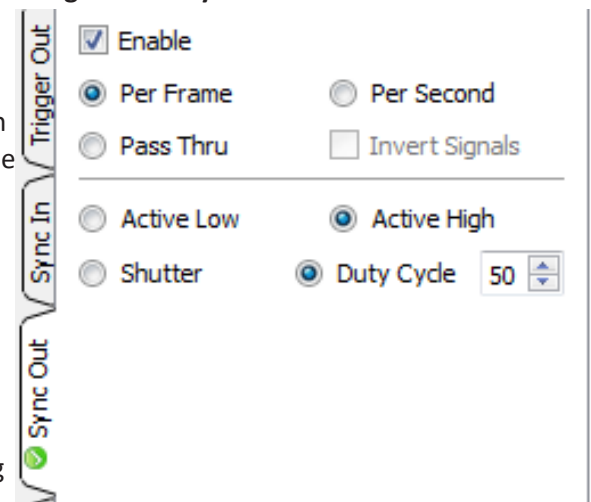
#### To set up Sync Out:

1. Open the Record Controls tab and locate the Sync Out controls.
2. Click on the check box to enable Sync Out.
3. The signal can either be **Active High**, meaning the signal goes high when the shutter opens, or **Active Low**, meaning the signal goes low with when the shutter opens. Select Active High or Low from the dialog box.
4. The signal can either follow the Shutter (integration time) or you can select Duty Cycle and control the % of frame time ( $1/\text{frame rate}$ ) for the active portion of the signal using the number box provided.

### Per Second

If you choose the “Per Second,” the camera will output a 1Hz signal. The only active options in this mode are Active High and Active Low.

**Figure 5-5: Sync Out Per Frame**



## Pass Thru

When you select Sync Out Pass Thru, the signal received on Sync In is sent to Sync Out. The only setting that affects this signal is the Invert Sync In option, which simply inverts the signal.

## 5-3 Master/Slave Setup

There are many possible configurations used to synchronize groups of cameras. The Master/Slave configuration is often used when a group cameras is used to capture multiple synchronous views of an event that is not driven by a clock or PLC. For example, when studying animal or human kinetics, the subject (animal or human) is not supplying a sync signal for the camera system, so the camera system uses its own: Sync Out from a Master camera.

In this configuration, any camera may be used as the Master.

Commonly, all cameras are set to the same Frame Rate and Resolution, are triggered together, and integrate frames together (synchronize frame start times). For this setup:

- Enable External Trigger for all cameras and use the same polarity for all.
- Sync Out from the Master camera is set to “Per Frame”
- Sync Out for the Slave cameras is set to “Pass Thru.” Invert Sync In is **not** selected.
- Sync In for the Slave cameras Master Frame rate is set the same as the Frame rate of the Master camera.
- Choice of Shutter or Duty Cycle does not matter.
- If the Master Sync Out is Active High, then the Slave Sync In must be set for Rising Edge. If

Figure 5-6: Sync Pass Thru

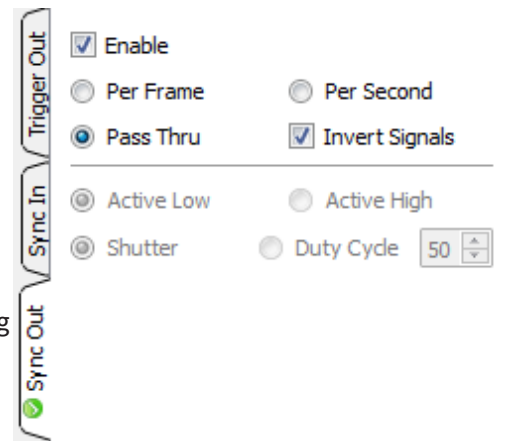
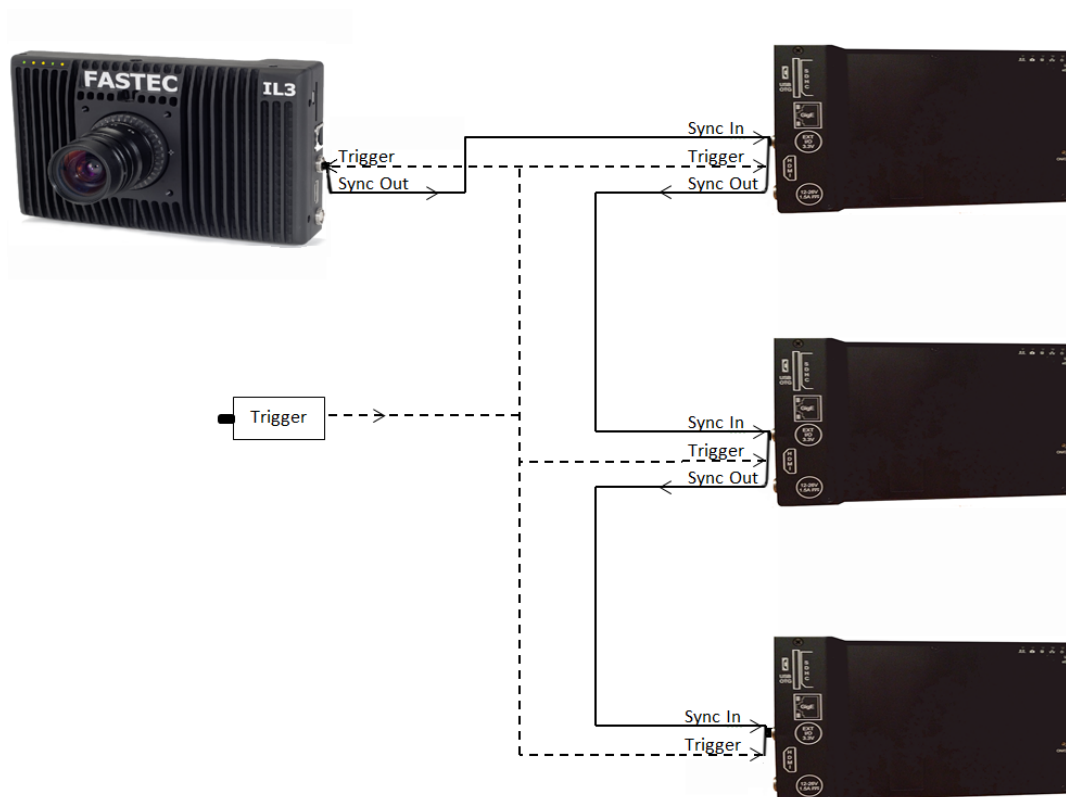


Figure 5-7: Master and Slave Cameras



Master Sync Out is Active Low, then the Slave Sync In must be set for Falling Edge.

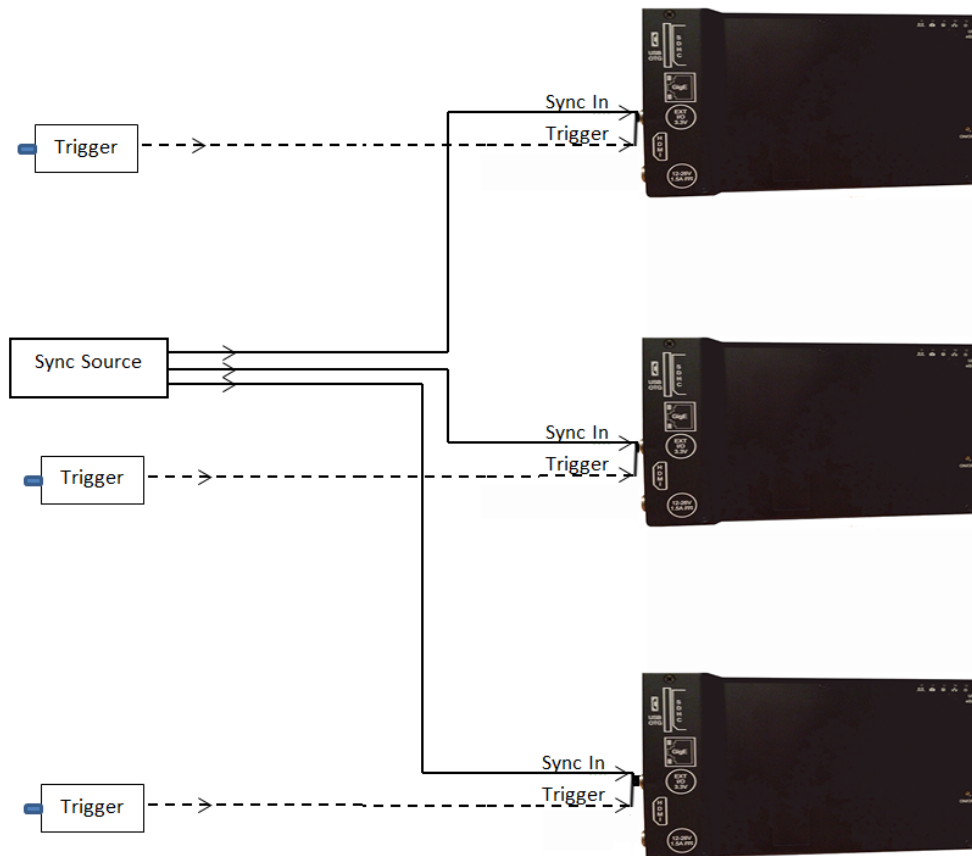
NOTE: For the “common” setup as well as for variations listed below, always make sure that the Post Trigger portion of the recording time for the Master camera is equal to or greater than each of the Slave cameras. This is important because Sync Out pulses cease with the completion of the capture, so the Master camera must continue recording until all Slave cameras complete their recordings.

Parameters that affect post trigger recording time include: Trigger position, Resolution, Bit depth, base internal Memory (camera model), Frame rate.

Variations on Master/Slave:

- Use a slower frame rate for one or more of the slave cameras by using a Rate Divisor in the Sync-In setup. (Make sure to make allowance for the extended time per the note above.)
- Extend the overall record time by adjusting the trigger position for all cameras. For example, set the Master to a Start trigger, the first Slave to 10%, the second Slave to 50%, etc. This would also be used if the subject is progressing through the different cameras' fields of view, as a runner running by each camera in sequence.
- Run cameras out of phase with each other. Higher effective frame rates can be simulated by running cameras out of phase with each other. This is usually done by using Duty Cycle in Sync Out, for example: if you set the Duty Cycle for 50% and invert the signal, the next camera in line will run 180 degrees out of sync.

Figure 5-8: External Sync: Local Grouping





## 5-4 External Source Sync

Synchronizing to an external source is most common in applications where a preferred sync pulse is available such as one from a PLC, IRIG, or GPS.

NOTE: Please refer to “Appendix F: Power and I/O Connections” on page 114, for electrical specifications.

This sync pulse may be used for a localized group of cameras, in which the cameras are connected as in “Figure 5-8: External Sync: Local Grouping” on page 64 is commonly used. The cameras may also be placed far apart, in which case they are connected to a distributed sync signal as in “Figure 5-9: External Sync: Distributed Grouping”.

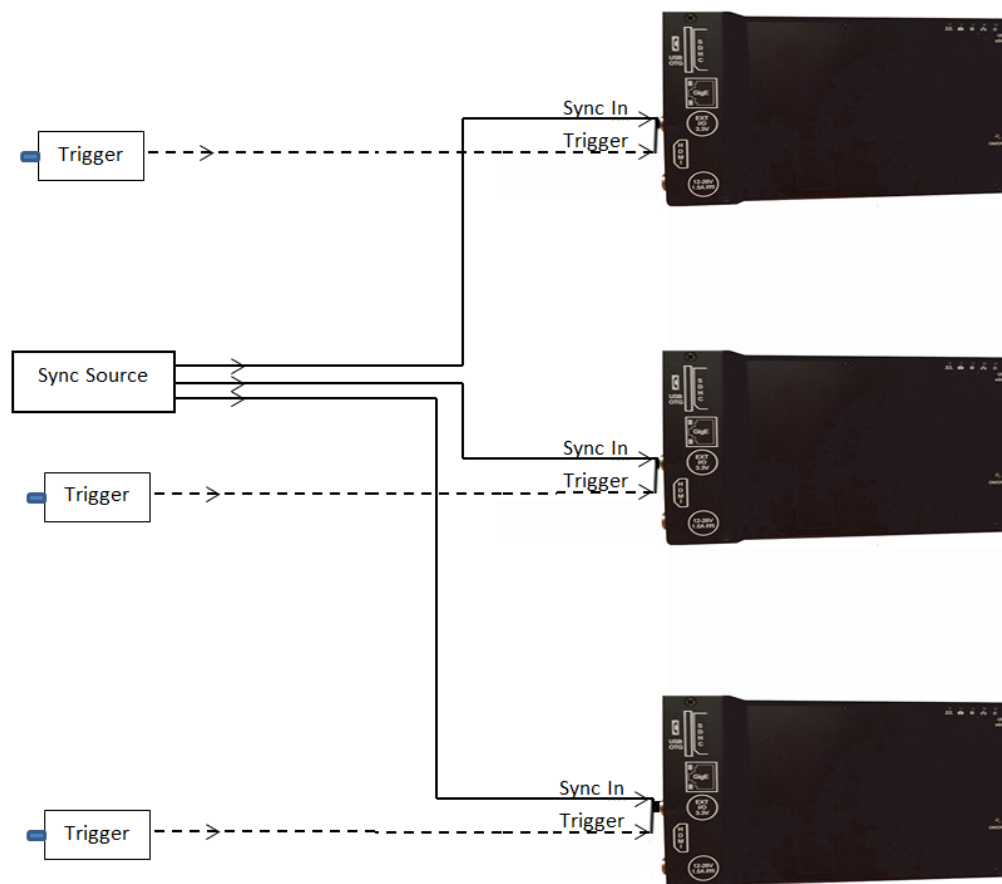
In the case of using a PLC or other local clock, you will need to know the polarity and frequency of the signal in order to set the cameras up. Optimum frame rates can often be derived using the Rate Devisor function.

When using IRIG or GPS as an input, you will first need to derive a 1Hz signal from the source, and then use the Per Second option. This gives you complete flexibility with respect to frame rate: you can select any frame rate you wish to use.

Note: full IRIG and GPS implementation is planned for a future release.

Triggering in a distributed grouping may either be implemented locally via switch, camera button, or software, or it may be available along with the sync as a distributed signal.

**Figure 5-9: External Sync: Distributed Grouping**

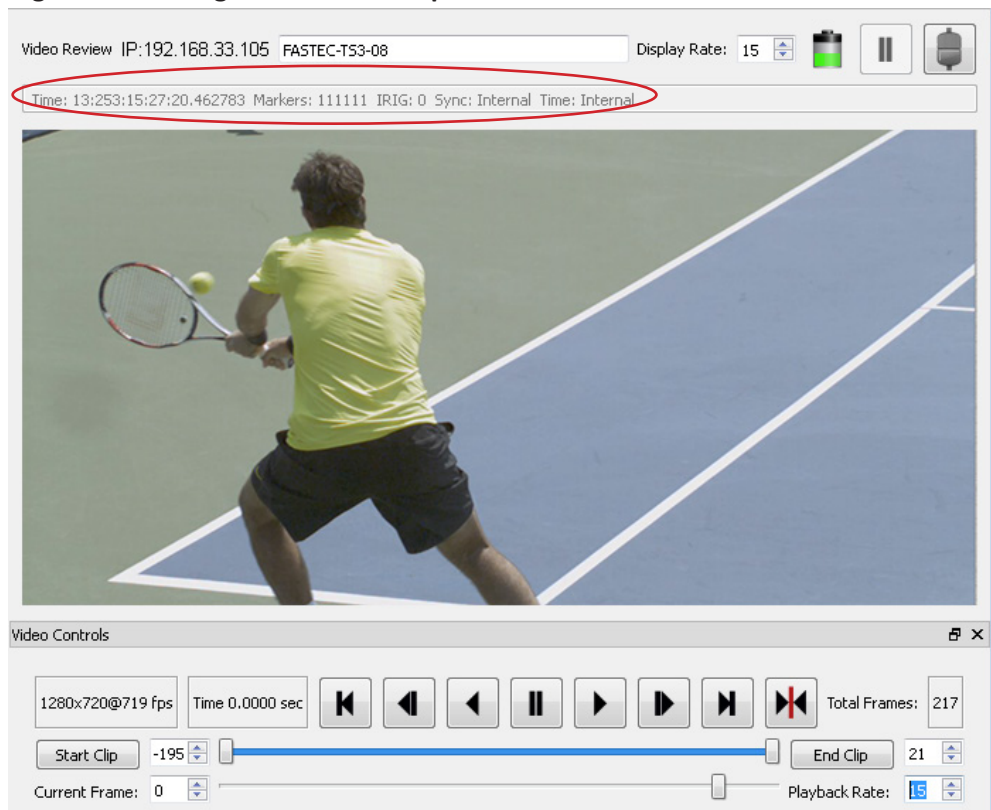


## 5-5 IL3 / IL4 / IL5 Timestamps and Markers

Whenever the ILx records imagery, it also records a timestamp for each frame. This timestamp may be displayed during playback and may also be saved to an XML file (see “Appendix J: Contents of <Capture>.XML File” on page 121 and “4-18 Saving Images to Mass Storage” on page 52).

To view the Timestamp and Markers, select “Per Frame Metadata” in the View Menu while in Playback mode.

**Figure 5-10: Image with Timestamp**



### Timestamp Format

Time: YY:DDD:HH:MM:SS.xxxxxx

For the example shown in Figure 5-10 this is:

YY = Year: 13 = 2013

DDD =Day: 253 = September 10 (See “Appendix O: Day Number Calendar Conversion” on page 128.)

HH:MM = Hour:Minute: 15:27 = 3:27pm

SS.xxxxxx = Seconds: 20.462783 (granularity to  $\mu$ sec)

Note: the Timestamp line is always available during playback from camera memory or from CAP files loaded into camera memory from an SSD. It is also seen in saved files played back via FasMotion, but only if they are accompanied by an XML file.

**If you are interested in archiving Markers and Timestamps, remember to save the XML file along with the video!**

### Markers: 111111

The Timestamp line includes event markers. In the example shown in Figure 5-10 all of the I/O pins were “high” for the duration of the displayed image frame.

For each I/O pin there is a default signal, such as Trigger-In, Sync-In, Arm-Out, etc. that can be enabled via the Control menu. These same I/O pins may be utilized for marking events in the captured video clip. The electrical interface is the same for all pins.

**NOTE: These pins are very sensitive to over voltage and can easily be damaged. Please refer to “Appendix F: Power and I/O Connections” on page 114.**

IRIG: 0

In the example IRIG is not enabled (0). (IRIG is not currently an option for the ILx.)

Sync: Internal

The Sync term can be Internal (internal camera clock used for frame timing), PPF (Sync-In pulse used for per-frame timing), or PPS (1Hz clock input at Sync in used to derive the camera frame timing). See “5-1 Sync In” on page 60.

Time: Internal (The Time is always set to Internal for the ILx as the IRIG option is not available.)

The pin out and default signal list for the markers is seen in. Any pin that has not been enabled for Trigger, Arm, or Sync, including those that default as outputs, may be used as a marker input.

**Table 5-1: I/O Pins to Markers**

(0x3f) = Marker:		0	0	1	1	1	1	1	1
I/O Pin	Default Signal								
x	Section Start	0							
x	Record Start		0						
7	Trigger-In			1					
4	Trigger-Out				1				
8	Sync-In					1			
3	Sync-Out						1		
6	Arm-In							1	
5	Arm-Out								1

**Figure 5-11: Per Frame Metadata from XML File**

On a camera that has none of its I/O options enabled, all of the I/O pins will be high and the Markers in the Timestamp line and in the per-frame metadata will always be 1's as in Table 5-1.

The markers are represented in the XML data in hexadecimal format: “<markers>0x3f”

If the user chooses to pull one or more of those pins down during a capture, all frames captured while those pins were held low will now show a “0” for the appropriate digit.

```
- <frame>
  <number>87</number>
  <irig>0</irig>
  <sync_mode>0</sync_mode>
  <time_state>0</time_state>
  <markers>0x3f</markers>
  <time>13:213:15:39:31.879023</time>
  See “Appendix J: Contents of <Capture>.XML File”
```

Section (not yet used) and Record Start are not tied to I/O pins. Record Start marks the beginning of FasCorder ROC and BROCC recordings on Dual Mode cameras in Long Record.

Example: If pins 4 and 5 are held down during some part of a recording, then, when viewing those frames the Timestamp line in playback would show Markers: 00101110.

Using this same example, the XML file would show <markers>0x2e.

### Using Event Markers:

1. Select an unused (not enabled) I/O pin to use as an input. For this example we will use Sync-Out, but any of the six I/O pins may be used. (We will first confirm that Sync-Out is not enabled by going to the Control menu on the camera GUI--we should see “Disabled” on the Sync Out line.)
2. Connect a switch or LVTTTL source to the selected I/O pin. (For our example, we will connect a simple switch to the Sync-Out BNC of the I/O cable.)
3. Make a recording (Arm and Trigger), closing the switch for some portion of the recording.
4. Review the recording in Playback with the Timestamp line turned on. (Select Per Frame Metadata in the View menu of FasMotion.) Scrub the playback bug back and forth along the timeline while watching for changes in the “Markers: xxxxxxxx” section of the timeline. Refer to “4-15 Reviewing Captured Imagery: Playback” on page 43 for details on using markers and viewing I/O data in Review.

You will see the Arm-Out marker go to 0: “Markers: 00111110” for the portion of the clip taken while the switch was closed.

If you save the clip with the XML file to a PC, you will be able to play the file back in FasMotion (any format except DNG) and see the Timestamp line. The XML file will contain the per-frame metadata for the clip, which includes the marker information. For this example you would see “0x3e” in the marker line for any frame for which the switch was closed.

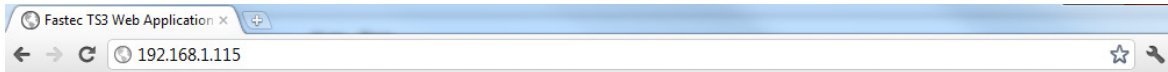
# 6 Using the Web App

## 6-1 Web App Overview

The Web Application is a utility built into both the ILx and its sibling, the TSx which makes control of the camera possible by any networked computer running an Internet Browser. No software needs to be loaded on the computer.

Enter the Web App by typing either the network-connected ILx's camera name or IP address into the address bar of an internet browser (See "3-11 Connect to the ILx Outside FasMotion" on page 22).

**Figure 6-1: Address bar (Chrome)**



The Application Window is comprised of:

- A Control Bar at the top, which includes Arm and Trigger buttons as well as the Battery Icon
- 6 Application Tabs, including the Camera Tab, Storage Settings Tab, Record Settings Tab, Record Control Tab, Display Settings Tab, and the Video Review Tab, which is present only when there is captured video available for Review.
- The Tabs Pane. When you click on a Tab it will open vertically along this pane. Tabs beneath the opened one will slide down the pane.
- The image area. This is where Live or Captured imagery appears.

In the figure below, TS3-12 is connected in Live Mode.

Notice that the Camera Name is displayed in brackets [ ] on the Camera Tab and that the camera's mode of operation (in this case "Live View" is listed there as well. The Trigger Button is absent because the camera has not yet been armed. The Review Tab is also absent as there is no video to review.

**Figure 6-2: Application Window Camera Tab**



## 6-2 Camera Tab

Clicking on the Camera Tab exposes its contents and shifts the other tabs down the Tabs Pane below it.

All tabs are always accessible, with the exception of the Review tab, which is only available in Review Mode (after video has been captured). Clicking on the Camera Tab a second time closes it. Opening another tab will also close the current one.

The Camera Tab always displays the Camera's current Mode of operation.

- Camera Live View, in which a live image is displayed in the Image Area.
- Camera Armed. This is the state of capturing pre-trigger frames.
- Camera Triggered. The camera is capturing post-trigger frames.
- Camera Video Review. The camera has finished recording. The captured video appears on the screen. Playback controls appear beneath the image window. (See "Web-App Review and Save" on page 75.)

You will also notice that when the camera is controlled via the Web App, the Mode script will say, "Waiting for Camera to Arm" or "Waiting for camera Trigger," etc. for a very short time until the app gets confirmation back from the camera that its state has changed.

If the computer loses communication with the camera, the Mode script will say "Camera Load Failure."

**To change the camera name:** highlight the camera name in the Edit Box and type in the new name. Press "tab" to accept.

**The Camera Configuration** may be loaded or saved via the Configuration Dialog. It may be reset using The "Reset to Factory Default..." button.

**The Network Configuration** of the camera may be accessed by clicking on the "Network..." button. Here you may setup either a DHCP or Static configuration.

WiFi Configuration gives the user the options of scanning for an SSID to connect with or using the Manual button to create an SSID for an ad hoc network. Please refer to "3-5 WiFi Setup" on page 16.

Note: A wired connection is needed to initially configure WiFi.

**To perform a Black Level Calibration**, cover the lens and click on the "Black Level Calibration..." button. If you need to change the gain setting, please use FasMotion or the on-camera interface.

Figure 6-3: Camera Tab

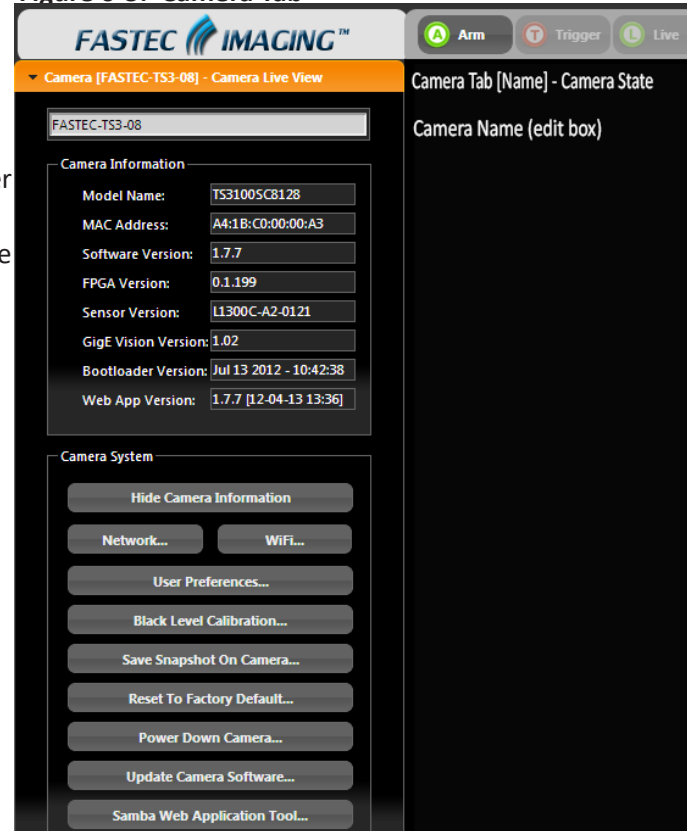
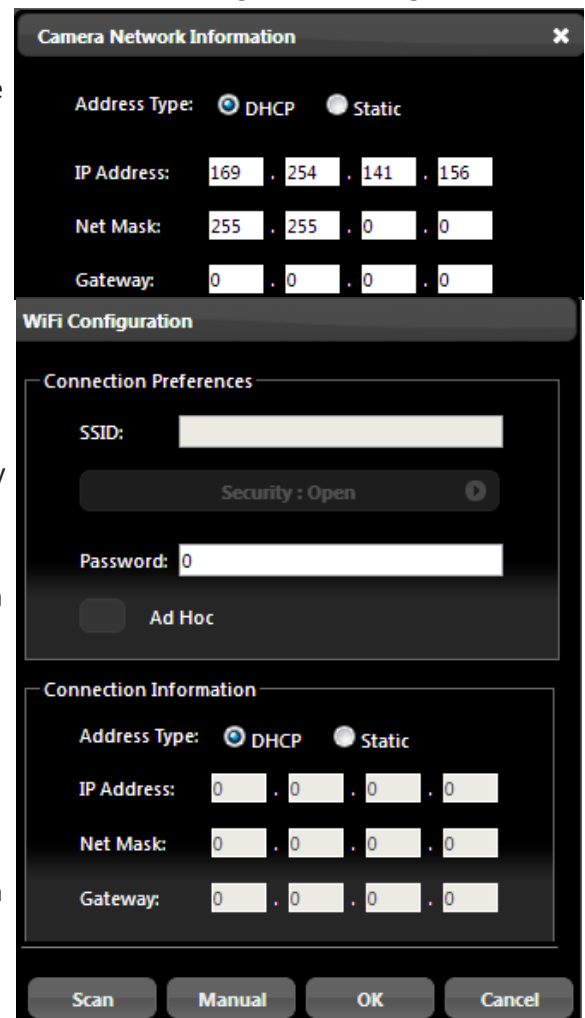


Figure 6-4: Network Configuration Dialog

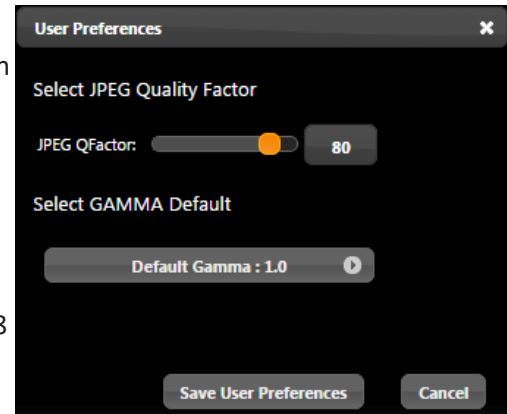




Settings accessed via the User Preferences dialog:

- **JPEG QFactor** sets the quality of the compression used by the camera for streaming (display via Web-GUI and FasMotion), Stills, JPEG stacks and compressed AVI files. The default value is 80, which produces a very good balance between size and quality. For larger, higher quality images, use a higher QFactor. For smaller, lower quality images and faster refresh rates, use a lower QFactor.
- **Default Gamma** setting is used both to set the default output Gamma for displayed and saved images, and to set the Gamma for the LCD display. Gamma of 1.0 (linear) is recommended unless you intend to encode your images with 2.2 Gamma. Please refer to “3-8 Controlling the Image Displays” on page 19.

Figure 6-5: Web App User Preferences



6-3 Storage Settings Tab

The Storage Tab is used to Browse or Format storage devices connected to or installed in the camera and also to set the session length (internal high-speed memory used for capturing video).

Browsing:

1. Use the radio buttons to choose the storage device to manage-- SD Card (SDHC), SSD (only browsable when operating in Standard Mode), or USB Drive.
2. Click on Browse Media... to open an Explore window for the device.
3. If you wish to explore another device from the explore window, click on “Parent Directory” to see the list of other devices.

The Explore window will look slightly different depending on the web browser and operating system you are using, but the content will be the same for all. (See Figure 6-7.)

Notice that in the example, we are looking at the directory of the SD Card: .../media/sdcard. Click on “hs\_video/” to find the stored video files. Click on “dcim/” then “100fastc/” to find stored stills and video stacks.

**To play a video**, click on the file name and the video will open in the default media player. Large stored videos may play slowly when opened this way. You may wish to copy them to a computer drive first, and play them from there.

**To open a still**, click on the file name and the still will open in the explore window. To return to the last directory, right click in the window (but not on the image) and select “back.”

Figure 6-6: Storage Settings Tab

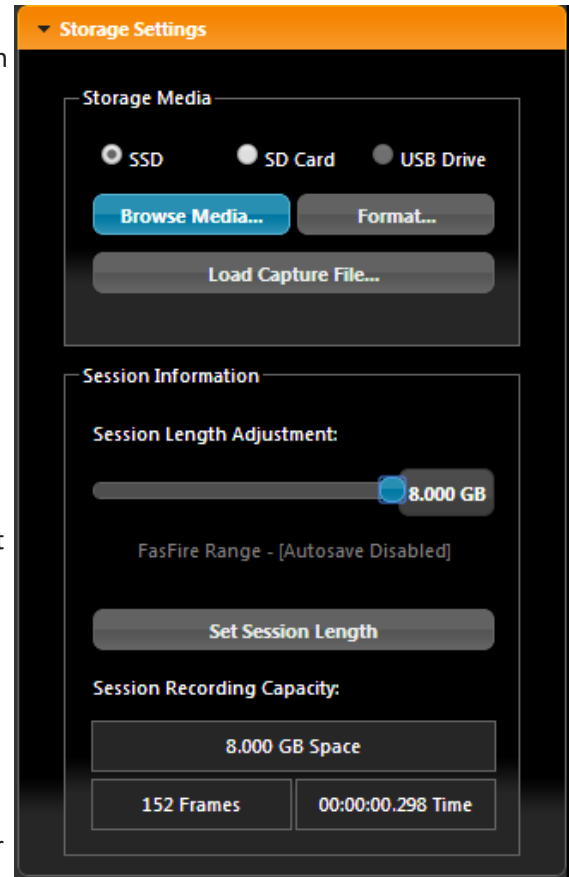
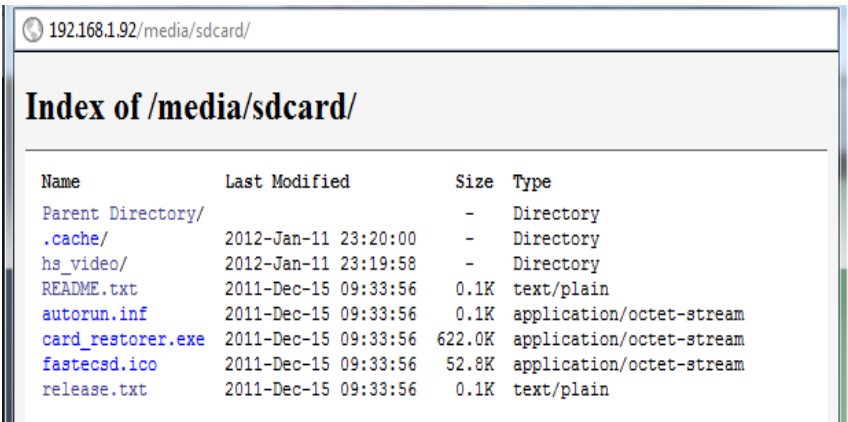


Figure 6-7: Explore Window



**To copy a video or still to a computer drive:**

1. Right click on the file you wish to open. A context menu will open with a list of actions. The list varies depending on the browser you are using.
2. If using Chrome, Firefox, or Safari, select "save link as..." or, if using Windows Internet Explorer, select "save target as..." This will open a dialog box allowing you to navigate to the drive and directory you wish to save the file to.

Note: This is recommended for stills and AVI files only. Only one file may be copied at a time. No files may be either deleted or moved via the Web App. In order to copy groups of files and directories (file stacks, etc.) open the camera in a separate Explore window.

**Formatting**

1. Use the radio button to choose the storage device to format-- SD Card (SDHC), SSD (internal drive), or USB Drive.
2. Click on Format...
3. Select the format type you wish to use (refer to Figure 6-8).

Note: Format choices vary depending on media type and camera version.

**Setting the Session Length**

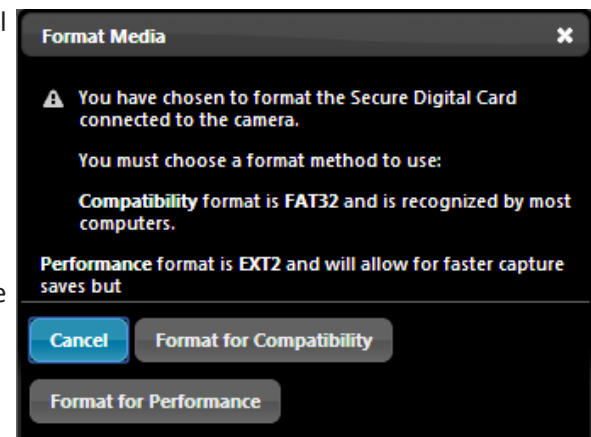
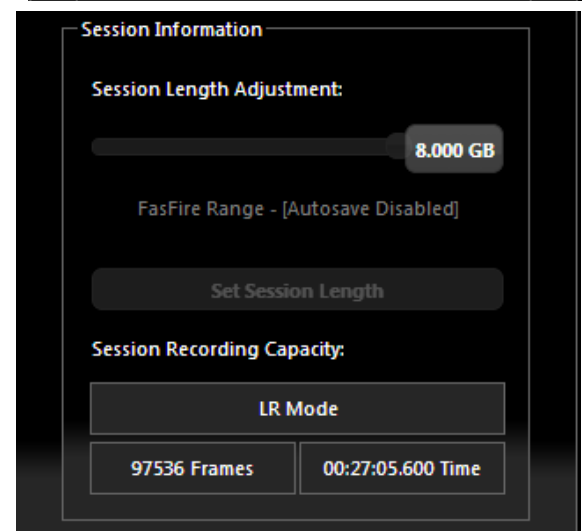
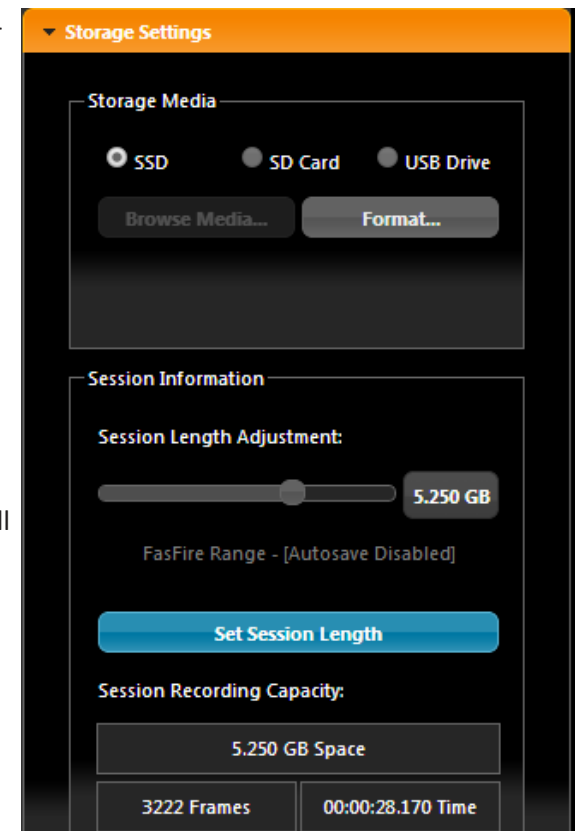
Session select the amount of memory to be used for capturing imagery on the ILs (not in Long Recording Mode). Session length dictates the number of frames captured as well as the capture time.

1. Move the Session Length Adjustment slider to the desired position. You will see the Time and # of Frames change as well as the Space in GB.
2. Click on the blue "Set Session Length" button to send the change to the camera.
3. To set the camera in FasFire mode, the session length will need to be set at less than half the memory size. When the slider is moved to where the camera may be operated in FasFire mode, the text below the Session Length Adjustment slider will become red.

Note that Autosave must be enabled in order to operate in FasFire Mode. Please refer to "4-13 FasFire" on page 40.

**Long Recording Mode**

When the TS4 is operated in Long Recording mode, the Session Length Adjustment slider becomes disabled and the Session Recording Capacity changes to "LR Mode."

**Figure 6-8: Formatting Media****Figure 6-9: Setting Session Length in Web App**

## 6-4 Record Settings

The Record Settings Tab is analogous to the Record tab in FasMotion. It contains the controls for setting ROI (Region of Interest), record Rate and Time (Frame Rate and Record Time), Shutter Speed, and Bit Depth, and FPN.

For an ILx operating in Long Record (LR) mode, the Basic and FasCorder options are selectable via this tab. Please refer to “4-14 Long Recording Modes” on page 42.

### Setting ROI:

1. If you wish to use one of the standard aspect ratios: 4:3, 5:4, or 16:9, click on the Frame Aspect Ratio bar and make your selection from those choices. If wish to select a custom aspect ratio, select that choice from the same pull down menu.
2. If you are using anything but a “Custom” for aspect ratio, you can adjust either width or height and the other will adjust automatically. You can either use the sliders or the edit boxes to make your selection. If you use the edit box, hit the “Tab” key on your computer keyboard or click outside the box to complete your entry.
3. Select the “Autoset” box if you wish the camera ROI set automatically for the largest resolution possible at the selected frame rate.
4. Select the “Center” box to center the ROI to the optical center. If this is unchecked, you may set the ROI offset using the Offset X and Y edit boxes (See “4-2 Setting Frame Rate and Resolution” on page 29).

### Setting the Frame Rate:

Either move the Frame Rate slider or edit the associated text box to change the frame rate.

The frame rate is limited by the resolution. There is a Max frame rate number next to the edit box letting you know what the maximum frame rate is for the current resolution. Clicking on the “Autoset” button will set the frame rate to that maximum number possible with the current resolution setting.

### Setting the Shutter Speed:

Set the shutter speed by moving the slider.

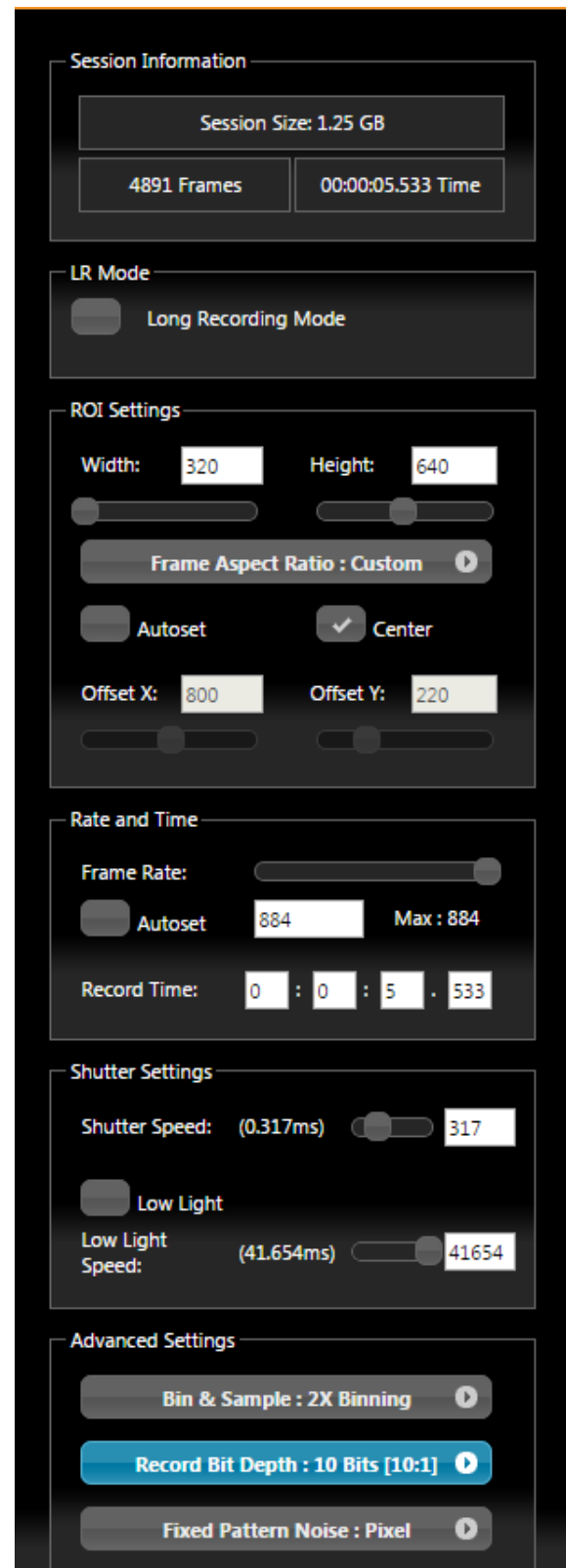
The minimum shutter speed (maximum sensor integration time) is limited by the frame rate. It is .006ms less than 1 frame time or  $1/(\text{frame rate} - .006\text{ms})$  for the IL3 and IL4;  $1/(\text{fr} - .012\text{ms})$  for IL5). The maximum shutter speed (minimum sensor integration time) is .002ms for IL3 / IL4, and .003ms for the IL5.

### Low Light: (See “4-3 Setting Shutter Speed” on page 30.)

The Low light feature lets you use shutter speeds up to 33.326ms for framing and focusing the camera prior to image capture. (During image capture the shutter speed will revert to its normal setting.)

Click on the Low Light check box to enable it. Use the slider to set the shutter speed.

Figure 6-10: Record Settings Tab



The Record Settings Tab, Advanced Settings box has one drop-down menu for Record Bit Depth and another for Fixed Pattern Noise.

#### Select Bit Depth for Recording:

(See “Application Note 2: Understanding Bit Depth” on page 79.)

Note that if 10 or 12 bits are selected for the recording, the recording time will be shorter, but you will have the added flexibility of selecting which 8 bits to view in Review or Save. (The bit selection drop down menu will appear in the Display Settings Tab.

#### Select FPN Setting:

FPN selection (Disabled / Column FPN / Pixel FPN) can be done from the Web-Application via the Advanced Settings menu. Black Frame Calibration may be done from the Camera Systems section of the Camera tab.

Figure 6-11: Record Settings Tab--Advanced Settings

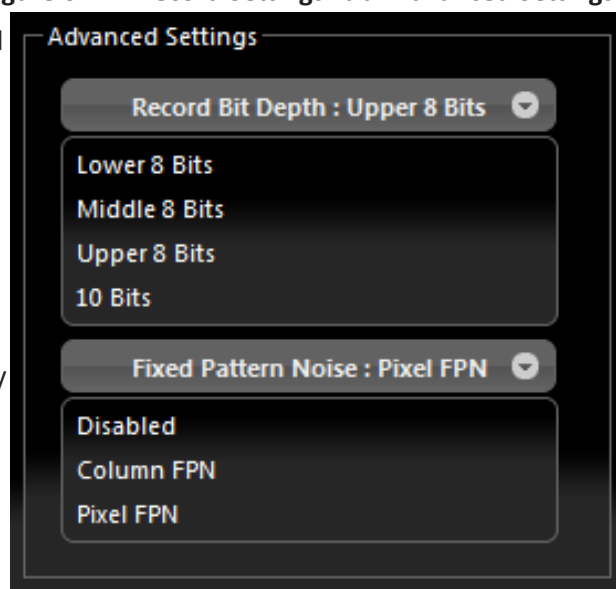
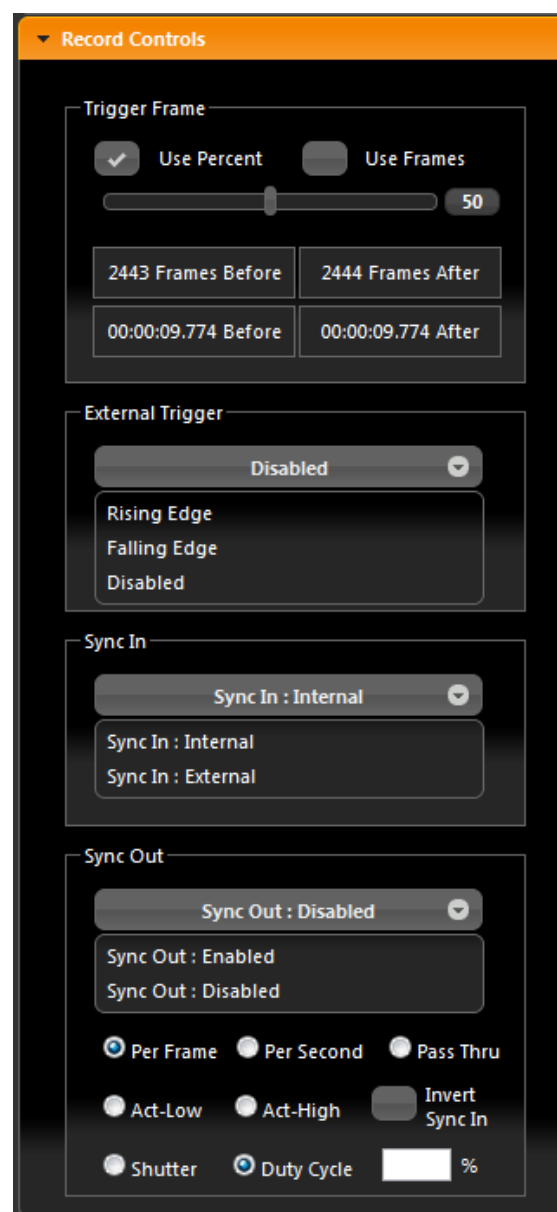


Figure 6-12: Record Controls Tab



## 6-5 Record Controls

The Record Controls Tab of the Web-App is shown in Figure 6-12 with the External Trigger, Sync In and Sync Out pull down menus open.

#### Setting the Trigger Position:

The trigger position is set via slider. There is much finer control of the trigger position using the Web-App than can be had on the camera GUI.

#### External Trigger:

**Please refer to “Appendix F: Power and I/O Connections” on page 114 for specification for all electrical connections, including External Trigger, Sync In and Sync Out.**

Select Rising Edge or Falling Edge to enable the External Trigger. Use Falling Edge for a simple switch closure.

Note: For the Dual Mode ILx in LR FasCorder mode (ROC or BROCC), the Trigger Frame slider will automatically set to “0” as ROC and BROCC both require “start” or triggers.

#### Sync In and Sync Out:

NOTE: If Sync in is enabled you will not see any Live or captured imagery unless there is a valid Sync In signal.

All of the options for camera synchronization are selectable on this menu.

Please refer to “5 Synchronizing Cameras” on page 60 for detailed descriptions of the options.

## 6-6 Display Settings Tab

“Figure 6-13: Display Settings Tab”, is shown with the /Bit Depth and White Balance selection boxes open.

Settings in this tab control displayed images, both Live and in Review, and all saved images except the RAW formats.

The Display **Bit Depth** selection box will only be present when the camera has been placed in 10-bit mode in the Record Settings Tab. (See “Figure 6-11: Record Settings Tab--Advanced Settings”.) For more detail on bit selection see “Application Note 2: Understanding Bit Depth” on page 79.

Select **White Balance\*** preset according to the available light.

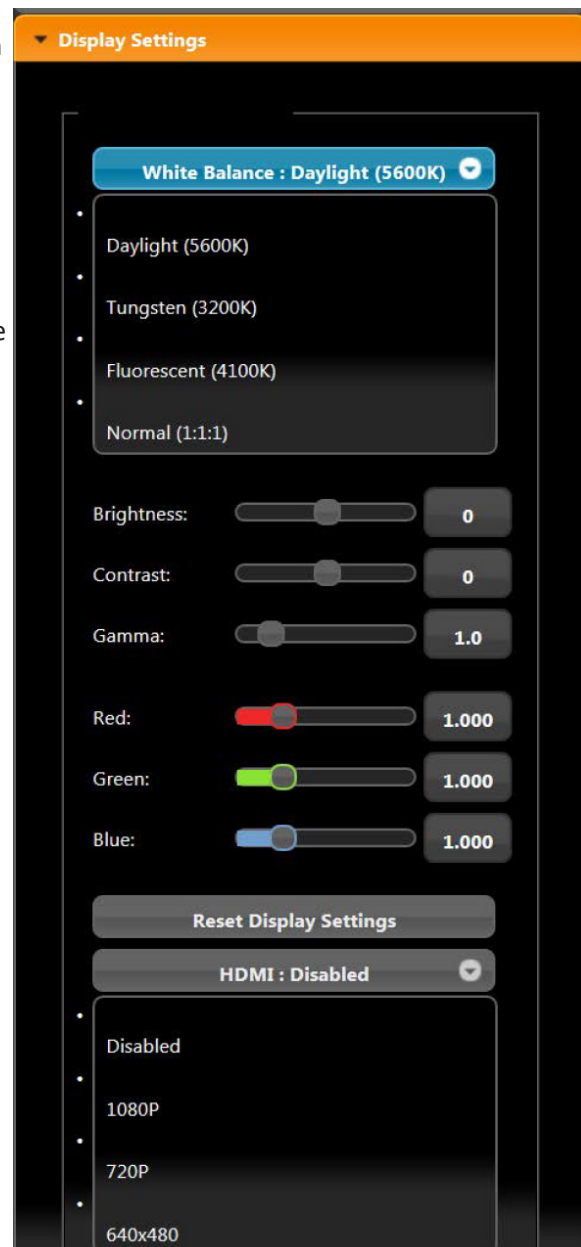
The sliders used for **Brightness, Contrast, and Gamma** you control over the same range as with the presets in the camera, but it is a much finer control.

The color sliders\* give you control over the RGB gains. It is advisable to use the color sliders with a grey card to get good color balance:

1. Frame the camera image on a neutral gray object. (A gray card, piece of white paper, white wall etc.)
2. Turn on the histogram on the camera display.
3. Adjust the light or F-stop so that the histogram shows most pixel values in mid-range. You will see a separate peak for Red, Green, and Blue. Green will likely be highest.
4. Adjust the gains for Blue and Red up so that the peaks match the Green. (\* Color cameras only.)

Use the HDMI dropdown menu to disable or set the HDMI output from the ILx.

Figure 6-13: Display Settings Tab



## 6-7 Arm, Trigger, Live, and Review Buttons

Use the Arm, Trigger, Live, and Review Buttons above the image window to control the state of the camera:

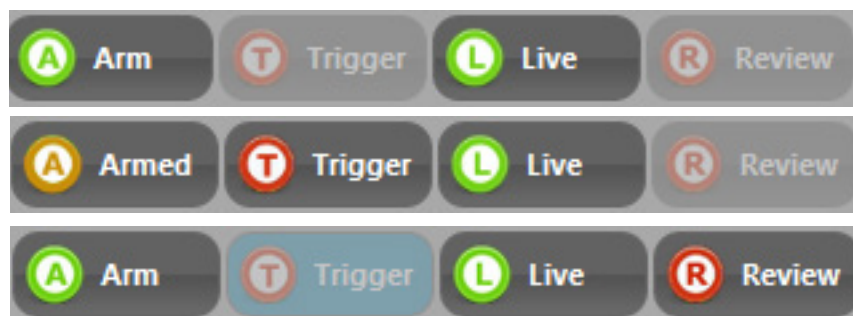
When the camera is in Live mode with no captured images in its buffer, the **Arm** and **Live** buttons will be enabled (bright) and the Trigger and Review buttons will be disabled (grayed).

Click on the **Arm** button whenever it is enabled and to go into Record mode. This will arm the camera, recording the pre-trigger frames.

The Arm button will now turn Brown and change to “Armed.” The Trigger button will become enabled. Clicking on the **Armed** (brown) button will de-arm the camera (after a warning message).

Trigger button function is dependent on the camera state and recording mode. In Basic mode the Trigger will initiate a record cycle on an Armed camera, which will end with the camera saving or playing back the recording. On the ILx In Long Record ROC mode, the Trigger will toggle the camera

Figure 6-14: Arm, Trigger, Live and Review Buttons





between Recording and Armed. In Long Record BROCC mode, the Trigger will capture a specified number of frames then return to Armed.

The **Live** button returns you to Live mode. If the camera is currently recording, there will be a warning message that proceeding will result in loss of unsaved video. If the camera is in Review mode, pressing the Live button will bring up an information box telling you that you are leaving Review and entering Live mode, but that captured video will remain in the camera until it is re-armed.

When in **Review** Mode, the Live and Review buttons act as a toggle between Live and Review. The current recording is not deleted until the camera is Armed or powered down.

## 6-8 Review Tab

When in Review Mode, the Review Tab will open and the Playback controls will appear beneath the Image window.

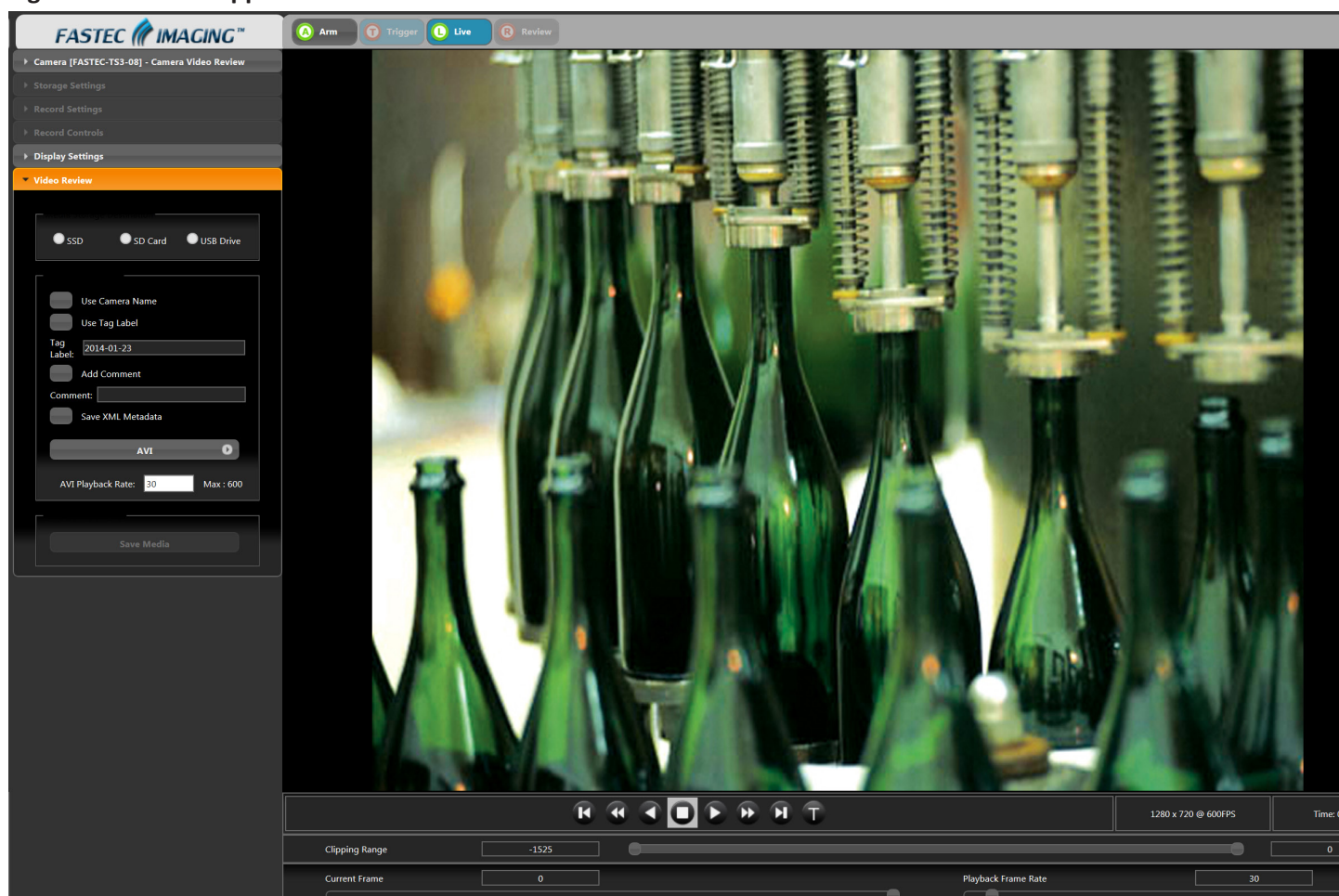
Note: While in Review, the image may be adjusted using the controls in the Display Settings Tab. See “6-6 Display Settings Tab” on page 74.

The Play buttons, which only appear when the mouse cursor is brought over them, have the same functions as on FasMotion (see “Table 4-4: Playback Control” on page 43), except that the Cut-In and Cut-Out points are entered by editing the Clipping Range boxes or by adjusting the slider between them. The clipping range is then used, as it is on the camera GUI for both playback and while saving to mass storage.

You may jump to the beginning of the clip (|<); to the end (|>) or to the Trigger frame (T). You may also move to any frame by editing the Current Frame box, or by moving the slider beneath it.

The Playback Frame Rate box may be edited directly or controlled via slider. The Playback Rate

Figure 6-15: Web-App Review and Save



governs the speed at which the clip is played back both forward and reverse.

The skip forward >> and reverse << buttons skip at 1/10th the Playback Frame Rate. If you set the Playback Rate at 30, the >> and << buttons will skip forward or back 3 frames; if you set it to 300, they will skip 30, etc.

Video clips may be saved to mass storage devices attached to or installed in the camera (SD Card, SSD, or USB Drive).

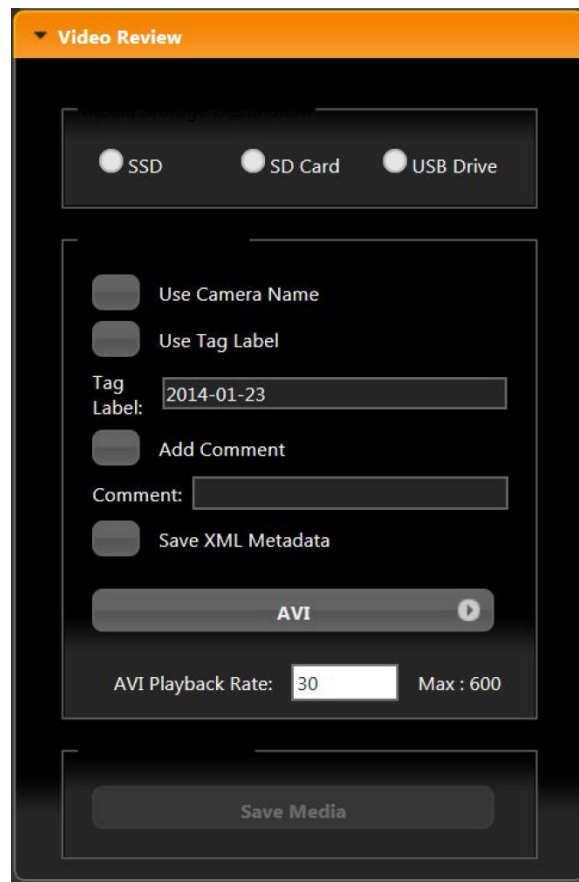
To save a video clip:

1. Adjust the Clipping Range (edit the boxes or move the sliders) to include the portion of the clip you wish to save.
2. Use the “Use Camera Name” and/or “Use Tag Label” check boxes and the Tag Label edit box to set up the file name prefix you wish to use.
3. Click on the File Type bar (labeled “AVI” in “Figure 6-16: Video Review Tab”) to select the file type.
4. Use the “Add a Comment” check box to add a comment to your video. This comment will appear in the camera metadata.
5. Select or deselect “Use Raw Format.” This check box will be active or grayed depending on the bit depth recorded and the file type selected.

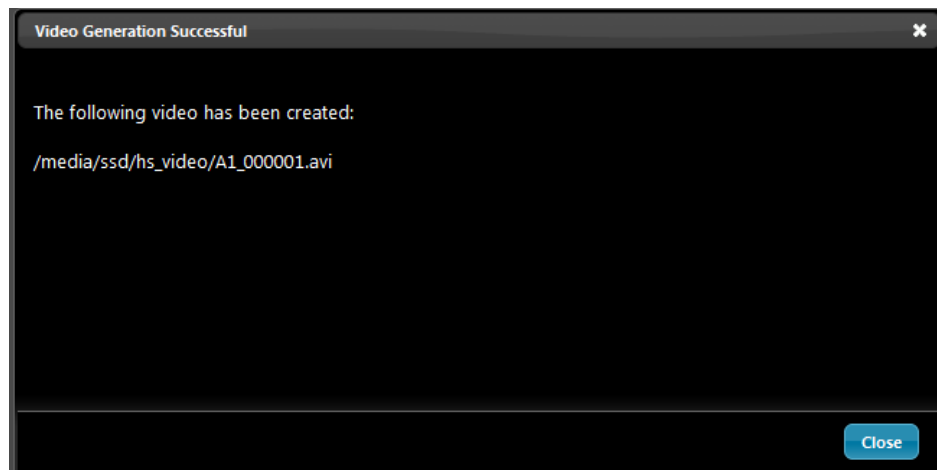
Please refer to “Application Note 6: Choosing an Image File Format” on page 92 for more details.

6. Select the destination drive using the “SD Card,” “SSD,” and “USB Drive” radio buttons.
7. Click on “Save Partition.”

A Progress Bar will appear beneath the image window showing the download status. When finished, an information window as in “Figure 6-17: Download Information Box” will appear.



**Figure 6-17: Download Information Box**



# Application Notes

## Application Note 1: Histograms

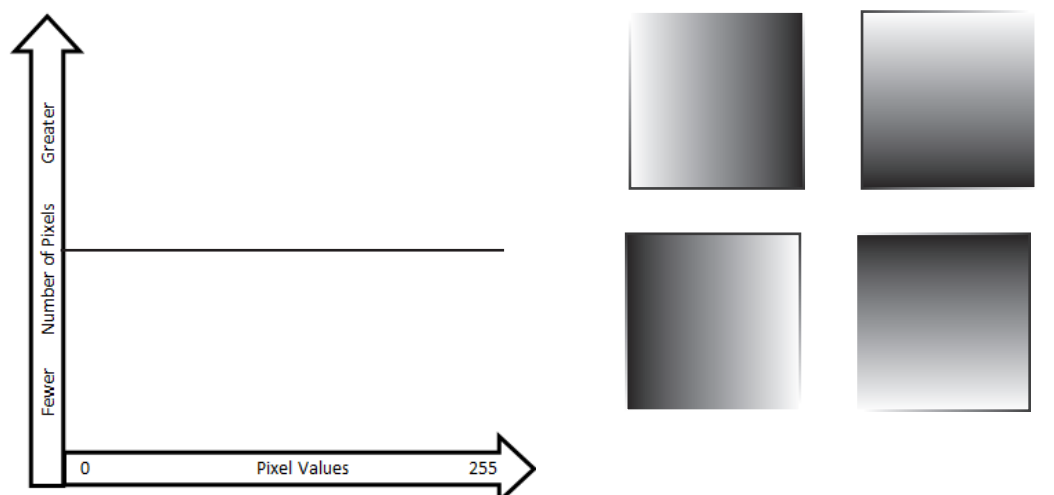
Histograms are available on the ILx to help the user assess the lighting and color balance of the scene framed by the camera. This App Note is provided to help the ILx user understand the information provided by histograms and to offer some basic guidance on their use.

Histograms are available on cameras with Mono and Color sensors. Histograms for Color cameras use Red, Green, and Blue lines to represent the RGB pixel values, while histograms for Mono cameras use a single black line to represent all pixel values.

Note: Histograms on the ILx always shows pixel values 0-255. When the camera is recording in 10-bit mode, the histogram uses high, med, or low 8-bits, depending on the Display setting.

### Mono Histograms:

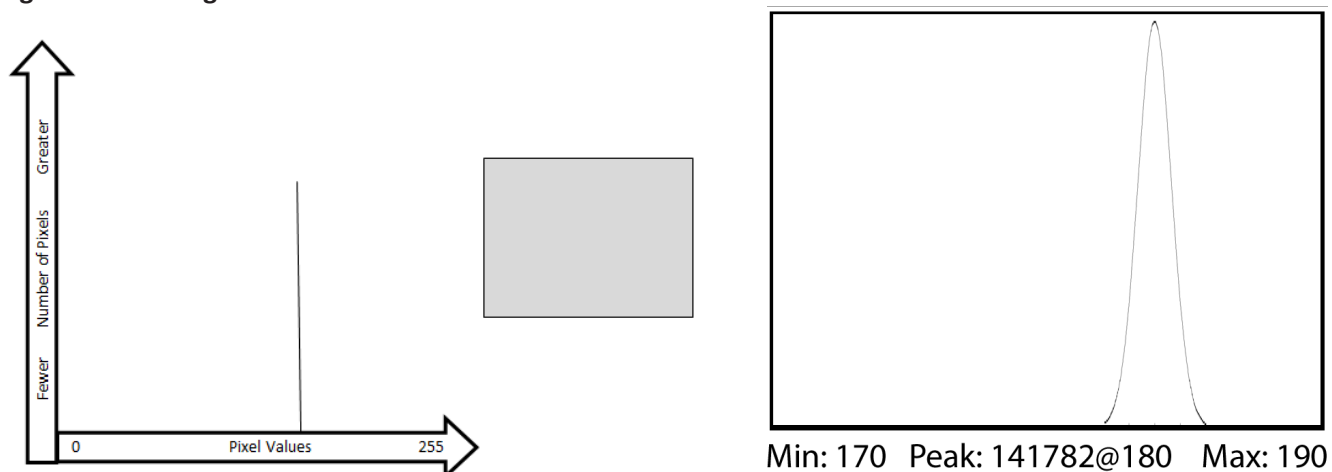
**Figure 7-1: Histogram: Linear Gradient**



The Mono histogram is a simple single-line graph. The Y-axis (vertical) represents the number of pixels. The X-axis (horizontal) represents pixel values. The first thing to understand is that the histogram offers quantitative information only; it includes no spatial information. Looking at a histogram gives you no idea of the location of bright or dark pixels in the image.

A histogram of a perfect linear gradient, regardless of its orientation would be a straight horizontal line because there would be exactly the same number of pixels of each value.

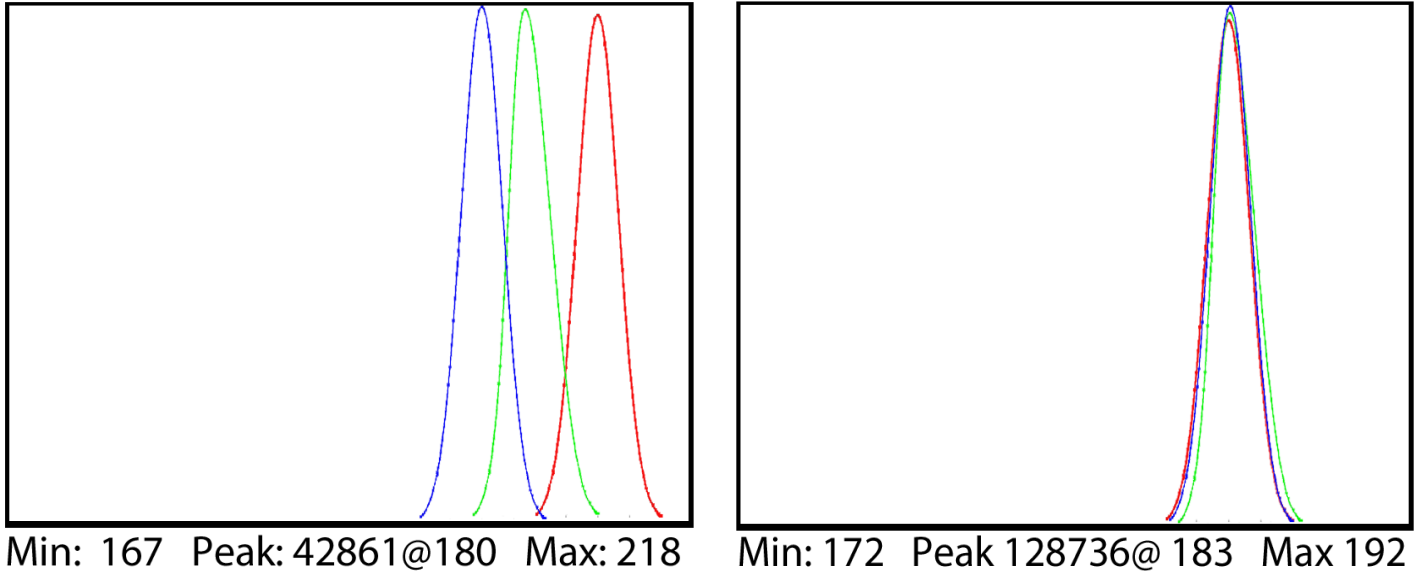
**Figure 7-2: Histogram: Mono-tonal**



The histogram of a perfect mono-tonal image is a straight vertical line because all of the pixels have the same value. In practice, because it is unlikely we will be able to image a perfectly flat field, the

histogram of a mono-tonal image will be a bell curve. The histogram shown to the right in Figure 7-2 is in the format used on the ILx. It shows minimum, maximum and peak values for the image. The peak value also includes the number of pixels exactly at the peak value: Peak: <# of pixels>@<pixel value>.

**Figure 7-3: Histogram: Monotonal Color Image**



If we view the same mono-tonal content used in Figure 7-2 on a color camera, we get the more complex histograms seen in Figure 7-3.

Assuming that the mono-tonal image is a neutral gray target, the histogram on the left shows what you would expect if the camera's color balance is shifted a bit toward the red, as it might be under tungsten illumination. In this case the color channels are easily visible as they are separated. The histogram on the right shows what you would expect if the camera's color balance is a good match.

#### Histograms and Exposure Settings

Professional Digital photographers are very sophisticated in their use of histograms. While the use of histograms as a tool for fine-tuning light and color content for artistic purposes is beyond the scope of this App Note, there are a couple of simple rules to follow that will be helpful.

1. The best images contain a balance of highlights and lowlights. To this end it is good to strive for a distributed grouping of peaks across the histogram.
2. Try to identify the peaks for any objects of interest in the scene. Make sure that those objects are not in danger of exceeding the camera's dynamic range--that they are not close in value to either 0 or 255.
3. Avoid Min: 0. If the minimum pixel level is 0, you know that some pixels are registering no light at all. If there are some very dark areas in the scene, you might expect this and accept it. But if the scene is more uniform and you need to be able to bring out details in the dark areas, avoid Min: 0, as no amount of gamma or brightness adjustment will help. If you are recording in 10-bit mode and viewing the upper 8-bits, you may wish to view mid- and low-8 bit settings just to see if you are truly at Min: 0
4. Avoid Max: 255. Once an area reaches saturation (255), it is game-over in terms of image processing. In color images this may even result in some color shifting as one color may easily saturate before the others.

## Application Note 2: Understanding Bit Depth

Each pixel in a digital image has a numeric value. Low numbers represent dark pixels; higher numbers represent brighter ones.

Mono images that we see displayed on computer screens use 256 shades of gray. The pixel values range from 0 to 255. Color images use 256 shades each of red green and blue. With 256 (red) x 256 (green) x 256 (blue), color images may use more than 16 million colors!

The IL3/IL4 sensor outputs 10-bit image data. This represents 1024 shades of gray for mono, and 1024 shades each for Red, Green, and Blue for color-- that would be  $1024^3$ ... over a billion colors! IL5 sensors output 12-bit image data, which represents 4096 shades of gray for mono and  $4096^3$  colors.

Consider 10-bit images:

Decimal numbers 0 to 1023 are expressed 0000000000 to 1111111111 in binary. Each binary digit is a "bit." So a 3 bit number, 000 to 111, is the equivalent to decimal 0 to 7. An 8-bit number, 00000000 to 11111111, is the equivalent to decimal 0 to 255. A 10-bit number is equivalent to decimal 0 to 1023.

Because we will be accessing the imagery on devices such as computers and LCD screens that can only display 256 shades of gray (or  $256^3$  colors) one valid option is to save only 8 of the 10 bits produced for each pixel of the sensor. If we choose this option, we will need to decide which 8 of the 10 bits to save. There are three choices:

1. **High 8-bit** (dropping the two least significant bits and saving the high-order bits):

11111111~~11~~

In this case we have a mapping that looks like this:

10-bit (1024) values (in decimal): 0 1 2 3 4 5 6 7 8 9 10 11 .....511.....1023

8-bit (256) values (in decimal): 0 0 0 0 1 1 1 1 2 2 2 2 .....127.....255

Note that for the 10-bit image 0 is black 511 is midway to saturation (white) and 1023 is at saturation. For the 8-bit image, 0 is black, 127 is midrange and 255 is white--the two images would appear the same to us.

2. **Mid 8-bit** (dropping the least significant bit and the most significant bit, saving the Mid-order bits):

~~1~~11111111~~1~~

In this case the mapping looks like this:

10-bit (1024) values: 0 1 2 3 4 5 6 7 8 9 10 11.....255.....511.....1023

8-bit (255) values: 0 0 1 1 2 2 3 3 4 4 5 5.....127.....255

Note that while we have the same starting point (black = 0), saturation now comes at the midrange of the original 10-bit data. Compared with the High 8-bit mapping, this image has twice as steep a response slope--it is much brighter. This brightness will come at the cost of seeing more noise, however.

3. **Low 8-bit** order bits (dropping the two most significant bits and saving the lower 8):

~~11~~11111111

10-bit (1024) values: 0 1 2 3 4 5 6 7 8 9 10 11.....255.....512.....1023

8-bit (255) values: 0 1 2 3 4 5 6 7 8 9 10 11.....255

As with the other mappings, black is black = 0, but with the Low 8-bit mapping, saturation comes twice as fast as with the Mid 8-bit and 4x as fast as with the High 8-bit.

Note: On the IL5, 8-bit images may be bit shifted to any of five positions so instead of having just high-8, mid-8, and low-8, there are two more intermediate choices, each shift changing the slope by a factor of two.



**Figure 7-4: High...Mid...and Low 8 Bits of the same Image**

This image represents the high 8-bits of the image. This is the normal setting for high-quality 8-bit images. The dynamic range of this image may be improved by increasing the Gamma.

Note: a better quality image may be created by setting bit depth to 10 and adjusting the gamma for the display being used.

The second image of the set represents the image with the using the middle 8-bits of an image (bits 11:4 of the IL5). Here you can see that there is more definition in the darker areas. There is increased noise, but it is not noticeable in this small image.

Using the middle 8-bits is basically equivalent to 2x digital gain.



The third image represents the low 8-bits of the image (bits 10:3 of the TS5). There is increased visibility into the dark shadows at the expense of more noise. This setting might be helpful when image quality is less important than visibility in low-light applications.

Using the low 8-bits ("low" for IL3 / IL4) is basically equivalent to 4x digital gain.



## Application Note 3: Trigger Position and the Circular Buffer

Capturing a high-speed event can be a tricky proposition. Often high speed events that we are interested in happen without warning. Other times high speed events are tightly controlled. The ILx is designed to handle myriad scenarios. Here are several examples:

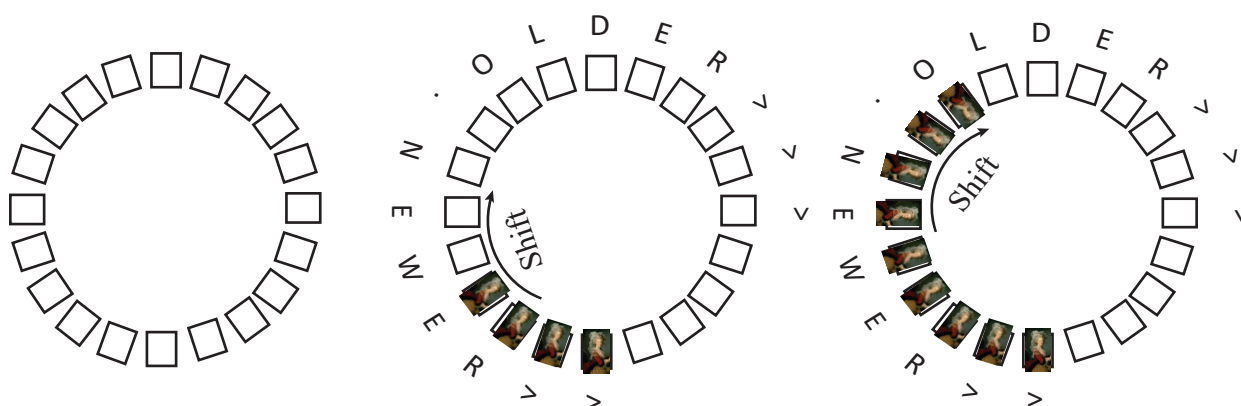
Example 1: Someone is blowing up a balloon until it pops. You want to capture the balloon pop. You have a partition of memory with one second of record time. It is very difficult to estimate within a second when that balloon is going to pop!

Example 2: Jams happen once or twice a day on an automated production line. When they occur, they may set off a chain of events that you would like to capture. The jam is detected by sensors on the machinery that is propagated to various parts of the line. You need to image the time just before the jam occurred to help understand the cause. You are equally as interested to capture the time just after the event to understand how the equipment reacted to the jam.

Example 3: You would like to image the launch of a missile. You have ample warning when ignition is to happen. There is a long count down. There may even be a signal available at launch time.

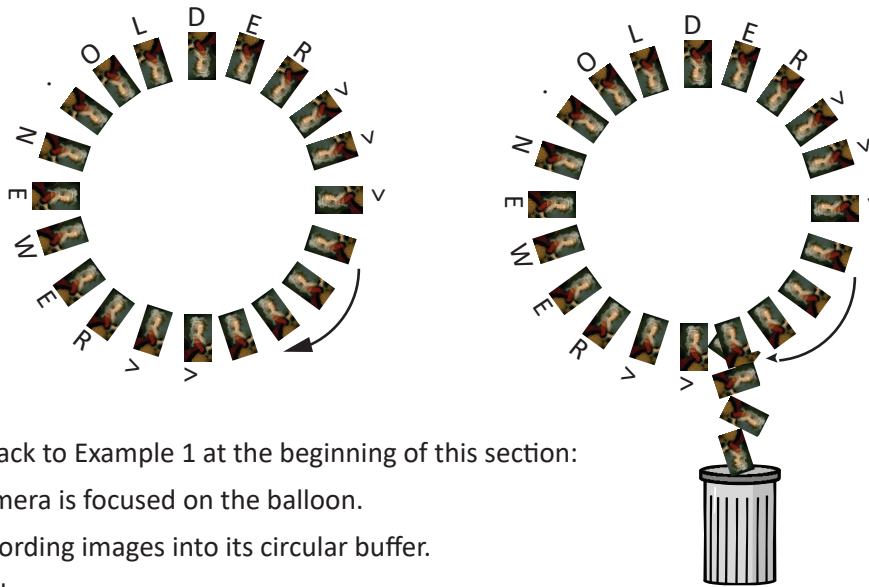
In order to capture events like the ones in the examples above, the ILx uses a circular image buffer that is able to capture high speed imagery indefinitely, though it may only be able to retain a few seconds at a time. The figure below is a representation of a circular buffer. First the empty buffer is seen with 20 empty slots for images. The second graphic shows the first four frames. With each frame added, the older images are shifted up, the newest ones added at the bottom.

**Figure 7-5: Circular Buffer Fills and Images Shift Position**



Eventually, the circular buffer will fill up and overflow, but when it does, it continues to keep the newest images as it discards the oldest.

**Figure 7-6: Circular Buffer Fills and Images Shift Position**



Referring back to Example 1 at the beginning of this section:

- The camera is focused on the balloon.
- It is recording images into its circular buffer.
- The balloon pops.

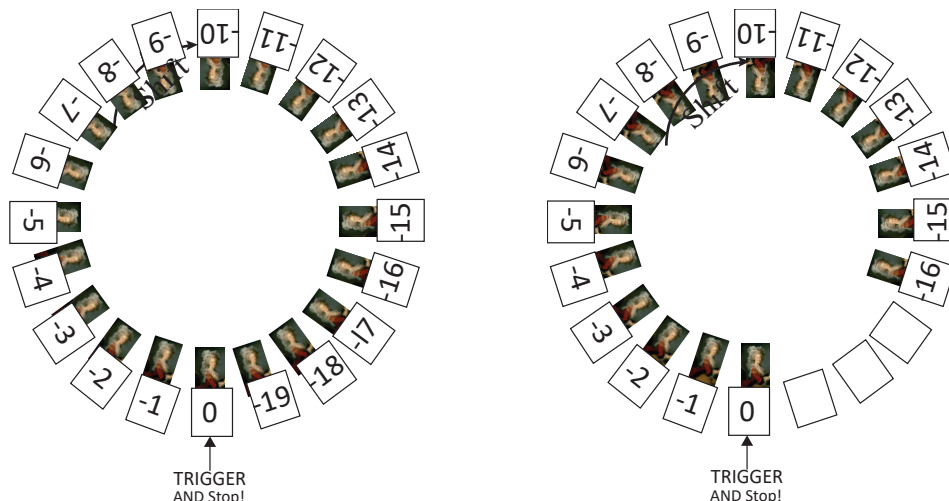
The camera has captured the event, now you just need to make the camera stop before the images are discarded. For this we use an **End Trigger**.

Note: In photography, the term “trigger” is often used in reference to the shutter--usually cameras are triggered to take one image. In high-speed video capture, we use the term in reference to controlling the acquisition of some (usually very large) number of video frames.

With the camera configured for an End Trigger the camera will fill its 20 frame circular buffer until it gets a Trigger from the Trigger Button on the top of the ILx, from a Trigger signal received on the Sync I/O connector, or from a software application. At that time it will Stop recording. The last frame recorded will be given the number “0.” All previous Frames will be given sequential negative numbers.

Played back, the resulting video begins on frame -19, progresses to frame 0, then stops. If the camera did not run long enough to fill its buffer, it would still stop when it received the trigger and the resulting video would be shorter, starting with a less negative number (#-16 in the graphic below).

**Figure 7-7: Circular Buffer Overflowing**



Referring back to Example 2 in the beginning of this section:

- The ILx is Recording the machinery running normally. It may be running for hours before anything interesting happens.
- The machinery has a problem.
- A signal is sent in reaction to the problem.

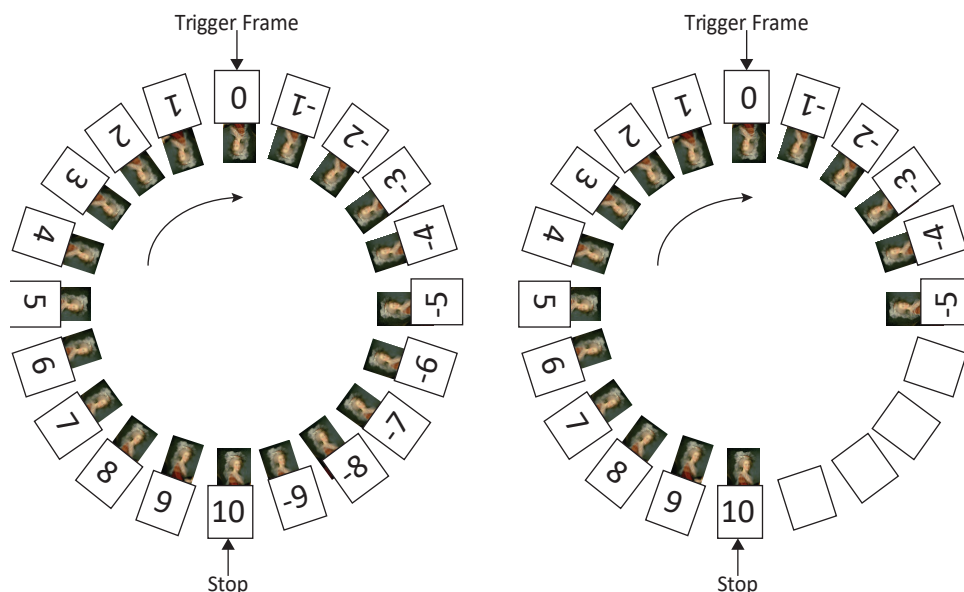
In this case, the camera needs to record the seconds before and after the problem is detected. The ILx has the perfect trigger setting for this. The 50% Trigger divides the image capture into two halves, the images just before the trigger is received (**pre-trigger frames**), and the images immediately after the trigger is received (**post-trigger frames**).

Using the **50% Trigger** the ILx fills the circular buffer until it gets the trigger. For the example here, there is a good chance it will be getting the trigger signal directly from the machinery to its Sync I/O connector, but it would work as well, triggered manually by a patient human.

When the ILx is triggered, it keeps recording until it has captured the 1/2 the buffer's worth of post-trigger frames. The buffer now has a number of pre-trigger frames with negative frame numbers, frame "0" and post-trigger frames with positive numbers. When played, the video on the below left begins with frame #-9 and ends with frame #10.

If the camera is triggered before it has captured its full allotment of pre-trigger frames, it will still record 1/2 the buffer in post-trigger frames and stop. The video on the right begins with frame #-5 and ends with frame #10.

**Figure 7-8: Circular Buffer End Trigger**



Referring back to the 3rd example at the beginning of the section:

- The ILx is framed and focused on a missile about to launch.
- It begins recording well before launch time. But it is only required to capture the launch.
- There is a countdown. The ILx receives its trigger electronically from launch control or manually.

In this case no video is required before time 0 of the launch. The Trigger acts like a “start button” for the camera to begin saving captured video.

For this type of recording, the ILx has a **Start Trigger**. Using the Start Trigger, when the ILx gets a trigger it will record Frame 0, then fill the buffer with post-trigger frames. When played back, the video will begin with Frame 0, then proceed with all positive frame numbers.

### Selecting Other Trigger Values

More likely than using the Start Trigger for example 3, however, is to use a 5% or 10% Trigger. This affords you a cushion of safety in case there is a problem with the launch signal--giving you time to trigger manually. Also in the case that there is a problem in the launch sequence just before ignition, that would be captured as well.

The 10% trigger works just like the 50% trigger explained above, except that only 10% of the imagery is captured pre-trigger, and 90% is captured post-trigger.

Using FasMotion or the Web-App, the trigger position can be placed anywhere by percentage or frame number.



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## Application Note 4: Frame Rate, Resolution, and Exposure

### Scale and Resolution/Frame Rate

Selecting the proper resolution and frame rate for a given high-speed event is important. It is based on the Field of View (FOV) required to get a good image of your object of interest and the speed at which the object will move through that FOV.

For example, if you wish to image an automobile traveling at 50 mph across an intersection, full resolution and a relatively slow frame rate will work because your field of view (FOV) will be large and the car will not be moving through it very quickly.

Imaging a bird traveling at the same speed will require a much smaller FOV as the bird is 1/20th the size of the car. If you wish to use the same scale (object size/FOV), the FOV becomes 1/20th the size and the bird moves through it 20x as fast.

If you got acceptable imaging of an auto at 60FPS, it may take 1250FPS to get similarly acceptable imaging of a bird moving at the same speed.

### Aliasing and Frame Rate

If you are imaging a motion that is cyclical in nature like a wheel spinning or a lever moving up and down, it is important to use a high enough frame rate to avoid motion aliasing. If you know the speed of the object, use a frame rate at least a few times as fast as the repetition rate to get a valid characterization of the motion. If you don't know the speed, use as high a frame rate as possible to start with and adjust from there. (Be sure to analyze the movement one frame at a time as the playback speed may cause aliasing as well.)

Generally you will choose to use the largest resolution possible for the frame rate required. This will give you the best definition of your object of interest. Smaller resolutions may be desired in order to increase the record time. Choosing the right shutter speed is dependent not only on the speed at which an object is traveling through the FOV, it is also dependent on how the imagery is going to be used.

For motion analysis it is best to get as short an exposure as possible in order to limit motion blur. (Motion blur can be defined as the number of pixels traversed by an edge of an object during an exposure.)

For smooth video, on the other hand, long exposures are best. These make for more attractive movies, but blurry stills.

## Application Note 5: Optimizing System for Image Transfers

Transferring large volumes of image data from the camera to a computer over the Gigabit Ethernet connection can be very fast on an optimized system. For example, a full 8GB camera buffer will produce about 25GB of color TIFF files. An optimized high-performance system may transfer 25GB of full-resolution images from camera in less than five minutes, while on a non-optimized system, the transfer could easily take more than an hour.

Several parameters contribute to file transfer performance:

- Network and PC hardware
- Computer activity
- FasMotion setup
- Image file format and resolution

### Network and PC Hardware

- Processor/Chipset type and speed: use fast multi-core processors, 64-bit system
- Memory capacity and speed: 4GB minimum. 8GB recommended
- Graphics card type speed and on-board memory: Graphics performance can throttle live and playback views, graphics cards without on-board memory will take system memory and may slow things down.
- NIC type and speed: NIC performance varies widely. Pick a Gigabit NIC that supports Jumbo Frames. We have found that some systems only perform well with Jumbo frames set to 9K, while others work well at 1500. This is a parameter that you may need to experiment with to get optimum results.
- Multiple Network interfaces may be available. For optimum transfers, disable or disconnect all interfaces other than the one to be used with the camera during transfers. Two or more interfaces are on the same subnet should never be allowed. (Having both wired and wireless interfaces active is a common problem.)
- Hard Disk type: sustained transfer speed is most important drive attribute. Having a second drive on the system for image transfers is helpful--avoid using the drive that the OS and any program files are on. SATA II or III SSD or high-speed spinning media drives may be added internally or externally to your PC. If the PC has an eSATA port, consider connecting an SSD to it for image transfers.
- Disk state: fragmented disks and disks that are running out of space will slow transfers.

### Computer OS and Software Management

- Close all other applications, services, updaters, etc., including performance monitors such as Task Manager, Wireshark, HD Tune Pro, etc. while running FasMotion.
- File System format: On a Windows PC, use NTFS for the data drive, for Mac use HFS+
- Do not index the target drive.
- Set UDP receive buffers to 3MB on Mac computers: edit or create `/etc/sysctl.conf` to contain the line: `net.inet.udp.recvspace=3145728`

Note: this requires some low-level changes to your Mac that you may not be accustomed to making. There is a lot of online help available, but if you need assistance please contact Fastec.

- PC Power Management: disable all, including sleep modes
- Disable all Firewalls and Anti-virus software! (You will not want the PC attached to the any outside network including the Internet while connected to the camera.)
- 3rd party filter drivers: (disable using NIC's properties page)

### NIC Parameters

- Set Transmit/Receive buffers to maximum (these may also be referred to as descriptors)
- Jumbo Frames/Packets set to maximum size (usually 9K). Experiment with these settings as results to vary from system to system. On a Mac, the setting is MTU 9000
- Enable full-duplex mode
- Set speed to 1000baseT (Gigabit)
- Enable interrupt moderation / throttling (set to adaptive if available)
- Enable Checksum offloads

### Camera Connection

- Point to point connection without any routers or switches between the camera and the computer is best. If you do need to use a Router or Switch, confirm that it supports and is configured for Gigabit Ethernet, UDP, and Jumbo Packets. Many Switches Some Routers have built-in firewalls- these will need to be disabled.
- Use Cat 5e or Cat 6 cables only. (Cat 5 cables do not support Gigabit Ethernet and may cause the system to run at 100Mb.)

### FasMotion Parameters

There are several parameters to be set to optimize performance. FasMotion Default Parameters are set conservatively so the application will run on an average non-optimized system. If your system is excessively slow or busy, you may need to change to more conservative settings. If you have optimized your system for image transfer performance, you will wish to change to more aggressive settings in order to get faster transfers.

#### UDP Transfers

The camera system, while controlled by FasMotion, uses UDP protocol for all video streaming (Live and Playback) and for all file transfers.

If the camera is allowed to send image data and metadata as fast as it is able, it will easily swamp most systems and will cause the UDP connection to fail. The system introduces an inter-packet delay to slow the camera down to a level where the PC can keep up.

#### Setting Packet Delay

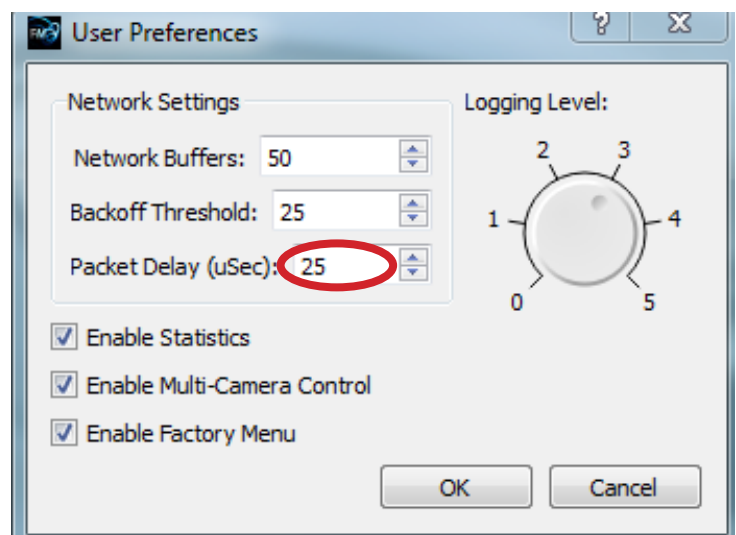
The camera is The Packet Delay setting is found in the FasMotion User Preferences dialog. This is an edit box/spinner that sets the inter-packet delay in  $\mu$ sec.

The default setting is 200. Very fast systems with direct connections will be able to keep up with a delay of 10 to 20, while slow systems or systems on shared networks may need a setting of 200 or higher. For transfers of very large numbers of very small frames (tens of thousands of JPGs, for example, or possibly large numbers of low-resolution stacks of uncompressed images) the delay will also need to be increased in order to accommodate file-system overheads.

Transfer performance can be monitored by simply watching the progress bar during a Save or Copy. If you notice the progress stopping often or if the system needs to retrieve missing frames at the end of a transfer, that is a good indication that the PC is not keeping up and that the Packet delay needs to be increased.

A better way to assess transfer performance is by enabling and reviewing the stats.csv file after a transfer (see the next section).

Figure 7-9: FasMotion User Preferences: Packet Delay



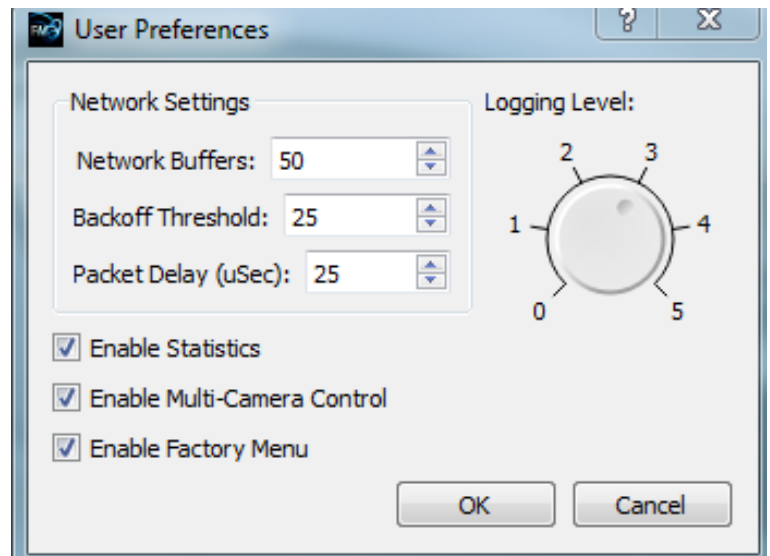
## Enabling Statistics in FasMotion

One important consideration in optimizing your system is how to compile results.

For information on all Save operations from camera to PC, enable Statistics. This creates a line of comma delimited text for every Save or transfer done to PC media (such as Save or Copy to Path) by FasMotion.

This information is collected each time a Save operation is performed and is appended to the file "Stats.csv" found in the Documents folder.

**Figure 7-10: FasMotion User Preferences: Enable Statistics**



Tab headers for this text file include:

- **Duration** -total time of the transfer (hh:mm:ss:decimal)
- **Bytes** - the number bytes transferred
- **Speed** - transfer speed in MB/s
- **Missed Frames** - frames missed in the first pass (these are retrieved at the end of the transfer)
- **Good Frames** - total number of frames transferred--this should match the number of frames in the clip
- **PktSize** -Packet Size (default is usually 1500, Jumbo frames may be up to 9000)
- **PktDlyBegin/End**--Packet Delay (the delay time in  $\mu$ sec set in the Camera Find window)
- **Buffer** - number of buffers reserved in PC memory
- **Backoff** - FasMotion keeps track of how much memory it is using for buffering images. If it uses more than the specified "Backoff," it will tell the camera to stop sending image data until it catches up
- **Min**--Minimum Buffers (the minimum number of buffers FasMotion had in reserve during the transfer. If this number gets down to 0, you will see a number in the "Missed Frames" column and you will notice in the Save dialog that the system had to go back and retrieve missed frames after the first pass.)
- **Drv** -Drive (the target drive letter such as E: or C:)
- **Ext** -Extension (the file type saved)

Table 7-1 on page 89 is from an actual benchmark test of an optimized system. The performance, which included saves of full (8GB) camera buffers of all file types in 1280 x 1024, 1280 x 720, and 512 x 512 resolutions, is representative of a very fast purpose-built system. A raid array used for storage is capable of unusually high sustained transfer rates. Table 7-2 on page 89 is from a benchmark test of a moderate-performance system.

**Table 7-1: Table Stats.txt High-Performance System**

Duration: h:m:s:dec	Bytes	Speed MB/s	Miss- Frames	ROI	Good- Frames	Pkt- Size	MissPkts	PktDly	Buffer	Backoff	Min	Drv	Ext
0:1:52:856	913889066	7.78172	0	1280x1024	6517	9000	0	20	250	125	244	E:	avi
0:2:24:731	8545872440	56.5971	0	1280x1024	6517	9000	0	20	250	125	227	E:	dng
0:4:44:3	25626251672	86.0532	0	1280x1024	6517	9000	0	20	250	125	124	E:	bmp
0:1:52:838	913889066	7.78172	0	1280x1024	6517	9000	0	20	250	125	245	E:	jpg
0:4:45:15	25627789684	85.7564	0	1280x1024	6517	9000	0	20	250	125	122	E:	tif
0:2:24:712	8543813068	56.5834	0	1280x1024	6517	9000	0	20	250	125	229	E:	tif
0:1:53:653	996320922	8.40855	0	1280x720	9269	9000	0	10	250	125	213	E:	avi
0:2:21:445	8547871800	57.8148	0	1280x720	9269	9000	0	10	250	125	226	E:	dng
0:5:6:405	25627450264	79.8701	0	1280x720	9269	9000	0	10	250	125	88	E:	bmp
0:1:53:630	996320922	8.40855	0	1280x720	9269	9000	0	10	250	125	231	E:	jpg
0:5:7:622	25629637748	79.6167	0	1280x720	9269	9000	0	10	250	125	89	E:	tif
0:2:21:446	8544942796	57.795	0	1280x720	9269	9000	0	10	250	125	221	E:	tif
0:5:8:805	25627450264	79.3514	0	1280x720	9269	9000	0	20	250	125	93	E:	bmp
0:1:55:323	1078091543	8.94042	0	512x512	32584	9000	0	20	250	125	196	E:	avi
0:2:27:543	8561250496	55.5418	0	512x512	32584	9000	0	20	250	125	72	E:	dng
0:7:13:126	25626924992	56.4428	0	512x512	32584	9000	0	20	250	125	84	E:	bmp
0:1:55:896	1078091543	8.94042	0	512x512	32584	9000	0	20	250	125	18	E:	jpg
0:7:13:978	25634614816	56.4598	0	512x512	32584	9000	0	20	250	125	63	E:	tif
0:2:26:260	8550953952	55.855	0	512x512	32584	9000	0	20	250	125	156	E:	tif

System: Intel i7-3770 CPU @ 3.40GHz

8.00GB RAM

ARECA (X86-64-STORPORT) SAS RAID (RAID6-ENGINE) (4 SSD drives)

- In the chart above, there are 3 sets of saves. Each line represents one save.
- The largest, uncompressed file types had the fastest transfer rates, but the longest transfer times
- Note that the Min (minimum buffers) get progressively smaller as the frame sizes got smaller and the number of frames increased. For 512 x 512 jpeg, the min value went down to 18. If the min value had gone to 0, the system would have begun missing frames and doing retries, greatly slowing things down. (For smaller resolutions a higher packet delay may be recommended)

**Table 7-2: Table Stats.txt Moderate-Performance System**

Duration: h:m:s:dec	Bytes	Speed MB/s	Miss- Frames	ROI	Good- Frames	Pkt- Size	MissPkts	PktDly	Buffer	Backoff	Min	Drv	Ext
0:1:51:796	251596130	2.16163	0	1280x1024	6517	9000	0	110	300	150	295	C:	avi
0:3:52:273	8545872440	35.1292	0	1280x1024	6517	9000	0	110	300	150	237	C:	dng
0:8:38:916	25626251672	47.1797	0	1280x1024	6517	9000	0	110	300	150	146	C:	bmp
0:1:51:717	251596130	2.16163	0	1280x1024	6517	9000	0	110	300	150	289	C:	jpg
0:8:38:554	25627789684	47.1826	0	1280x1024	6517	9000	0	110	300	150	51	C:	tif
0:3:52:391	8543813068	35.1208	0	1280x1024	6517	9000	0	110	300	150	212	C:	tif

System: Intel i5-2400S CPU @ 2.50GHz

6.00GB RAM

ST31000524AS Drive: 7200 RPM spinning media SATA/SAS

Note: Installation of an additional drive, capable of high sustained transfer speeds can boost performance substantially. This same system was used for the downloads in "Table 7-5: Finding the Correct Packet Delay Value" on page 91, but those used an external target drive.



### When the PC is Too Busy:

Referring to Table 7-3, you will notice that for several of the transfers there are missing frames and packets. These were downloads of only 188 frames, which should be very easy considering that FasMotion reserved 250 buffers--more than enough to buffer the entire transfer. The Min (minimum buffers) never got close to the Backoff number, so FasMotion never got a chance to slow the camera down before it started missing frames.

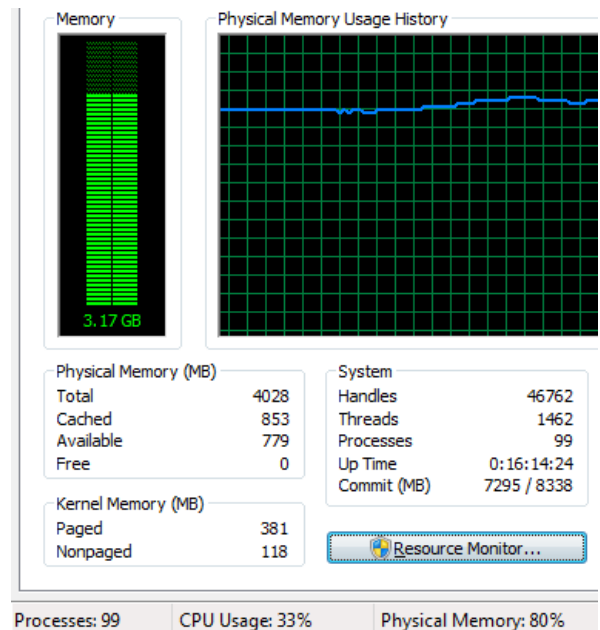
To understand what happened here, it is helpful to look at the performance tab in Task Manager. Notice in Figure 7-11 that the "Free" memory has gone to 0. This means that, having no more physical memory, the system is going to slow down. It will not be able to service the application properly.

What is happening here is that the system is very busy. To create this example, the computer used had about a dozen applications open.

It is common to have a lot of applications and services running "in the background" on a computer. In order to get consistent high-speed file transfers from FasMotion it is very important to have as little else running on the PC as possible.

Note: In each instance on the table, all of the frames were successfully saved as the system automatically retrieves any "missed frames" at the end of the download.

**Figure 7-11: Memory Usage in Task Manager**



**Table 7-3: Missing Frames on a Busy System**

Duration h:m:s:dec	Bytes	Speed MB/s	Miss- Frames	ROI	Good- Frames	Pkt- Size	MissPkts	PktDly	Buffer	Backoff	Min	Drv	Ext
0:0:6:650	26573616	4.22376	0	1280x1024	188	1500	0	180	250	125	236	C:	AVI
0:0:33:468	246528160	7.12447	0	1280x1024	188	1500	0	180	250	125	247	C:	DNG
0:1:40:407	739256608	7.0501	5	1280x1024	188	1500	9708	180	250	125	248	C:	BMP
0:0:7:611	26563368	3.61897	3	1280x1024	188	1500	280	180	250	125	216	C:	JPG
0:1:41:698	739300976	6.98072	5	1280x1024	188	1500	5354	180	250	125	247	C:	TIF
0:0:33:951	246468752	7.12276	1	1280x1024	188	1500	578	180	250	125	247	C:	TIF

### Use Jumbo Packets!

Referring to Table 7-4, using Jumbo Packets (sometimes called Jumbo Frames) can make a big difference. You may find that a larger packet delay is required with Jumbo Frames, but because the packets are bigger, there are fewer of them, and fewer delays as well.

In this example there was about a 3x improvement in transfer rate simply by using Jumbo Packets.

**Table 7-4: Benefit from Jumbo Packets**

Duration h:m:s:dec	Bytes	Speed MB/s	Miss- Frames	ROI	Good- Frames	Pkt- Size	MissPkts	PktDly	Buffer	Backoff	Min	Drv	Ext
0:0:28:484	484259096	16.4938	0	1280x960	394	1500	0	40	200	100	196	F:	tif
0:0:28:156	484259096	16.4938	0	1280x960	394	1500	0	40	200	100	195	F:	tif
0:0:9:438	484259096	51.3139	0	1280x960	394	9000	0	40	200	100	182	F:	tif
0:0:26:734	1317578048	48.3285	0	1280x960	1072	9000	0	40	200	100	105	F:	tif
0:0:47:203	2443418992	49.5793	0	1280x960	1988	9000	0	40	200	100	190	F:	tif

### Finding the Correct Packet Delay Value:

The correct packet delay value is one where the PC can keep up with the flow of incoming packets. The use of the buffer will sometimes mask the fact that the drive is not quite keeping up.

Referring to Table 7-5, compare the Min column (that is the minimum number of buffers available during the save) with the “Good Frames” column (the number of frames saved). You can see that as the number of frames increases, the Min number decreases, which means that the hard drive is not quite keeping up with the flow.

Note: In each instance on the table, all of the frames were successfully saved as the system automatically retrieves any “missed frames” at the end of the download.

**Table 7-5: Finding the Correct Packet Delay Value**

Duration h:m:s:dec	Bytes	Speed MB/s	Miss- Frames	ROI	Good- Frames	Pkt- Size	MissPkts	PktDly	Buffer	Backoff	Min	Drv	Ext
0:0:14:663	1179664800	80.3583	0	1280x1024	300	9000	0	40	200	100	178	K:	bmp
0:0:19:266	1572886400	78.9485	0	1280x1024	400	9000	0	40	200	100	174	K:	bmp
0:0:23:562	1966108000	81.5229	0	1280x1024	500	9000	0	40	200	100	168	K:	bmp
0:0:28:242	2359329600	80.3583	0	1280x1024	600	9000	0	40	200	100	161	K:	bmp
0:0:41:923	3538994400	82.3182	0	1280x1024	900	9000	0	40	200	100	152	K:	bmp
0:0:56:45	4718659200	80.3583	0	1280x1024	1200	9000	0	40	200	100	130	K:	bmp
0:1:10:535	5898324000	80.3583	0	1280x1024	1500	9000	0	40	200	100	105	K:	bmp
0:1:33:768	7864432000	80.6463	0	1280x1024	2000	9000	0	40	200	100	99	K:	bmp
0:2:19:27	11796648000	80.9364	0	1280x1024	3000	9000	0	40	200	100	99	K:	bmp
0:5:13:731	25626251672	78.0802	1	1280x1024	6517	9000	40	40	200	100	99	K:	bmp
0:5:15:858	25626251672	77.5844	0	1280x1024	6517	9000	0	50	200	100	188	K:	bmp
0:5:16:5	25626251672	77.3389	0	1280x1024	6517	9000	0	35	200	100	99	K:	bmp
0:5:16:338	25626251672	77.3389	0	1280x1024	6517	9000	0	25	200	100	96	K:	bmp

The last three downloads shown on the table demonstrate that a higher Packet Delay is a little better for this system. In these last three saves, delays of 50, 35, and 25 were used. You can see that the speed of the transfer was not really affected by the increased delay times, but that the Min buffer value was very high. For this system a Packet Delay of 40 will probably be OK, but 50 is a better number because the system can maintain the same transfer rate without exhausting its buffers.

**Table 7-6: Sample Mac Stat.csv Entries**

Duration	Bytes	Speed (MB/sec)	Miss- Frames	Good- Frames	PktSize	MissPkts	PktDly- Begin	PktDly- End	Buffer	Back- off	Min	Drv	Ext
0:1:53:53	855392409	7.21917	0	9269	9000	0	20	20	200	100	174	/U	avi
0:1:52:853	855392409	7.28362	0	9269	9000	0	20	20	200	100	194	/U	jpg
0:2:24:884	8552320920	56.6398	0	9269	9000	0	20	20	200	100	197	/U	bmp
0:4:34:914	25626251672	89.1938	0	6517	9000	0	15	15	200	100	198	/U	bmp
0:4:36:409	25626251672	88.5475	0	6517	4500	0	10	10	200	100	198	/U	bmp
0:2:34:456	12804839864	79.2964	0	6946	9000	0	20	20	200	100	196	/U	tif
0:2:34:982	12804839864	79.2964	0	6946	4500	0	10	10	200	100	196	/U	tif
0:3:12:49	12804839864	63.6023	0	6946	1500	0	10	10	200	100	195	/U	tif
0:1:24:165	600384525	6.81632	0	6946	9000	0	20	20	200	100	176	/U	avi
0:1:27:766	600384525	6.58128	0	6946	4500	0	20	20	200	100	176	/U	avi

The examples on this table were test results using a MacBook Pro with a built-in SSD. The first three entries were from a mono camera, the rest are color. The TIFF files were 10-bit raw TIFFs. Note that the fastest speeds were from the largest files (color BMP). The MacBook Pro in this configuration is the fastest computer we have tested.

## Application Note 6: Choosing an Image File Format

ILx cameras are capable of outputting images in 7 different file formats. These formats serve different purposes depending on imaging and work flow requirements.

JPEG images are compressed in order to take the least space. A recording saved as JPEGs results in an image stack, whereby each frame is a file. JPEG compression quality (0-100, with 100 being highest quality, lowest compression) may be selected by the user in the camera User Preferences menu. Default "JPEG Qfactor" is 80, which results in compression of 10:1 to 20:1 for average scenes.

AVI files are basically JPEGs placed in a "wrapper," resulting in one video file that is playable on many popular video players.

BMP and TIF files are almost identical--both being uncompressed, fully processed images. Like JPEGs they are saved as stacks, but are much larger.

DNG, TIF (raw), and CAP files are raw formats, meaning that color images are not interpolated. Color interpolation takes 8-bit images and colorizes them, which produces 24-bit files 3x as large. DNG and TIF (raw) files are smaller than BMP and TIF files. DNG and TIF (raw) are stacks, while CAP files contain a whole "Session" of images.

- **JPEG:** JPEG compressed, user selectable compression, saved as video stacks. All image and color processing done on camera. 8-bit data only is preserved so output is 8-bits/pixel mono, or 24-bits/pixel color.\*
- **AVI:** Motion JPEG compressed, user selectable compression, user selectable playback rate, saved as one file. All image and color processing done on camera. 8-bit data only is preserved so output is 8-bits/pixel mono, or 24-bits/pixel color.\*
- **DNG:** Not compressed, raw format with "as shot" parameters saved within images. 8-bit or 10-bit data preserved (for producing 24-bit or 30-bit color images). Available on color cameras only. All image processing excluding FPN correction, but including color interpolation, brightness, contrast, gamma, color gains, etc. to be done off-camera in 3rd-party software. Compatible with Adobe and Black Magic imaging software. 8-bit images saved 8 bits/pixel; 10-bit images saved 16 bits/pixel
- **BMP:** Not compressed. Saved as video stacks. Bitmap. All image and color processing done on camera. 8-bit data only is preserved so output is 8-bits/pixel mono, or 24-bits/pixel color.\*
- **TIF:** Not compressed. Saved as video stacks. Almost identical in size and specification to BMP, but has added "TIFF tags." All image and color processing done on camera. 8-bit data only is preserved so output is 8-bits/pixel mono, or 24-bits/pixel color.\*
- **TIF (raw):** Not compressed. Saved as video stacks. 8-bit or 10-bit data preserved (for producing 24-bit or 30-bit color images and 8-bit or 10-bit mono images). 8-bit data is saved as un-interpolated 8-bit images. 10-bit data is saved as un-interpolated 16-bit images. Similar to DNG format, except that the "as shot" values must be parsed from the metadata files (not written into the image files).
- **CAP:** Proprietary Fastec "partition capture" image format. Raw image data from sensor is saved in a file along with FPN correction (black frame), as well as "as shot" parameters. 8-bit or 10-bit data is preserved. CAP files may be loaded back into camera image memory, then saved again to any media in any of the other formats.

Note: CAP files are only available on cameras with SSDs, SN A0 and higher.

\*Note: When 10-bit data is recorded, all 10 bits are used in the 16-bit image processor. For formats that only save 8-bit data, this means that all of the image processing done still uses all of the 10-bit data and there still may be a discernible (certainly a measurable) difference in the 8-bit processed images produced. (If you capture both 10-bit and 8-bit images of the same scene, then save them as 8-bit color images, the ones captured in 10 bits will have a higher number of discrete colors than those captured in 8 bits.

**Table 7-7: File Format Features**

Format	Processing	Size @1280 x 1024		Pro	Con
		8-bit	10-bit		
JPG	JPEG Compression Color Interpolation Brightness, Contrast, Gamma, Gains, FPN*	241K (color)		<ul style="list-style-type: none"> <li>Small</li> <li>Popular still format</li> <li>Easy analysis</li> </ul>	<ul style="list-style-type: none"> <li>Degrades with re-processing</li> <li>Huge folders full of files</li> </ul>
AVI	JPEG Compression Color Interpolation Brightness, Contrast, Gamma, Gain, FPN*	241K (color)		<ul style="list-style-type: none"> <li>Small</li> <li>Popular video format</li> <li>Nice 1-file archive format</li> </ul>	<ul style="list-style-type: none"> <li>Degrades with re-processing</li> </ul>
DNG	FPN*, ("As-shot" parameters** saved-not processed)	1281K (raw)	2561K (raw)	<ul style="list-style-type: none"> <li>Maintains highest image fidelity</li> <li>All bits saved in 10-bit mode</li> <li>Compatible with high-quality image and video production tools</li> <li>Compact vs BMP/TIF</li> </ul>	<ul style="list-style-type: none"> <li>Huge folders full of files</li> </ul>
BMP	Color Interpolation Brightness, Contrast, Gamma, Gains, FPN*	3841K (color)		<ul style="list-style-type: none"> <li>Good image fidelity</li> <li>Compatible with popular imaging tools</li> </ul>	<ul style="list-style-type: none"> <li>Huge folders full of files</li> </ul>
TIF	Color Interpolation Brightness, Contrast, Gamma, Gains, FPN*	3841K (color)		<ul style="list-style-type: none"> <li>Good image fidelity</li> <li>Compatible with popular imaging tools</li> </ul>	<ul style="list-style-type: none"> <li>Huge folders full of files</li> </ul>
TIF(r)	FPN* only	1281K (raw)	2561K (raw)	<ul style="list-style-type: none"> <li>Maintains highest image fidelity</li> <li>All bits saved in 10-bit mode</li> <li>Compact vs BMP/TIF</li> </ul>	<ul style="list-style-type: none"> <li>Huge folders full of files</li> </ul>
CAP	None (black frame and "As-shot" parameters** saved)	1291K (raw)	1725K (raw)	<ul style="list-style-type: none"> <li>Maintains highest image fidelity</li> <li>Only format that can be played back by the camera</li> <li>1-file format</li> <li>Fastest Saves to SSD</li> <li>Convert to any other format via the camera</li> </ul>	<ul style="list-style-type: none"> <li>Proprietary format</li> </ul>

\*FPN: FPN correction is user-selectable. If FPN is set to Column, the correction is at the sensor-level and is asserted for all file types. If it is set to Off/Disabled, there will be no correction in any format. If it is set to Pixel, the black frame will be subtracted in all formats except for CAP. For CAP files, the black frame is copied into the CAP file and the correction is asserted when creating image data display and conversion.

\*\* "As-shot" parameters: all image processing parameters, including color corrections, gains, brightness, contrast, and gamma are saved, but not asserted (pixel values are not manipulated). This allows for post-processing of the original pixel data.

**Table 7-8: Save to SSD Benchmarks**

	1280x1024 10-bit		1280 x 1024 8-bit		1280x720 10-bit		1280x720 8-bit		512x512		256x256	
	Rate MB/s	Images /s	Rate MB/s	Images /s	Rate MB/s	Images /s	Rate MB/s	Images /s	Rate MB/s	Images /s	Rate MB/s	Images /s
CAP	104.46	84.64	104.37	62.56	125.34	142.58	118.01	100.60	115.65	458.86	103.35	1652.59
DNG	52.47	41.96	100.14	40.05	44.22	50.28	83.53	47.50	15.16	60.05	3.21	50.92
BMP	127.32	33.95	127.57	34.02	109.17	41.40	109.35	41.47	45.80	60.58	9.77	52.09
JPG	4.34	27.64	2.40	27.25	1.65	27.90	1.06	28.05	1.42	37.96	0.45	35.58
TIFF	127.25	33.93	126.91	33.84	109.22	41.42	108.48	41.14	45.27	59.87	9.77	52.01
TiFF(r)	52.37	41.89	100.43	40.17	43.90	49.93	83.29	47.37	15.13	59.97	3.24	51.63

## Application Note 7: Advanced Calibration

Calibration on the TSx accomplishes two functions:

1. Sets the black level of the camera.
2. Saves a dark frame used to correct FPN. (If Pixel FPN is selected.)

See “4-8 Black Level Calibration” on page 35 for more details.

### Advanced Calibration:

1. Cover the lens.
2. From FasMotion, select “Black Level Calibration” from the Camera Menu.
3. Click on “Advanced” to open the Advanced Calibration dialog and raw histogram.
4. Set the Gain and Offset (Black level) values you wish to use and click on “Calibrate.”

Note: the raw histogram shows raw 10-bit values (not RGB). The scale goes from 0 to 1023.

### Applying Gain:

Gain values from 1.0 to 4.0 may be applied in increments of 0.5.

Doubling the gain (from 1.0 to 2.0, or from 1.5 to 3.0) will double the responsivity. This is equivalent to doubling the exposure or opening the lens 1 f-stop.

Doubling the gain will also double the amount of noise in the image, including the FPN. This is easily seen from Figure 7-13. The signals shown in the histograms are what the sensor “sees” with the lens cap on (in the absence of light). This is the noise signal that is subtracted from the image with Pixel FPN on. (If Column FPN is on, this same noise signal will be suppressed on a per-column basis within the sensor.)

The image quality is best at a gain of 1.0, but it remains very good through a gain of 2.0, especially for scenes that do not have a large dynamic range. Using higher gain values works well for applications where image quality may be balanced with the need to eliminate motion blur or where higher frame rates are needed.

Figure 7-12: Black Level Calibration Dialog

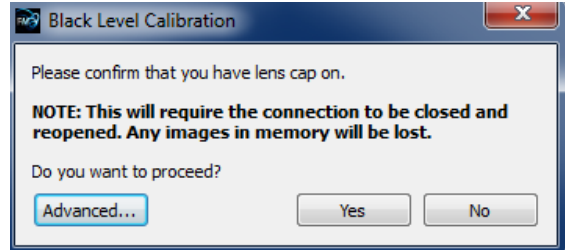


Figure 7-13: Advanced Calibration Dialog and Raw Histogram

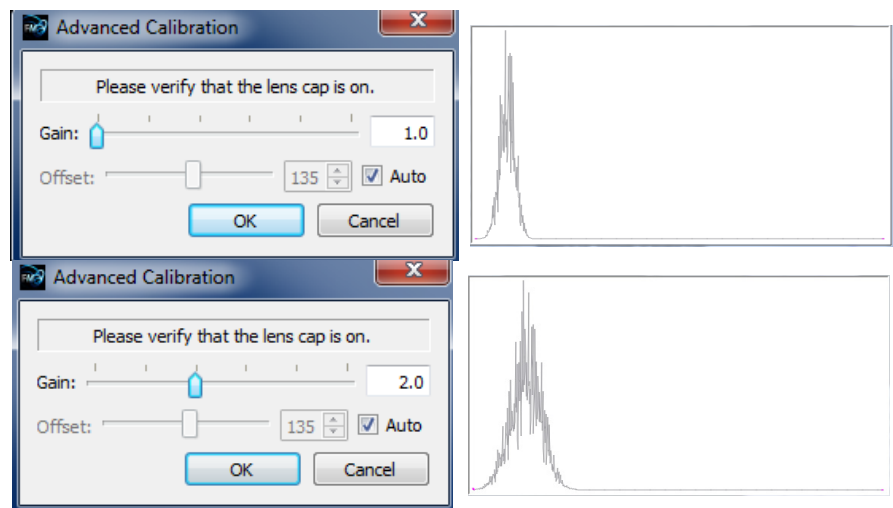


Figure 7-14: Example of Analog Gain





### Adjusting Black Level Offset:

Adjusting the black level Offset may accomplish several things:

- Set the image slightly darker (reduce offset) or brighter (increase offset) to fine-tune the features in the image that appear black. This is the classic photographic use of black level adjustment. The key here is to make very small changes. Just a couple of counts change in the offset will make a discernible difference in the image.
- Reduce near-saturation noise in a high-contrast image with FPN set to Pixel by reducing the offset. This has the effect of reducing the amplitude of the noise signal near saturation caused by subtraction of the dark frame. It has the side-effect of slightly increasing the noise near black. It can be done at any gain level, but it becomes increasingly valuable as the gain increases, causing increased noise
- Reduce the near-black noise by increasing the offset. This is the opposite of the bullet, above. As the offset decreases, the darkest portion of the signal becomes clipped. This clipped portion is not captured in the Black Frame, so it is not calibrated out, causing increased noise near black. To eliminate near-black noise, increase the offset.

**Figure 7-15: Example of Manual Black Level Adjustment**



Both images in Figure 7-15 were taken after calibrations with the gain set to 2.0. The top image was calibrated with the Black Level set to Automatic while the bottom image was calibrated with the Black Level set manually. The histograms shown with these images are the raw histograms taken during calibration (with the lens covered).

The top image has a noisy near-saturation section, circled in red. The bottom image, calibrated with the offset reduced, does not suffer from the same issue.

Note: When using the offset adjustment to eliminate near-saturation noise, be careful using Gamma adjustment as well. Near-saturation noise may be eliminated by adjusting the Gamma, then reducing the exposure or aperture to move the image away from saturation. If the offset is decreased as in the example here, some dark pixels will be clipped as evidenced in the magenta “bumper” in the histogram. Increasing Gamma when dark pixels are clipped will expose noise in the dark areas of the image.

# Appendices

## Appendix A: Definition of terms

Table 8-1: Definitions

Arm	When armed, the camera will capture and write images into a partition of camera memory, and then overwrite it continually until it receives a trigger.
Arm/Record Bug	The Arm/Record Bug is the small vertical line used in conjunction with the Record Bar to indicate the progress of the camera while acquiring pre- and post-trigger images.
AVI	Audio Video Interleave (AVI) is a popular file type for electronic video. AVI files may include certain types of image/video data (compressed or un-compressed), audio data, and metadata.
Backlight	The Backlight is the illumination used to light the LCD display on the camera.
Battery Status LED	Battery Status LED States:
Bit Depth	Images captured by the ILx sensor are read in binary form. Each pixel is given a binary 10-bit value from 0000000000 to 1111111111, or, in decimal form, from 0 to 1023. 0 is black, 1023 is white—all numbers in between are shades of gray from very dark to very bright. The camera operator has the option of recording all ten bits (1024 shades) or 8 bits (256 shades). If the operator chooses to record 8-bit data, they must choose which 8 bits of the ten to record. They may wish to record the Lower 8 bits, which will greatly enhance the dark areas of the image, tend to saturate the bright areas, and will expose more noise; or the Middle 8 bits, which will somewhat enhance the dark areas wash out the brighter areas, and expose some noise; or the High 8 bits, which will be the cleanest image, but with the least definition in the darker areas.
BMP Stack	BitMaP (BMP) files contain un-compressed image data. Each file contains one image. A BMP Stack is a collection of images. The BMP Stack produced by the ILx is a collection of frames, written as BMP files representing a captured video sequence.
Brightness	Linear image control that boosts all pixel values without disturbing the slope of the curve.
CinemaDNG	CinemaDNG is an open digital cinema format that uses the Adobe Digital Negative Specification (DNG), widely used as an archival format for Raw images. The specification is an attempt to standardize digital commercial video format thereby simplifying collaboration and workflow across the entertainment industry and all other industries dependent on digital video recording, i.e. automobile crash testing, military testing, etc.
Color Temperature	The Color Temperature of an ideal black body is defined as its surface temperature in kelvins (K). The Color Temperature of a light source is an assigned value that closely approximates what a human would perceive as a match between that light source and an ideal black body at that Temperature (K). High color temperatures are seen bluish, while lower color temperatures are seen reddish.
Config.	Camera Configuration that can be saved and reloaded. Includes settings for Frame Rate, Resolution, Shutter Speed, Trigger, bit depth, and Auto Save.
Contrast	Linear image control that enhances the difference between pixel values by changing the slope of the curve, while maintaining the mean value.
Cursor	The cursor may be any graphic indication of where the current focus is within the user interface. This may be anything from a blinking vertical line as used within a dialog box when the user is entering text, or it may be a change in the color of a button as when navigating through menus.

<b>Custom Camera Control Application</b>	Camera control software compatible with the ILx.
<b>DHCP</b>	DHCP is a utility by which a server dynamically assigns IP addresses to clients on a network. When DHCP is selected in the Network Menu, the camera will allow a server on a connected network to assign it an IP address.
<b>Dialog</b>	A Dialog is a box that requires user input such as the selection of an option, or the entering of a number or text.
<b>Download</b>	Electronically moving image data from a camera to a "remote" device, i.e. a PC or other mass storage.
<b>Enable Raw</b>	A raw image is one where all image processing including colorization, white balance, brightness, contrast, and gamma, are all bypassed.
<b>File Type</b>	Digital files are commonly identified by their extensions. Familiar types include PDF, TXT, JPEG, TIFF, DOC, MP3, etc. Each of these files has a specified format that usually includes information in the file header and specially formatted data that applications on PCs, Cameras, Printers, Smartphones, and other electronic devices can read, write, and decipher for human viewing, editing, listening, etc.
<b>Gain</b>	In imaging the term Gain is most often used as a multiplier applied to a pixel value.
<b>Gamma</b>	Power curve often used to encode image data so that a picture displayed on a given monitor appears true to the human perception of the original scene. Nominally, a particular display may have decode Gamma of 1.0, common among laptops, or 2.2, common among larger LCD and LED displays.
<b>HDMI</b>	HDMI, High-Definition Multimedia Interface, is used to transmit digitized video (and audio) data from the camera to a remote display. This is a popular method for connecting consumer products such as televisions, cable TV boxes, DVD players, etc.
<b>Image Memory</b>	Image memory is the internal memory in the camera reserved for raw image data. This is volatile memory that is erased when the camera is shut down.
<b>JPEG Stack</b>	Joint Photographic Expert Group (JPEG) file format is a highly compressed file format, capable of reducing image files to a fraction of the size of a BMP or lossless TIFF. The image quality of JPEGs is excellent, although there may be some discernible noise in the displayed image, often referred to as JPEG artifacts.
<b>Menu</b>	Once an item in the Menu Bar is selected, the corresponding Menu appears below.
<b>Menu Bar</b>	The Menu Bar is the bar across the top of the camera display that lists the Menu Items.
<b>Network</b>	The camera may be connected to one or more computers via its RJ45 GigE (Gigabit Ethernet) connection.
<b>NTP Time</b>	Network Time Protocol: Network Protocol for synchronizing time clocks of devices attached to a given network or internet, within a few hundredths of a second.
<b>Play/Review Bug</b>	In Review there is a progress bar that graphically indicates the position of the currently viewed frame within the image sequence. The small vertical line that is used as the indicator is referred to as the Review Bug.
<b>Record</b>	The camera is acquiring images and storing them in internal memory. This begins when the camera is armed, and ends after a trigger is received.
<b>Record Bar</b>	When the camera is Armed and it commences capturing images, the Record Bar presents a graphic indication of the progress of filling the buffer.
<b>Refresh Rate</b>	Rate at which image data is re-painted on the display. For CRTs this is analogous to the vertical frequency.

<b>Review</b>	Review is a camera utility for viewing image data while it resides in camera memory. It includes options for playing the imagery as a movie, forward or backward, or stepping through the frames one at a time, or stepping through every 10th frame. It also allows the user to adjust starting and ending points for an image sequence for viewing or saving. The user may adjust image properties such as brightness, contrast, gamma, color balance when reviewing the images. If 10 bit images have been saved, the user may also select which 8 bits to display. It is important to note that image adjustments made while using Review do not alter the image data in camera memory although they do alter the viewed and saved images.
<b>Save</b>	Moving image data from a camera's internal memory to some other mass storage device. This mass storage may be local, such as the SSD drive within the camera, or remote, such as a PC.
<b>SD</b>	This is Secure Digital memory, such as the SD-card used as a plug-in mass storage device for the camera.
<b>SSD</b>	Solid state drive that is located inside the camera. This is a non-volatile mass storage device retains its data when the camera is powered down.
<b>Static IP</b>	In order for one networked device to "talk" to each other, they need to have compatible IP addresses. One way to assure this is for the user to assign unchanging (static) IP addresses to each device.
<b>Status Menu Bar</b>	The Status Bar is a line of text at the bottom of the display that appears when the camera menus are turned on.
<b>Sub Menu</b>	Within each Menu, there may be additional Sub Menus from which to select.
<b>TIFF Stack</b>	Tagged Image File Format (TIFF) is a much more flexible format than the BMP, in that it may use one of several compression schemes, may be used to store multiple images (multi-page TIFF), and may include metadata in the form of Tags. Developers may apply for their own block of private Tags. The TIFF is the only file format used in the ILx that is compatible with 10-bit images. The TIFF Stack produced by the ILx is a collection of frames, written as BMP files representing a captured video sequence.
<b>Trigger</b>	The trigger is a signal sent to the camera either via the trigger switch on the camera or from an external source applied to the camera's trigger input connector. When an armed camera receives a trigger, it will capture and write a prescribed number of frames into camera memory, then stop capturing images. If the ILx receives a Trigger while in Live Mode, it will take a still image.
<b>Update Rate</b>	The rate at which the ILx or a PC can process a new frame of video and send it to the display.
<b>USB</b>	A thumb drive or some other mass memory device may be attached via the USB port of the camera.
<b>USB OTG</b>	When a PC is connected to the USB OTG (USB On The Go) port of the camera, the camera appears as a mass storage device to the PC, much like plugging a thumb drive into a PC's USB port. The camera is automatically a slave to the PC.
<b>Web Application</b>	Camera control software that runs via web browser such as Windows Internet Explorer, Safari, Firefox, etc.
<b>White Balance</b>	Many different kinds of illumination may be used with high speed cameras. Typical color temperatures for common types of illumination are used to compute RGB gains, which, when applied to captured imagery, should approximate what a human would perceive as accurate color. The term White Balance refers to the idea that, presented with a white card under a given light source, the camera should produce a white image.

## Appendix B: IL3 / IL4 Specifications

Table 8-2: Specifications

<b>Sensor</b>	10 bit CMOS sensor, color or monochrome
<b>Resolution IL3S / IL4</b>	1280 x 1024 pixels maximum
<b>Resolution IL30-L</b>	800 x 600 pixels maximum
<b>Pixel Size</b>	14 $\mu$ m square
<b>Light Sensitivity</b>	3,200 ISO monochrome, 1,600 ISO color
<b>Record Rate IL3S / IL4</b>	24 to 510 fps @ 1280 x 1024, over 64,000 fps at reduced resolutions
<b>Record Rate IL3L</b>	24 to 1250 fps @ 800 x 600
<b>Long Record IL4LR2</b>	24 to 183 fps @ 1280 x 1024, up to 3,000 fps at reduced resolutions
<b>Long Record IL4LR3 / IL3D</b>	24 to 366 fps @ 1280 x 1024 up to 6,000 fps at reduced resolutions
<b>Shutter</b>	Global electronic shutter from 2 $\mu$ sec to 41.667ms
<b>Image Memory</b>	4GB standard, 8GB optional
<b>Removable Storage</b>	SD card (SDHC: 32GB maximum), USB Flash drive
<b>Recording Modes</b>	Normal (Basic), Autosave, FasFire, Long Recording (IL4 and IL3D)
<b>File Formats</b>	BMP, TIFF, JPG, AVI, TIFF (RAW), DNG, CAP
<b>Lens Mount</b>	C-mount, F-mount, or PL-mount
<b>PC Communication Ports</b>	USB 2.0 device (Micro-B) Ethernet (10/100/1000Base-T)
<b>Control Software</b>	FasMotion (for PC or Mac), web interface (all platforms)
<b>External I/O Sync</b>	Trigger In/Out, Sync In/Out, Arm In/Out (LVTTTL or switch closure)
<b>Video Out</b>	HDMI (1080p, 720p, 480p)
<b>Construction</b>	Machined aluminum housing
<b>Power</b>	10-26 VDC external power supply
<b>Power Consumption</b>	20 Watts maximum
<b>Operating Environment</b>	+5°C to +40°C
<b>Size and Weight</b>	185mm W x 112mm H x 45.5mm D. 1 Kg
<b>Optional Features</b>	
<b>WiFi</b>	802.11 b/g/n, security: open, WEP, WPA(2) - PSK
<b>SSD Storage</b>	Solid State Drive (SSD): 250GB, 500GB, 1TB, 2TB
<b>Long Record on IL3 "D"</b>	Streams uncompressed video to SSD; 8GB mem. + SSD required



## Appendix C: IL5 Specifications

<b>Sensor</b>	<b>12-bit 5MP CMOS sensor with 5µm square pixels, color or monochrome</b>
<b>Sensor Modes</b>	<b>Standard; binning 2x2, 4x4; sub-sampling 2x2, 4x4; combination 2x bin + 2x sub</b>
<b>Minimum Frame Rate (all modes and models)</b>	<b>24fps</b>
<b>Maximum frame Rate at Maximum Resolution by Model</b>	<b>IL5-Q: QSVGA 2560 x 2048 @ 253fps; IL5-H: HD 1920x1080 @ 634fps; IL5-S: SXGA 1280x1024 @ 991fps (1280 x 1014 @ 1000fps); IL5-L SVGA 800x600 @ 1677fps</b>
<b>Maximum Frame Rate at Minimum Resolution (all models)</b>	<b>64 x 32 @ 29,090fps</b>
<b>Long Record Opt: Max frame Rate at Max Resolution by Model</b>	<b>IL5-Q: QSVGA 2560 x 2048 @ 91fps; IL5-H: HD 1920x1080 @ 231fps; IL5-S: SXGA 1280x1024 @ 366fps; IL5-L SVGA 800x600 @ 993fps</b>
<b>Long Record Opt: Max Frame Rate at Min Resolution (all models)</b>	<b>320 x 240 @ 5000fps (cameras with 1TB SSD may do frame rates &gt;6000fps)</b>
<b>Light Sensitivity</b>	<b>1600 to 12,800* ISO monochrome, 800 to 6400* ISO color (depending on mode)</b>
<b>Shutter</b>	<b>Global electronic shutter from 3µsec to 41.654ms</b>
<b>Image Memory</b>	<b>4GB (std.) or 8GB (optional)</b>
<b>Removable Storage</b>	<b>SDHC SD card (32GB maximum), USB flash drive</b>
<b>File Formats</b>	<b>Stacks – BMP, DNG, JPEG, TIFF, Tiff(raw); Video – AVI, CAP(raw); Still – JPEG</b>
<b>Lens Mounts</b>	<b>C-mount (std.), F-mount or PL-mount (optional)</b>
<b>Communication Ports</b>	<b>USB 2.0 device (micro-B), Ethernet (10/100/1000Base-T)</b>
<b>Control Software</b>	<b>FasMotion (PC/Mac application), web interface (browser on all platforms)</b>
<b>Six External I/O Ports</b>	<b>Markers, Trigger In/Out, Sync In/Out, Arm In/Out (LVTTTL (3.3V) or switch closure)</b>
<b>Marker Data Views</b>	<b>FasMotion playback timeline and o-scope mode, XML file</b>
<b>Video Out</b>	<b>HDMI (1080p30, 1080p60, 720p, 480p)</b>
<b>Construction</b>	<b>Anodized machined aluminum housing</b>
<b>Power</b>	<b>10-26v @ 22W (max). Universal power supply included</b>
<b>Operating Environment</b>	<b>+5°C to +50°C</b>
<b>Size and Weight</b>	<b>184mm W x 112mm H x 40mm D. 1Kg (2.2 lbs.).</b>
<b>Optional Features</b>	
<b>WiFi</b>	<b>802.11 b/g/n, security: open, WEP, WPA(2) - PSK</b>
<b>SSD Storage</b>	<b>Solid State Drive (SSD): 250GB, 500GB, 1TB, 2TB</b>
<b>Long Record</b>	<b>Streams uncompressed video to SSD; 8GB mem. + SSD required</b>

## Appendix D: IL3 / IL4 Record / Resolution Tables

NOTE: These tables include only a sampling of resolution and frame rate values. Resolutions are available in increments of 2 x 2 pixels from 48 x 32 (maximum 60518fps) to 1280 x 1024 (to 800 x 600 in IL3100L models). Minimum resolution in for the IL4 in Long Recording mode is 320 x 240. All are available via Advanced Settings on the camera GUI, the Web-App or FasMotion software. Frame rates are available in 1fps increments from 24 fps to the maximum rate for any resolution and mode.

### 4:3 Resolutions (Standard Modes)

Table 8-3: IL3 / IL4 Resolutions, Rates, and Times

Resolution		Frame Rate	4GB Capacity				8GB Capacity			
H.	V.	FPS	8-bit		10-bit		8-bit		10-bit	
			Time (s)	Frames	Time (s)	Frames	Time (s)	Frames	Time (s)	Frames
320	240	60	921.4	55286	687.3	41240	1853.1	111187	1385.6	83139
320	240	125	442.3	55286	329.9	41240	889.5	111187	665.1	83139
320	240	250	221.1	55286	165.0	41240	444.7	111187	332.5	83139
320	240	500	110.6	55286	82.5	41240	222.3	111187	166.3	83139
320	240	1000	55.3	55286	41.2	41240	111.2	111187	83.1	83139
320	240	1250	44.2	55286	33.0	41240	88.9	111187	66.5	83139
320	240	1500	36.9	55286	27.5	41240	74.1	111187	55.4	83139
320	240	2000	27.6	55286	20.6	41240	55.6	111187	41.6	83139
320	240	4000	13.8	55286	10.3	41240	27.8	111187	20.8	83139
320	240	5600	9.9	55286	7.4	41240	19.8	111187	14.8	83139
320	240	6259 (Max)	8.8	55286	6.6	41240	17.8	111187	13.3	83139
640	480	60	230.4	13825	172.3	10337	463.4	27805	346.5	20789
640	480	125	110.6	13825	82.7	10337	222.4	27805	166.3	20789
640	480	250	55.3	13825	41.3	10337	111.2	27805	83.1	20789
640	480	500	27.7	13825	20.7	10337	55.6	27805	41.6	20789
640	480	1000	13.8	13825	10.3	10337	27.8	27805	20.8	20789
640	480	1250	11.1	13825	8.3	10337	22.2	27805	16.6	20789
640	480	1959 (Max)	7.1	13825	5.3	10337	14.2	27805	10.6	20789
800	600	60	147.5	8848	110.5	6628	296.6	17796	222.2	13330
800	600	125	70.8	8848	53.0	6628	142.4	17796	111.1	13330
800	600	250	35.4	8848	26.5	6628	71.2	17796	53.3	13330
800	600	500	17.7	8848	13.3	6628	35.6	17796	26.7	13330
800	600	1000	8.8	8848	6.6	6628	17.8	17796	13.3	13330
800	600	1299 (Max)	6.4	8848	5.1	6628	13.7	17796	10.3	13330
(5:4):										
1280	1024	60	54.0	3240	40.5	2428	108.6	6517	81.4	4884
1280	1024	125	25.9	3240	19.4	2428	52.1	6517	39.1	4884
1280	1024	250	13.0	3240	9.7	2428	26.1	6517	19.5	4884
1280	1024	500	6.5	3240	4.9	2428	13.0	6517	9.8	4884
1280	1024	510 (Max)	6.4	3240	4.8	2428	12.9	6517	9.6	4884

**16:9 IL3 / IL4 Resolutions (Standard Modes)**

Resolution		Frame Rate	4GB Capacity				8GB Capacity			
H.	V.	FPS	8-bit		10-bit		8-bit		10-bit	
			Time (s)	Frames	Time (s)	Frames	Time (s)	Frames	Time (s)	Frames
480	270	60	546.1	32767	409.6	24577	1098.3	65899	823.8	49428
480	270	125	262.1	32767	196.6	24577	527.2	65899	395.4	49428
480	270	250	131.1	32767	98.3	24577	263.6	65899	197.7	49428
480	270	500	65.5	32767	49.2	24577	131.8	65899	98.8	49428
480	270	1000	32.8	32767	24.6	24577	65.9	65899	49.4	49428
480	270	1500	21.8	32767	16.4	24577	43.9	65899	32.9	49428
480	270	2000	16.4	32767	12.3	24577	32.9	65899	24.7	49428
480	270	3000	10.9	32767	8.2	24577	21.9	65899	16.5	49428
480	270	4187 (Max)	7.8	32767	5.9	24577	15.7	65899	11.8	49428
640	360	60	307.2	18433	229.7	13782	617.9	37072	461.9	27718
640	360	125	147.5	18433	110.3	13782	296.6	37072	221.7	27718
640	360	250	73.7	18433	55.1	13782	148.3	37072	110.9	27718
640	360	500	36.9	18433	27.6	13782	74.1	37072	55.4	27718
640	360	1000	18.4	18433	13.8	13782	37.1	37072	27.7	27718
640	360	1500	12.3	18433	9.2	13782	24.7	37072	18.5	27718
640	360	2600 (Max)	7.1	18433	5.3	13782	14.3	37072	10.7	27718
800	450	60	196.6	11798	147.3	8837	395.4	23727	296.2	17773
800	450	125	94.4	11798	70.7	8837	189.8	23727	142.2	17773
800	450	250	47.2	11798	35.3	8837	94.9	23727	53.3	17773
800	450	500	23.6	11798	17.7	8837	47.4	23727	35.5	17773
800	450	1000	11.8	11798	8.8	8837	23.7	23727	17.8	17773
800	450	1500	7.9	11798	5.9	8837	15.8	23727	11.8	17773
800	450	1727 (Max)	6.8	11798	5.1	8837	13.7	23727	10.3	17773
1024	576	60	120.0	7201	89.8	5390	241.4	14482	180.7	10841
1024	576	125	57.6	7201	43.1	5390	115.9	14482	86.7	10841
1024	576	250	28.8	7201	21.6	5390	58.0	14482	43.4	10841
1024	576	500	14.4	7201	10.8	5390	30.0	14482	21.7	10841
1024	576	750	9.6	7201	7.2	5390	19.3	14482	14.4	10841
1024	576	1106 (Max)	6.5	7201	4.9	5390	13.2	14482	9.9	10841
1280	720	60	76.8	4608	57.6	3454	154.5	9269	115.8	6946
1280	720	125	36.9	4608	27.6	3454	74.1	9269	55.6	6946
1280	720	250	18.4	4608	13.8	3454	37.1	9269	27.8	6946
1280	720	500	9.2	4608	6.9	3454	18.5	9269	13.9	6946
1280	720	725 (Max)	6.4	4608	4.8	3454	12.8	9269	9.6	6946

**1:1 IL3 / IL4 Resolutions (Standard Mode)**

Resolution		Frame Rate	4GB Capacity				8GB Capacity			
H.	V.	FPS	8-bit		10-bit		8-bit		10-bit	
			Time (s)	Frames	Time (s)	Frames	Time (s)	Frames	Time (s)	Frames
256	256	60	1079.7	64784	803.6	48217	2171.47	130288	1616.2	96970
256	256	125	518.3	64784	385.7	48217	1042.3	130288	775.8	96970
256	256	250	259.1	64784	192.9	48217	521.2	130288	387.9	96970
256	256	500	129.6	64784	96.4	48217	260.6	130288	193.9	96970
256	256	1000	64.8	64784	48.2	48217	130.3	130288	97.0	96970
256	256	1500	43.2	64784	32.1	48217	86.9	130288	64.6	96970
256	256	2000	32.4	64784	24.1	48217	65.1	130288	48.5	96970
256	256	4000	16.2	64784	12.1	48217	32.6	130288	24.2	96970
256	256	6870 (Max)	9.4	64784	7.0	48217	19.0	130288	14.1	96970
400	400	60	442.4	26543	330.2	19809	889.7	53381	664.0	39838
400	400	125	212.3	26543	158.5	19809	427.0	53381	318.7	39838
400	400	250	106.2	26543	79.2	19809	213.5	53381	159.3	39838
400	400	500	53.1	26543	39.6	19809	106.8	53381	79.7	39838
400	400	1000	26.5	26543	19.8	19809	53.4	53381	39.8	39838
400	400	2000	13.3	26543	9.9	19809	26.7	53381	19.9	39838
400	400	3339 (Max)	7.9	26543	5.9	19809	16.0	53381	11.9	39838
512	512	60	270.0	16201	202.1	12128	543.0	32583	406.5	24391
512	512	125	129.6	16201	97.0	12128	260.7	32583	195.1	24391
512	512	250	64.8	16201	48.5	12128	130.3	32583	97.6	24391
512	512	500	32.4	16201	24.3	12128	65.2	32583	48.8	24391
512	512	1000	16.2	16201	12.1	12128	32.6	32583	24.4	24391
512	512	1500	10.8	16201	8.1	12128	21.7	32583	16.3	24391
512	512	2162 (Max)	7.5	16201	5.6	12128	15.1	32583	11.3	24391
800	800	60	110.6	6636	82.9	4971	222.4	13347	166.6	9998
800	800	125	53.1	6636	39.8	4971	106.8	13347	80.0	9998
800	800	250	26.5	6636	19.9	4971	53.4	13347	40.0	9998
800	800	500	13.3	6636	9.9	4971	26.7	13347	20.0	9998
800	800	977 (Max)	6.8	6636	5.1	4971	13.7	13347	10.2	9998
1024	1024	60	67.7	4059	50.5	3032	135.8	8146	101.6	6098
1024	1024	125	32.5	4059	24.3	3032	65.2	8146	48.8	6098
1024	1024	250	16.2	4059	12.1	3032	32.6	8146	24.4	6098
1024	1024	500	8.1	4059	6.1	3032	16.3	8146	12.2	6098
1024	1024	624 (Max)	6.5	4059	4.9	3032	13.1	8146	9.8	6098

IL4100LR2 and IL3D with External SSD in Long Record mode							
Resolution		LR2 8-bit Frame Rates and Times hh:mm:ss			LR2 10-bit Frame Rates and Times hh:mm:ss		
H.	V.	FPS	256GB SSD	512GB SSD	FPS	256GB SSD	512GB SSD
320	240	60	15:13:34	30:27:08	60	11:07:35	22:15:11
320	240	125	7:18:31	14:37:01	125	5:20:27	10:40:53
320	240	250	3:39:15	7:18:31	250	2:40:13	5:20:27
320	240	500	1:49:38	3:39:15	500	1:20:07	2:40:13
320	240	1000	0:54:49	1:49:38	1000	0:40:03	1:20:07
320	240	2000	0:27:24	0:54:49	2000	0:20:02	0:40:03
320	240	3083 (Max)	0:17:47	0:35:34	2253 (Max)	0:13:00	0:25:59
400	400	60	7:13:55	14:27:50	60	5:27:30	10:55:00
400	400	125	3:28:17	6:56:34	125	2:37:12	5:14:24
400	400	250	1:44:08	3:28:17	250	1:18:36	2:37:12
400	400	500	0:52:04	1:44:08	500	0:39:18	1:18:36
400	400	1000	0:26:02	0:52:04	1000	0:19:39	0:39:18
400	400	1464 (Max)	0:17:47	0:35:34	1105 (Max)	0:13:25	0:26:51
512	512	60	4:31:13	9:02:26	60	3:21:49	6:43:38
512	512	125	2:10:11	4:20:22	125	1:36:52	3:13:44
512	512	250	1:05:06	2:10:11	250	0:48:26	1:36:52
512	512	500	0:32:33	1:05:06	500	0:24:13	0:48:26
512	512	901 (Max)	0:18:04	0:36:07	681 (Max)	0:13:26	0:26:53
640	480	60	3:51:26	7:42:52	60	2:51:50	5:43:41
640	480	125	1:51:05	3:42:10	125	1:22:29	2:44:58
640	480	250	0:55:33	1:51:05	250	0:41:14	1:22:29
640	480	500	0:27:46	0:55:33	500	0:20:37	0:41:14
640	480	770 (Max)	0:18:02	0:36:04	580 (Max)	0:13:23	0:26:47
800	600	60	2:27:06	4:54:11	60	1:50:33	3:41:05
800	600	125	1:10:36	2:21:13	125	0:53:04	1:46:07
800	600	250	0:35:18	1:10:36	250	0:26:32	0:53:04
800	600	496 (Max)	0:17:48	0:35:35	373 (Max)	0:13:22	0:26:45
1280	720	60	1:17:07	2:34:14	60	1:29:55	2:59:50
1280	720	125	0:37:01	1:14:02	125	0:43:10	1:26:19
1280	720	259 (Max)	0:17:52	0:35:44	194 (Max)	0:20:50	0:41:40
1024	1024	60	1:07:48	2:15:37	60	0:50:44	1:41:29
1024	1024	125	0:32:33	1:05:06	125	0:24:21	0:48:42
1024	1024	227 (Max)	0:17:55	0:35:51	170 (Max)	0:13:25	0:26:49
1280	1024	60	0:54:13	1:48:27	60	0:40:38	1:21:17
1280	1024	125	0:26:02	0:52:03	125	0:19:30	0:39:01
1280	1024	183 (Max)	0:17:47	0:35:33	136 (Max)	0:13:19	0:26:39



IL4100LR3 / IL3-D in Long Record mode (max fps limited to 1250fps on TS3L models)							
Resolution		LR3 8-bit Frame Rates and Times hh:mm:ss			LR3 10-bit Frame Rates and Times hh:mm:ss		
H.	V.	FPS	256GB SSD	512GB SSD	FPS	256GB SSD	512GB SSD
320	240	60	15:13:34	30:27:08	60	11:07:35	22:15:11
320	240	125	7:18:31	14:37:01	125	5:20:27	10:40:53
320	240	250	3:39:15	7:18:31	250	2:40:13	5:20:27
320	240	500	1:49:38	3:39:15	500	1:20:07	2:40:13
320	240	1000	0:54:49	1:49:38	1000	0:40:03	1:20:07
320	240	2000	0:27:24	0:54:49	2000	0:20:02	0:40:03
320	240	4000	0:13:42	0:27:24	4000	0:10:01	0:20:02
320	240	6167 (Max)	0:08:53	0:17:47	4507 (Max)	0:06:30	0:12:59
400	400	60	7:13:55	14:27:50	60	5:27:30	10:55:00
400	400	125	3:28:17	6:56:34	125	2:37:12	5:14:24
400	400	250	1:44:08	3:28:17	250	1:18:36	2:37:12
400	400	500	0:52:04	1:44:08	500	0:39:18	1:18:36
400	400	1000	0:26:02	0:52:04	1000	0:19:39	0:39:18
400	400	2929 (Max)	0:08:53	0:17:47	2211 (Max)	0:06:43	0:13:25
512	512	60	4:31:13	9:02:26	60	3:21:49	6:43:38
512	512	125	2:10:11	4:20:22	125	1:36:52	3:13:44
512	512	250	1:05:06	2:10:11	250	0:48:26	1:36:52
512	512	500	0:32:33	1:05:06	500	0:24:13	0:48:26
512	512	1802 (Max)	0:09:02	0:18:04	1362 (Max)	0:06:43	0:13:26
640	480	60	3:51:26	7:42:52	60	2:51:50	5:43:41
640	480	125	1:51:05	3:42:10	125	1:22:29	2:44:58
640	480	250	0:55:33	1:51:05	250	0:41:14	1:22:29
640	480	500	0:27:46	0:55:33	500	0:20:37	0:41:14
640	480	1541 (Max)	0:09:01	0:18:01	1160 (Max)	0:06:41	0:13:23
800	600	60	2:27:06	4:54:11	60	1:50:33	3:41:05
800	600	125	1:10:36	2:21:13	125	0:53:04	1:46:07
800	600	250	0:35:18	1:10:36	250	0:26:32	0:53:04
800	600	500	0:17:39	0:35:18	500	0:13:16	0:26:32
800	600	993 (Max)	0:08:53	0:17:47	746 (Max)	0:06:41	0:13:22
1280	720	60	1:17:07	2:34:14	60	1:29:55	2:59:50
1280	720	125	0:37:01	1:14:02	125	0:43:10	1:26:19
1280	720	250	0:18:31	0:37:01	250	0:21:35	0:43:10
1280	720	518 (Max)	0:08:56	0:17:52	389 (Max)	0:10:25	0:20:50
1280	1024	60	0:54:13	1:48:27	60	0:40:38	1:21:17
1280	1024	125	0:26:02	0:52:03	125	0:19:30	0:39:01
1280	1024	365 (Max)	0:08:55	0:17:50	273 (Max)	0:06:41	0:13:22

## Appendix E: IL5 Record / Resolution Tables

NOTE: These tables include only a sampling of resolution and frame rate values. Resolutions are available in increments of 2 x 2 pixels from 64 x 32 to the maximum resolution for each model. Minimum resolution in for the IL5-D models in Long Recording mode is 320 x 32. Frame rates are available in 1fps increments from 24 fps to the maximum rate for any resolution. Note that maximum frame rates are higher when binning is enabled on resolutions equal to or less than 768 wide.

### Sample IL5 16:9 Resolutions

Table 8-4: IL5 Resolutions, Rates, and Times

Resolution		Time and Frames listed for 8GB cameras (for 4GB cameras divide by 2)							
H.	V.	8-bit			10-bit			12-bit	
		FPS	Time (s)	909,446 Frames	FPS	Time (s)	677,396 Frames	FPS	Time (s)
128	72	125	7275.6		125	5419.2		125	4483.2
		250	3637.8		250	2709.6		250	2241.6
		500	1818.9		500	1354.8		500	1120.8
		1000	909.4		1000	677.4		1000	560.4
		2500	363.7		2500	270.9		2500	224.1
		5000	181.8		5000	135.4		5000	112.0
		10,000	90.9		10,000	67.7		10,000	56.0
		12,099*	75.1		10,139*	66.8		10,139*	55.2
		17,108**	53.1		14,257**	47.5		14,257**	39.3
320	180	125	1167.5	145,935 Frames	125	872.8	109,103 Frames	125	729.8
		250	583.7		250	436.4		250	364.9
		500	291.9		500	218.2		500	182.5
		1000	145.9		1000	109.1		1000	91.2
		2000	72.9		2000	54.5		2000	45.6
		4000	36.4		4000	27.2		4000	22.8
		5329*	27.3		4451*	24.5		4451*	20.4*
		8100**	18.0		6750**	16.1		6750**	13.5**
448	252	125	595.8	74,477 Frames	125	444.9	55,613 Frames	125	370.7
		250	297.9		250	222.4		250	185.3
		500	148.9		500	111.2		500	92.6
		1000	74.4		1000	55.6		1000	46.3
		2000	37.2		2000	27.8		2000	23.1
		3881*	19.1		3234*	17.1		3234*	14.3
		5995**	12.4		4996**	11.1		4996**	9.2
640	360	125	292.0	36,499 Frames	125	218.3	27,289 Frames	125	14.8
		250	146.0		250	109.2		250	91.3
		500	73.0		500	54.6		500	45.6
		750	48.7		750	36.4		750	30.4
		1000	36.5		1000	27.3		1000	22.8
		1500	24.3		1500	18.2		1500	15.2
		2000	18.2		2000	13.6		2000	11.4
		2757*	13.2		2297*	11.8		2297*	9.9
		4314**	8.4		3595**	7.5		3595**	6.3

\*maximum frame rate without binning

\*\*maximum frame rate with binning enabled

## IL5 16:9 Resolutions, Continued

Resolution		8GB Capacity (for 4GB cameras divide Time by 2)								
H.	V.	8-bit			10-bit			12-bit		
800	450	FPS	Time (s)	23,360 Frames	FPS	Time (s)	17,498 Frames	FPS	Time (s)	14,600 Frames
		60	389.3		60	291.6		60	243.3	
		125	186.9		125	140.0		125	116.8	
		250	93.4		250	70.0		250	58.4	
		500	46.7		500	35.0		500	29.2	
		1000	23.4		1000	17.5		1000	14.6	
		1500	15.5		1500	11.6		1500	9.7	
		2221	10.5		1851	9.4		1851	7.8	
Supported by IL5-S, H, and Q Models:										
1024	576	125	114.1	14,258 Frames	125	85.4	10,673 Frames	125	889.5	8,903 Frames
		250	57.0		250	42.7		250	444.7	
		500	28.5		500	21.3		500	222.3	
		750	19.0		750	14.2		750	27.8	
		1000	14.2		1000	10.6		1000	8.9	
		1746	8.1		1455	7.3		1455	6.1	
1280	720	125	73.0	9,125 Frames	125	54.7	6,839 Frames	125	45.6	5,703 Frames
		250	36.5		250	27.4		250	22.8	
		500	18.3		500	13.7		500	11.4	
		750	12.2		750	9.1		750	7.6	
		1000	9.1		1000	6.8		1000	5.7	
		1403	6.5		1169	5.8		1169	4.8	
Supported by IL5-H and Q Models:										
1600	900	125	46.7	5840 Frames	125	35.0	4374 Frames	125	29.2	3650 Frames
		250	23.4		250	17.5		250	14.6	
		500	11.7		500	8.7		500	7.3	
		625	9.3		625	7.0		625	5.8	
		758	7.7		633	6.9		633	5.8	
1920	1080	60	67.6	4,055 Frames	60	50.7	3,041 Frames	60	42.2	2,534 Frames
		125	32.4		125	24.3		125	20.3	
		250	16.2		250	12.2		250	10.1	
		500	8.1		500	6.1		500	5.1	
		634	6.4		529	5.7		529	4.8	
Supported by IL5-Q only:										
2560	1440	60	38.0	2,281 Frames	60	28.5	1,709 Frames	60	23.8	1,425 Frames
		125	18.2		125	13.7		125	11.4	
		250	9.1		250	6.8		250	5.7	
		359	6.4		300	5.7		300	4.8	

## Sample IL5 5:4 Resolutions

Resolution		8GB Capacity (for 4GB cameras divide Time by 2)								
H.	V.	8-bit			10-bit			12-bit		
		FPS	Time (s)		FPS	Time (s)		FPS	Time (s)	
128	102	125	5140.9	642,615 Frames	125	3823.0	477,872 Frames	125	3166.6	395,828 Frames
		250	2570.5		250	1911.5		250	1583.3	
		500	1285.2		500	955.7		500	791.7	
		1000	642.6		1000	477.8		1000	395.8	
		2000	321.3		2000	238.9		2000	197.9	
		4000	160.6		4000	119.4		4000	98.9	
		8943*	71.8		7452*	64.1		7452*	53.1	
		13,071**	49.1		10,892**	43.8		10,892**	36.3	
250	200	125	1334.2	166,770 Frames	125	1000.8	125,097 Frames	125	840.7	105,089 Frames
		250	667.1		250	500.4		250	420.4	
		500	333.5		500	250.2		500	210.2	
		1000	166.8		1000	125.1		1000	105.1	
		2000	83.4		2000	62.5		2000	52.5	
		4828*	34.5		4023*	31.0		4023*	26.1	
		7380**	22.5		6150**	20.3		6150**	20.3	
320	256	125	831.6	103,950 Frames	125	621.8	77,727 Frames	125	519.7	64,968 Frames
		250	415.8		250	310.9		250	259.9	
		500	207.9		500	155.5		500	129.9	
		1000	104.0		1000	77.7		1000	65.0	
		2000	51.3		2000	38.3		2000	32.0	
		3823*	26.8		3186*	24.0		3186*	20.1	
		5910**	17.3		4925**	15.5		4925**	13.0	
512	410	60	676.3	40,575 Frames	60	506.2	30,372 Frames	60	420.2	25,212 Frames
		125	324.6		125	243.0		125	201.7	
		250	162.3		250	121.5		250	100.9	
		500	81.2		500	60.7		500	50.4	
		1000	40.6		1000	30.4		1000	25.2	
		2431*	16.4		2026*	14.8		2026*	12.2	
		3818**	10.4		3182**	9.4		3182**	7.8	
640	512	60	329.7	19,783 Frames	60	294.8	17,685 Frames	60	270.8	16,247 ,Frames
		125	158.3		125	141.5		125	130.0	
		250	79.1		250	70.7		250	65.0	
		500	39.6		500	35.4		500	32.5	
		1000	19.8		1000	17.7		1000	16.3	
		1959	13.1		1632*	11.7		1632*	9.8	
		3093**	8.2		2577**	7.4		2577**	6.2	
750	600	60	310.7	18,639 Frames	60	233.6	14,016 Frames	60	194.7	11,680 Frames
		125	149.1		125	112.1		125	93.4	
		250	74.6		250	56.1		250	46.7	
		500	37.3		500	28.0		500	23.4	
		1000	18.6		1000	14.0		1000	11.6	
		1677*	11.1		1398*	10.0		1398*	8.3	
		2657**	7.0		2214**	6.3		2214**	5.2	

## IL5 5:4 Resolutions, Continued

Resolution		8GB Capacity (for 4GB cameras divide Time by 2)								
H.	V.	8-bit			10-bit			12-bit		
		FPS	Time (s)	Frames	FPS	Time (s)	Frames	FPS	Time (s)	Frames
Supported by IL5-S, H, and Q Models:										
1024	820	60	169.1	10,145 Frames	60	126.6	7,594 Frames	60	105.6	6,334 Frames
		125	81.2		125	60.8		125	50.7	
		250	40.6		250	30.4		250	25.3	
		500	20.3		500	15.2		500	12.7	
		750	13.5		625	12.2		625	10.1	
		1234	8.1		1028	7.2		1028	6.0	
1280	1024	60	108.3	6,499 Frames	60	81.2	4,870 Frames	60	67.7	4,062 Frames
		125	52.0		125	39.0		125	32.5	
		250	26.0		250	19.5		250	16.3	
		500	13.0		500	9.7		500	8.1	
		991	6.4		826	5.8		826	4.8	
Supported by IL5-H and Q Models:										
1350	1080	60	97.2	5,834 Frames	60	73.0	4,382 Frames	60	60.1	4,382 Frames
		125	46.7		125	35.1		125	28.8	
		250	23.3		250	17.5		250	14.4	
		500	11.7		500	8.8		500	7.2	
		634	9.2		529	8.3		529	6.8	
1500	1200	60	77.9	4,672 Frames	60	58.4	3,504 Frames	60	48.7	2,920 Frames
		125	37.4		125	28.0		125	23.4	
		250	18.7		250	14.0		250	11.7	
		500	9.3		477	7.3		477	6.1	
		571	8.2							
Supported by IL5-Q only:										
2000	1600	60	43.8	2,628 Frames	60	32.8	1,970 Frames	60	27.4	1,642 Frames
		125	21.0		125	15.8		125	13.1	
		250	10.5		250	7.9		250	6.6	
		404	6.5		337	5.8		337	4.9	
2560	2048	60	26.7	1,604 Frames	60	20.0	1,202 Frames	60	16.7	1,002 Frames
		125	12.8		125	9.6		125	8.0	
		253	6.3		211	5.7		211	4.7	



## Sample IL5 4:3 Resolutions

Resolution		8GB Capacity (for 4GB cameras divide Time by 2)								
H.	V.	8-bit			10-bit			12-bit		
		FPS	Time (s)	Frames	FPS	Time (s)	Frames	FPS	Time (s)	Frames
128	96	125	5461.4	682,675 Frames	125	4067.0	508,375 Frames	125	3364.2	420,527 Frames
		250	2730.7		250	2033.5		250	1682.1	
		500	1365.4		500	1016.8		500	841.1	
		1000	682.7		1000	508.4		1000	420.5	
		2000	341.3		2000	254.2		2000	210.3	
		4000	170.7		4000	127.1		4000	105.1	
		9485*	72.3		7862*	64.6		7862*	53.4	
		13,718**	49.765		11,432**	44.4		11,432**	36.7	
256	192	125	1368.0	171,001 Frames	125	1018.2	127,278 Frames	125	842.1	105,258 Frames
		250	684.0		250	509.1		250	421.0	
		500	342.0		500	254.6		500	210.5	
		750	228.0		750	169.7		750	140.3	
		1000	171.0		1000	127.3		1000	105.3	
		2000	85.5		2000	63.6		2000	52.6	
		5017*	34.0		4180*	30.4		4180*	25.1	
		7652**	22.3		6377**	19.9		6377**	16.5	
320	240	125	875.7	109,466 Frames	125	654.8	81,852 Frames	125	547.4	68,427 Frames
		250	437.9		250	327.4		250	273.7	
		500	218.9		500	163.7		500	136.9	
		1000	109.5		1000	81.9		1000	68.4	
		2000	54.7		2000	40.9		2000	34.2	
		4065*	26.9		3387*	24.1		3387*	20.2	
		6267**	17.4		5222**	15.6		5222*	13.1	
512	384	60	712.9	42,771 Frames	60	533.6	32,017 Frames	60	443.0	26,578 Frames
		125	342.2		125	256.1		125	212.6	
		250	171.1		250	128.1		250	106.3	
		500	85.5		500	64.0		500	53.2	
		1000	42.8		1000	32.0		1000	26.6	
		2590*	16.5		2158*	14.8		2158*	12.3	
		4061**	10.4		3384**	9.4		3384**	7.8	
640	480	60	456.3	27,375 Frames	60	341.1	20,468 Frames	60	285.2	17,110 Frames
		125	219.0		125	163.7		125	136.9	
		250	109.5		250	81.9		250	68.4	
		500	54.8		500	40.9		500	34.2	
		1000	27.4		1000	20.5		1000	17.1	
		2086*	13.1		1738*	11.7		1738*	9.8	
		3289**	8.3		2741**	7.4		2741**	6.2	

## IL5 4:3 Resolutions, Continued

Resolution		8GB Capacity (for 4GB cameras divide Time by 2)								
H.	V.	8-bit			10-bit			12-bit		
800	600	FPS	Time (s)	17,520 Frames	FPS	Time (s)	13,124 Frames	FPS	Time (s)	10,950, Frames
		60	292.0		60	218.7		60	182.5	
		125	140.2		125	105.0		125	87.6	
		250	70.1		250	52.5		250	43.8	
		500	35.0		500	26.2		500	21.9	
		750	23.4		750	17.5		750	14.6	
		1677	10.4		1398	9.3		1398	7.8	
Supported by IL5-S, -H and -Q models:										
1024	768	60	178.2	10,694 Frames	60	133.4	8 005 Frames	60	111.3	6,677 Frames
		125	85.6		125	64.0		125	53.4	
		250	42.8		250	32.0		250	26.7	
		500	21.4		500	16.0		500	13.4	
		750	14.3		750	10.6		750	8.9	
		1316	8.1		1097	7.2		1097	6.0	
1280	960	60	114.1	6,844 Frames	60	85.5	5,129 Frames	60	71.3	4,277 Frames
		125	54.8		125	41.0		125	34.2	
		250	27.4		250	20.5		250	17.1	
		500	13.7		500	10.3		500	8.6	
		1057	6.4		880	5.8		880	4.8	
Supported by IL5-H and -Q models:										
1440	1080	60	90.1	5,407 Frames	60	67.6	4,055 Frames	60	56.3	3,379 Frames
		125	43.3		125	32.4		125	27.0	
		250	21.6		250	16.2		250	13.5	
		500	10.8		500	8.1		500	6.8	
		634(Max)	8.5		529(Max)	7.7		529(Max)	6.4	
Supported by IL5 Q only:										
2000	1500	60	46.7	2,803 Frames	60	35.0	2,101 Frames	60	29.2	1,752 Frames
		125	22.4		125	16.8		125	14.0	
		250	11.2		250	8.4		250	7.0	
		431(Max)	6.5		359(Max)	5.9		359(Max)	4.9	
2560	1920	60	28.5	1,711 Frames	60	21.4	1,282 Frames	60	17.8	1,069 Frames
		125	13.7		125	10.3		125	8.6	
		270f(Max)	6.3		225(Max)	5.7		225(Max)	4.8	

**IL5-D Long Record**

Resolution		1TB Capacity SSD (for cameras with 512GB divide by 2)											
H	V	8 Bits				10 Bits				12 Bits			
		FPS	Hr	Min	Sec	FPS	Hr	Min	Sec	FPS	Hr	Min	Sec
320	240	60	59	28	32	60	43	27	47	60	37	40	3
		125	28	32	53	125	20	51	44	125	18	4	49
		250	14	16	26	250	10	25	52	250	9	2	24
		500	7	8	13	500	5	12	56	500	4	31	12
		1000	3	34	6	1000	2	36	28	1000	2	15	36
		2000	1	47	3	2000	1	18	14	2000	1	7	48
		3082e	1	9	19	2252e	1	9	28	1952e	1	9	28
		3394*	1	3	5	3394**	0	46	6	3394**	0	39	57
		5000**	0	41	0	4505***	0	34	43	3905***	0	34	43
512	512	60	17	39	24	60	13	8	22	60	10	58	16
		125	8	28	31	125	6	18	25	125	5	15	58
		250	4	14	15	250	3	9	12	250	2	37	59
		500	2	7	7	500	1	34	36	500	1	18	59
		915e	1	9	28	681e	1	9	27	568e	1	9	32
		1634	0	38	54	1362	0	34	43	1137	0	34	44
640	480	60	15	4	0	60	11	11	17	60	9	25	0
		125	7	13	55	125	5	22	13	125	4	31	12
		250	3	36	57	250	2	41	6	250	2	15	36
		500	1	48	28	500	1	20	33	500	1	7	48
		781e	1	9	26	580e	1	9	26	488e	1	9	28
		1562	0	34	43	1160	0	34	43	976	0	34	44
800	600	60	9	34	34	60	7	11	51	60	6	0	38
		125	4	35	47	125	3	27	17	125	2	53	6
		250	2	17	53	250	1	43	38	250	1	26	33
		496e	1	9	30	373e	1	9	28	311e	1	9	34
		500	1	8	56	500	0	51	49	500	0	43	16
		993	0	34	43	746	0	34	44	623	0	34	43
Supported by IL5-S, -H and -Q models:													
1280	720	60	5	1	20	60	3	45	14	60	3	8	20
		125	2	24	38	125	1	48	7	125	1	30	24
		250	1	12	19	250	0	54	3	250	0	45	12
		260e	1	9	32	194e	1	9	39	162e	1	9	45
		520	0	34	46	389	0	34	44	325	0	34	46

\*Maximum frame rate in LR3 (Fast SSD) without binning.

\*\*Maximum frame rate in LR3 (Fast SSD) binning enabled.

eMaximum frame rate for External SSD (eSATA)

## IL5-D Long Record, Continued

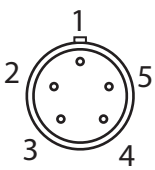

Resolution		1TB Capacity SSD (for cameras with 512GB divide by 2)											
H	V	8 Bits				10 Bits				12 Bits			
		FPS	Hr	Min	Sec	FPS	Hr	Min	Sec	FPS	Hr	Min	Sec
1280	1024	60	3	31	52	60	2	38	45	60	2	12	24
		125	1	41	42	125	1	16	12	125	1	3	33
		183e	1	9	28	137e	1	9	31	114e	1	9	41
		250	0	50	51	274	0	34	45	228	0	34	50
		366	0	34	44								
Supported by IL5-H and -Q models:													
1350	1080	60	3	9	54	60	2	22	43	60	1	58	56
		125	1	31	9	125	1	8	30	125	0	57	5
		164e	1	9	28	123e	1	9	37	102e	1	9	57
		250	0	45	34	246	0	34	48	205	0	34	48
		328	0	34	44								
1920	1080	60	2	13	43	60	1	40	26	60	1	23	41
		115e	1	9	46	86e	1	10	4	72e	1	9	44
		125	1	4	11	125	0	48	12	125	0	40	10
		231	0	34	44	173	0	34	50	144	0	34	52
Supported by IL5 Q only:													
2560	1440	30	2	30	36	30	1	52	51	30	1	34	9
		60	1	15	18	60	0	56	25	60	0	47	4
		65e	1	9	30	48e	1	10	32	40e	1	10	36
		130	0	34	45	97	0	34	54	81	0	34	52
2560	2048	30	1	45	53	30	1	19	21	30	1	6	12
		45e	1	10	35	34e	1	10	1	28e	1	10	56
		60	0	52	56	68	0	35	0	57	0	34	50
		91	0	34	54								

eMaximum frame rate for External SSD (eSATA)

## Appendix F: Power and I/O Connections

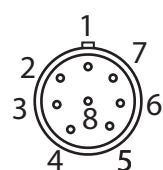
### Power Connections For the IL3

Table 8-5: Power Pin Out

(View from Solder cup side of connector) 		Use Lemo 1B.305 compatible plug (FGG.305.CLAD.42.NZ Pictured here) Refer to <a href="http://www.lemo.com">http://www.lemo.com</a> 
Pin	Signal	
1	+12 to 24VDC	
2	+12 to 24VDC	
3	No Connection	
4	Ground	
5	Ground	

### I/O Connections: Sync and Trigger

Table 8-6: I/O Connector Pin Out

(View from Solder cup side of connector) 		Use Lemo 1B.308 compatible plug Refer to <a href="http://www.lemo.com">http://www.lemo.com</a>
Pin	Signal	
1	Ground	
2	Analog Reserved	
3	LVTTTL Sync Out	
4	LVTTTL Trigger Out	
5	LVTTTL Arm Out	
6	LVTTTL Arm In	
7	LVTTTL Trigger In	
8	LVTTTL Sync In	

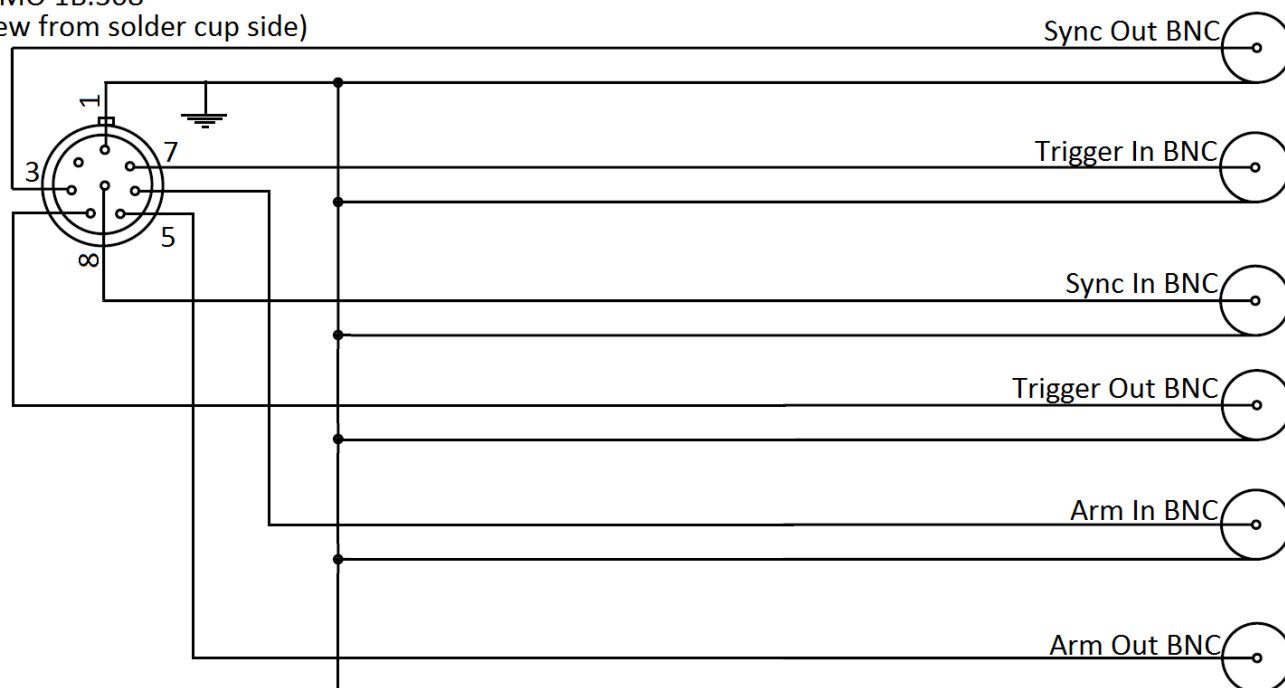
The IL3 is shipped with a Sync I/O cable for connecting external Trigger, Sync Out, and Sync In signals. The cable has a LEMO connector for the IL3 end and BNC connectors for the three signals.



**Figure 8-1: Sync I/O Cable Drawing**

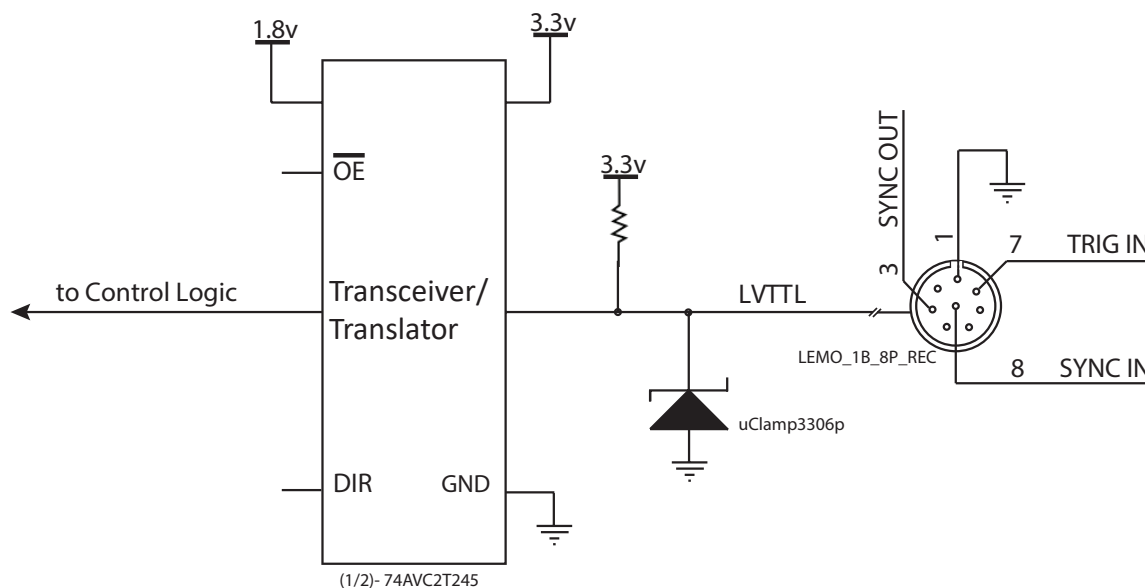
LEMO 1B.308

(View from solder cup side)



For simplicity, the schematic below represents one I/O signal.

The  $\mu$ Clamp is for ESD protection.

**Figure 8-2: Sync I/O Camera Interface Schematic**

The ILx I/O circuits are designed to operate at LVTTTL levels (3.3v). The inputs will respond to simple switch closures.

**NOTE: THESE I/O PORTS ARE FOR LVTTTL LEVELS ONLY. VOLTAGES ABOVE 3.3V WILL HARM THE ILx.**

There is an I/O conditioning accessory available from Fastec that accepts signals up to 24v. The conditioner uses opto-isolators to protect the camera from over-voltage.

**For inputs greater than 3.3v:**

PLCs and other devices that operate on higher voltage levels than the TSx may be used for triggering and other I/O inputs with the proper conditioning circuit.

The output of the triggering device may be connected to the conditioning circuit in one of two ways, depending on whether the output is capable of sourcing or sinking  $\geq 5\text{mA}$ .

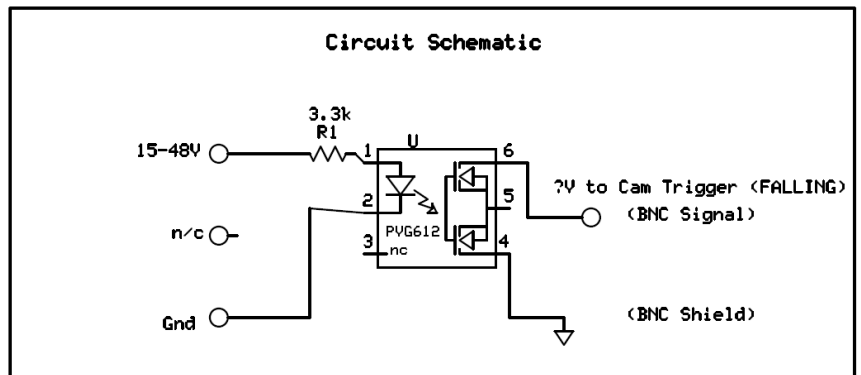
The conditioning circuit also provides opto-isolation between the driving circuit and the camera. The opto-isolator adds about 2msec (0.002 seconds) of delay to the input.

The PLC to 3.3V Adapter is available directly through Fastec:

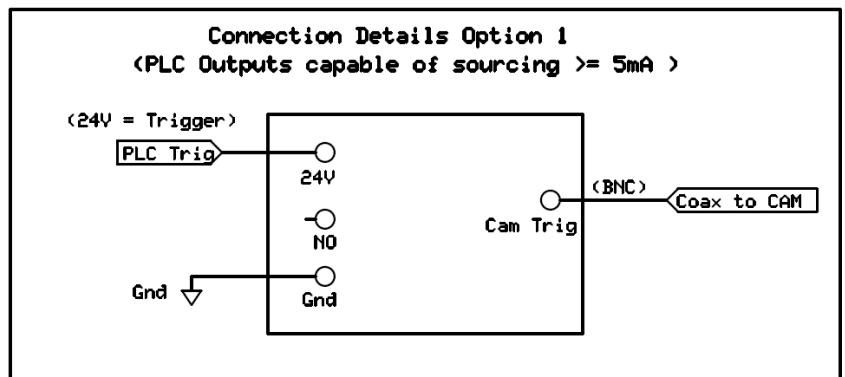
support@fastecimaging.com

(858) 592-2342

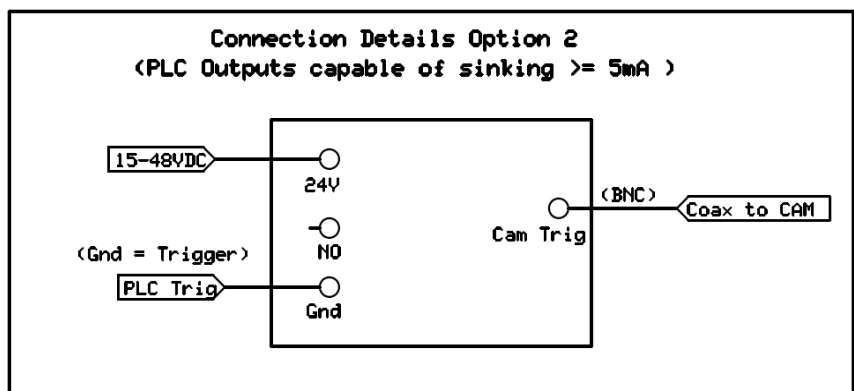
**Figure 8-3: PLC to 3.3V Adapter Schematic**



**Figure 8-4: PLC 24V as Camera Trigger**



**Figure 8-5: PLC Low as Camera Trigger**

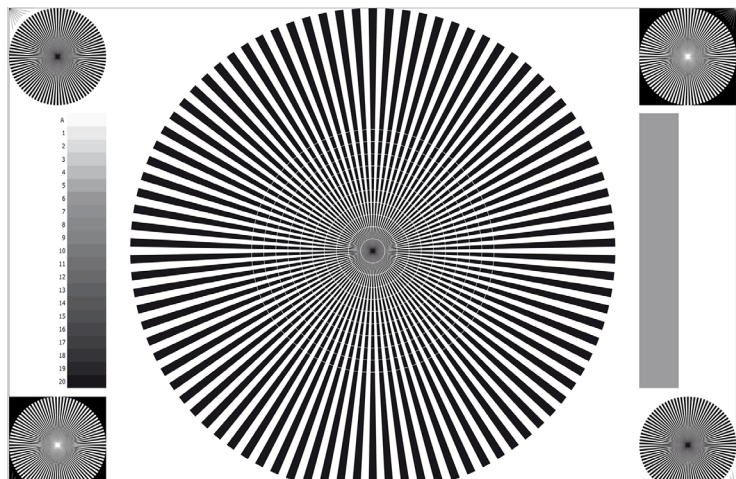


## Appendix G: Adjusting Back Focus

### Symptoms of incorrect Back Focus Adjustment:

- Zoom lenses lose focus when zooming in or out. (Not all zoom lenses are designed to remain focused, so be careful not to prematurely jump to the conclusion that the back focus needs adjustment.)
- Lenses will not focus at infinity.
- The witness marks (distance marks) on lenses are always off in the same direction.

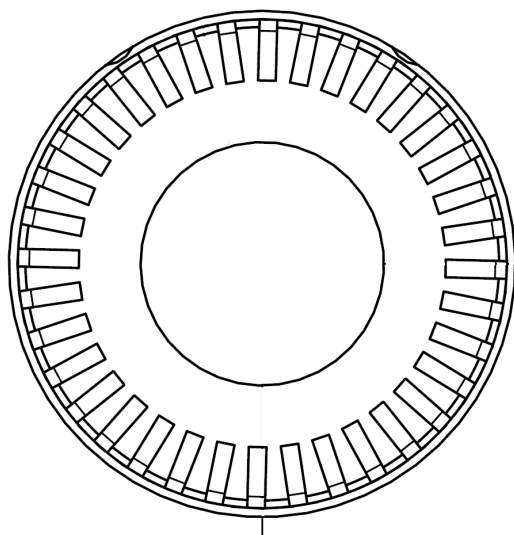
Figure 8-6: Focus Chart



### Tools required for Back Focus Adjustment:

- High quality lens--or lens that you need to use for a particular test --Best if it is very fast--f/1.4 or faster.
- A high quality focus chart can be very helpful. In a pinch, you can print one yourself. An 8 1/2 x 11" or A-Size Siemens Star chart will work for the example here.
- A 3/32" hex Allen wrench for the C-mount lock screws. (See "ILx Top View" on page 4.)

Figure 8-7: C-Mount



### Adjustment procedure:

1. Connect the IL3 to an LCD display, either via a PC connection or the HDMI port. You will wish to have a very good view of the image--the larger the better.
2. Select the lens you wish to use. For our discussion we will use a 1" format Navitar 50mm f/.95 lens.
3. Decide on a distance. . For this discussion we will use 5', or 1.5m.
4. Set your target 5' / 1.5m from the target. The proper way to measure is from the image plane to the target. The image plane would be about 17.5 mm behind the face of the C-mount. Set the target as flat and square to the camera as possible. Usually, taping it to a wall is the easiest.
5. Get plenty of flat white light on the target.
6. Set the ILx up to frame the image. Using a 50 mm lens at 1.5m, the field of view at 800 x 600 resolution, the image will be just a little larger than the focus chart. Use smaller resolutions to zoom-in for fine adjustment.
7. Make a reference mark on the C-mount adapter to mark your starting point. This can be done with a little dab of white out, or a small piece of tape.
8. Frame and focus the camera on the focus target.
9. Set the lens aperture wide open: f/.95 for this lens.

10. Adjust the illumination and/or the exposure setting to get the right exposure, avoiding saturation. (Keep the lens set at its largest aperture. It is important to use the shallowest depth of focus possible.)
  11. Look at the witness mark on the lens. It should be pointing to 5'/1.5m. If it is not, continue on with the adjustment.
  12. Set the lens to the 5'/1.5m witness mark.
  13. If the focus got noticeably worse, go on with the adjustment.
  14. Loosen the two C-Mount Lock screws (see "Figure 1-3: ILx Top View" on page 4). The C-Mount is threaded onto the IL3 Optical Block. Loosening the screws enable turning the C-Mount for adjustment.
  15. Turn the C-mount adapter a short distance one direction, then back to where it was, then the other direction. You will quickly learn which way to turn it to get better results.
- Note: The C-mount has 3/32 threads on it. It also has a scalloped pattern on its edge comprising 36 indentations. Rotating the mount the distance of one of these indentations is equivalent to adjusting the back focus distance a .022mm or a little less than .001." It is a good goal to adjust the back focus to within a couple of these indentations, or less than .05mm / .002."
16. When you are satisfied that the back focus is adjusted as well as you can get it, tighten the two adjustment screws and reconfirm the focus.

#### Setting For Infinity:

If you will be using the IL3 exclusively for close by objects and are satisfied that the back focus is correct, you may skip this part. If, however, you will be using the camera for activities where it will be imaging far away objects, you will want to confirm that it can focus at infinity.

**Figure 8-8: Navitar 50mm f/95 Lens**



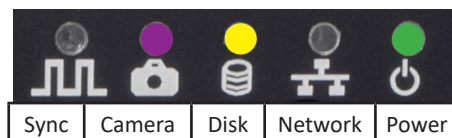
To do this you will need to find a place where you can set the camera up that has a good view of objects at various distances.

17. Check the location of the reference mark made on the lens in #7, above.
18. Look at the last witness mark on the lens before infinity. Find an object in your field of view that is approximately the distance indicated by that last witness mark. For example on the Navitar 50mm f/.95 lens, the last witness mark before infinity is 10m. So you would find an object approximately 10m away and focus on it.
19. Is the lens now set close to the 10m witness mark? Continue finding targets farther and farther away to get a feel for how far the lens can focus to.

If the best focus for very far objects is at or a tiny bit before the infinity stop, the lens is OK. If you find that the best focus for the farthest objects is not close to the infinity stop, or you find that you just cannot focus on far away objects, repeat #14 through #16 above.

## Appendix H: Camera Status LEDs

Table 8-7: Camera Status LEDs



Power LED:		Solid Green whenever the ILx is powered up.
Network LED:		Fast blinking Amber whenever the ILx is sending or receiving on the network.
Disk LED:		Fast blinking Amber whenever the ILx SSD or SDHC are accessed.
Camera LED:		Solid Green whenever in Live mode (operating, but not recording).
		Blinking Red slowly (1Hz) when the ILx is Armed, not triggered; Recording in ROC or BROCC
		Blinking Amber slowly (1Hz) when ILx is Armed, not recording in ROC or BROCC
		Blinking Red quickly (2Hz) when the ILx is Triggered in Basic and FasFire
		Blinking Purple slowly (1Hz) when the ILx is Armed in Autosave (recording, not triggered).
		Blinking Purple quickly (2Hz) when the ILx is Triggered in Autosave.
Sync LED:		Solid Amber when in Review mode (playing back recorded images).
		Solid Yellow: Sync = Per/Frame, IRIG= 0, Signal state= any
		Blinking Purple: Sync = Per Second (not synchronized)
		Solid Purple: Sync = Per Second
		Off: Sync disabled



## Appendix I: Contents of Frame.txt file

### [Image]

```
roi_x=240
roi_y=212
width=800
height=600
bit_mode=upper 8
frame_count=15
trigger_frame=278
start_frame=270
end_frame=284
time_stamp=2013:03:21 13:44:56
comment=Test 3_21a
```

x = image offset from corner of sensor  
y = image offset from corner of sensor  
(These will vary with resolution.)

If centered:

$x = (<\text{resolution}> - 1280)/2$

$y = (<\text{resolution}> - 1024)/2$

(If not centered, then user values)

### [Camera]

```
make=FASTEC
model=IL3100LC4
fpga_rev=0x0001009b
software_version=1.5.38
mac_address=a4:1b:c0:00:00:be
camera_name=FASTEC-IL3-BE
sensor_type=C31L
```

Sensor = C31L (Color)

Sensor = M31L (Mono)

### [Record]

```
fps=24
shutter_speed=41666
multi_slope=0:0
trigger_settings=22
sync_in=0x0
sync_out=0x0
```

Multi-slope = option not implemented

Trigger, Sync\_in, Sync\_out superseded by per-frame metadata in XML file.

### [Normalization]

```
red_balance=276
blue_balance=348
green_balance=256
brightness=100
contrast=100
gamma=100
sensor_gain=100
red_gain=0
green_gain=0
blue_gain=0
red_matrix=[236,20,3]
blue_matrix=[10,-205,451]
green_matrix=[-36,248,44]
```

<xxx\_balance> = color balance presets or custom setting

brightness, contrast, gamma: user settings

<xxx\_gain> user color gain settings

<xxx\_matrix> 3x3 color correction matrix

## Appendix J: Contents of <Capture>.XML File

<pre> &lt;FastecMetadata&gt;   &lt;capture version="1.0"&gt;     &lt;image&gt;       &lt;frame_count&gt;120&lt;/frame_count&gt;       &lt;start_frame&gt;0&lt;/start_frame&gt;       &lt;end_frame&gt;119&lt;/end_frame&gt;       &lt;bit_mode&gt;upper 8&lt;/bit_mode&gt;       &lt;roi&gt;         &lt;x&gt;0&lt;/x&gt;         &lt;y&gt;0&lt;/y&gt;         &lt;width&gt;1280&lt;/width&gt;         &lt;height&gt;1024&lt;/height&gt;       &lt;/roi&gt;       &lt;trigger&gt;         &lt;frame&gt;1220&lt;/frame&gt;         &lt;time&gt;14:021:11:03:16.732882&lt;/time&gt;       &lt;/trigger&gt;       &lt;comment&gt;Test 5&lt;/comment&gt;     &lt;/image&gt;     &lt;camera&gt;       &lt;make&gt;FASTEC&lt;/make&gt;       &lt;model&gt;IL3100LR3M8256&lt;/model&gt;       &lt;fpga_rev&gt;0x800100c7&lt;/fpga_rev&gt;       &lt;software_version&gt;1.7.16&lt;/software_version&gt;       &lt;mac_address&gt;a4:1b:c0:00:00:fa&lt;/mac_address&gt;       &lt;camera_name&gt;FASTEC-TS3-FA&lt;/camera_name&gt;       &lt;sensor_type&gt;M31L&lt;/sensor_type&gt;     &lt;/camera&gt;     &lt;record&gt;       &lt;fps&gt;250&lt;/fps&gt;       &lt;shutter_speed&gt;4000&lt;/shutter_speed&gt;       &lt;multi_slope&gt;0:0&lt;/multi_slope&gt;       &lt;sync_in&gt;0x0&lt;/sync_in&gt;       &lt;sync_out&gt;0x0&lt;/sync_out&gt;     &lt;/record&gt;     &lt;normalization&gt;       &lt;red_balance&gt;256&lt;/red_balance&gt;       &lt;green_balance&gt;256&lt;/green_balance&gt;       &lt;blue_balance&gt;256&lt;/blue_balance&gt;       &lt;brightness&gt;100&lt;/brightness&gt;       &lt;contrast&gt;100&lt;/contrast&gt;       &lt;gamma&gt;100&lt;/gamma&gt;       &lt;sensor_gain&gt;100&lt;/sensor_gain&gt;       &lt;red_gain&gt;0&lt;/red_gain&gt;       &lt;green_gain&gt;0&lt;/green_gain&gt;       &lt;blue_gain&gt;0&lt;/blue_gain&gt;       &lt;red_matrix&gt;[256,0,0]&lt;/red_matrix&gt;       &lt;green_matrix&gt;[0,256,0]&lt;/green_matrix&gt;       &lt;blue_matrix&gt;[0,0,256]&lt;/blue_matrix&gt;     &lt;/normalization&gt;   &lt;/capture&gt;   &lt;frames&gt;     &lt;frame&gt;       &lt;number&gt;0&lt;/number&gt;       &lt;hw_number&gt;1&lt;/hw_number&gt;       &lt;irig&gt;0&lt;/irig&gt;       &lt;sync_mode&gt;0&lt;/sync_mode&gt;       &lt;time_state&gt;0&lt;/time_state&gt;       &lt;markers&gt;0x003f&lt;/markers&gt;       &lt;time&gt;14:021:11:03:11.849599&lt;/time&gt;     &lt;/frame&gt;   &lt;/frames&gt; </pre>	<p>Frame count = number of saved frames</p> <p>Start frame = First frame saved (from 0)</p> <p>x = image offset from corner of sensor y = image offset from corner of sensor (These will vary with resolution.</p> <p>If centered:  <math>x = (\text{&lt;resolution&gt;} - 1280)/2</math>  <math>y = (\text{&lt;resolution&gt;} - 1024)/2</math>        (If not centered, then user values)</p> <p>Sensor = C31L (Color)        Sensor = M31L (Mono)</p> <p>Multi-slope = option not implemented</p> <p>&lt;xxx_balance&gt; = color balance presets or custom setting        brightness, contrast, gamma: user settings        &lt;xxx_gain&gt; user color gain settings        &lt;xxx_matrix&gt; 3x3 color correction matrix</p> <p>IRIG = 0 (disabled)        IRIG = 1 (enabled)        Time State = 0 (Master)        Time State = 1-3 (Sync In: Per Sec Slave)        Time State = 4-6 (Sync In: Per Sec IRIG)</p> <p>sync_mode = 0 (disabled)        sync_mode = 1 (Per Frame)        sync_mode = 2 (Per Second)</p>
--	---

## Appendix K: IL3 Updates

If you are notified by Fastec or one of its distributors that an update is available, they will give you a link to download it to a PC. The PC will need to have an SD Card port or have a card reader attached to it. (Note: It is possible to use the camera's SD Card port for this purpose by attaching to the PC via the OTG cable.)

**Important: Save all image data on the camera before updating. File metadata structures may change with updated firmware!**

### Update Procedure:

1. Download the update file to a Windows PC. The update file name will be in the form of "ts3\_revxx.x.x\_<Year>\_<date>.exe." For example, the latest revision as of the 1st of August, 2013 is: ts3\_rev1.6.34\_2013\_0301.exe and FasMotion\_1.6.34.exe. Updates always include both camera firmware and FasMotion software. The version numbers should match. **Update the camera first!**
2. Insert the SDHC card into the PC card slot or card reader. **Please note the drive letter the PC assigns the card.**
3. Double click on the update file. The Update Screen will appear. Click Next.
4. A License Agreement will appear. Click the check box to accept the terms and click Next.
5. A screen will appear for selecting the SD Card. **Make sure that you have selected the correct drive letter before clicking on Install.** A new window with a progress bar will appear.
6. Once the update program has finished writing to the SD Card, a final screen will appear. Click on Finish. Eject the SD Card from Windows and remove it from the PC.
7. Insert the SD Card into the SDHC slot of the ILx.
8. Open the camera in FasMotion and Select "Update" in the Camera Menu. The camera will now disconnect and perform the update internally, then reboot. This will take a few minutes.
9. After the camera boots up, re-connect to FasMotion.
10. Confirm the Software Version in the Find Camera window. (See Figure 8-9.)
11. Go to the Configuration menu and select "Factory Config." The camera will reboot.
12. Perform a black level calibration. (See "4-8 Black Level Calibration" on page 35.)
13. If the ILx has an SSD, it should be formatted before use.
14. Restore the SD Card before using it for image file storage. (See "Restoring the SD Card.")

Figure 8-9: Camera Information

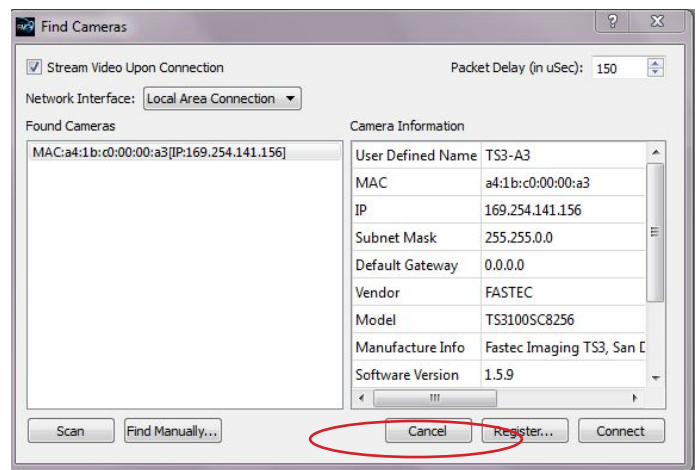


Figure 8-10: Camera Update Screens



## Alternate Update Methods

### Update from using the Power Button:

1. Follow #s 1-7 on the previous page.
2. Power down the ILx.
3. Press and hold the ON/OFF button while applying power to the ILx. You may release the button as soon as you see the LEDs flashing on the ILx.
4. Once the ILx is booted, follow steps 9-14 on the previous page.

### Restoring the SD Card

The SD card you have used for the camera update now contains the files and folders listed in Figure 8-11. Refer to the TS3\_Release\_Notes file for information about the update.

The format of the SD Card has been changed and now there is very little (35MB) accessible space left.

To Restore the SD Card:

1. Attach the SD Card to a Windows PC.
2. Run card\_restorer.exe from the SD Card.
3. You will see a message box asking if you wish to re-partition and erase the SD card. Click on "Yes."
4. The next message box will tell you that the process will take a few moments. Click on "OK."
5. Next, you will see a command window open and see some text scrolling by.
6. Finally, you will see a message box saying "Reformatting is now complete!"

Figure 8-11: Contents of Update SD Card

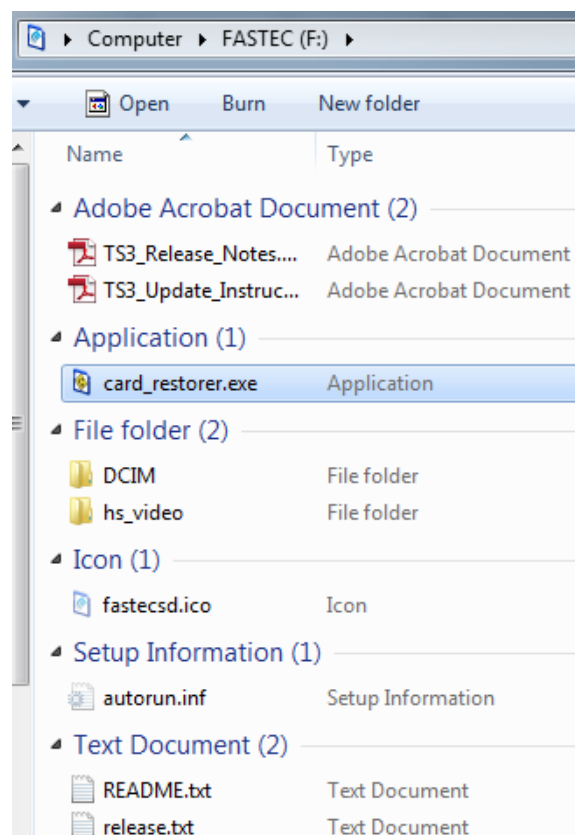
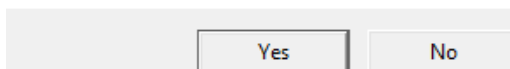


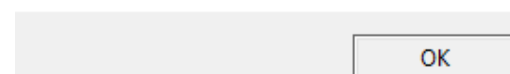
Figure 8-12: SD Card Restorer Messages

The camera firmware updater removable drive [F] will now be re-partitioned and all data on it will be erased!

Are you ABSOLUTELY sure you want to do this?



This make take a few moments. Please click OK and wait for another popup indicating completion.



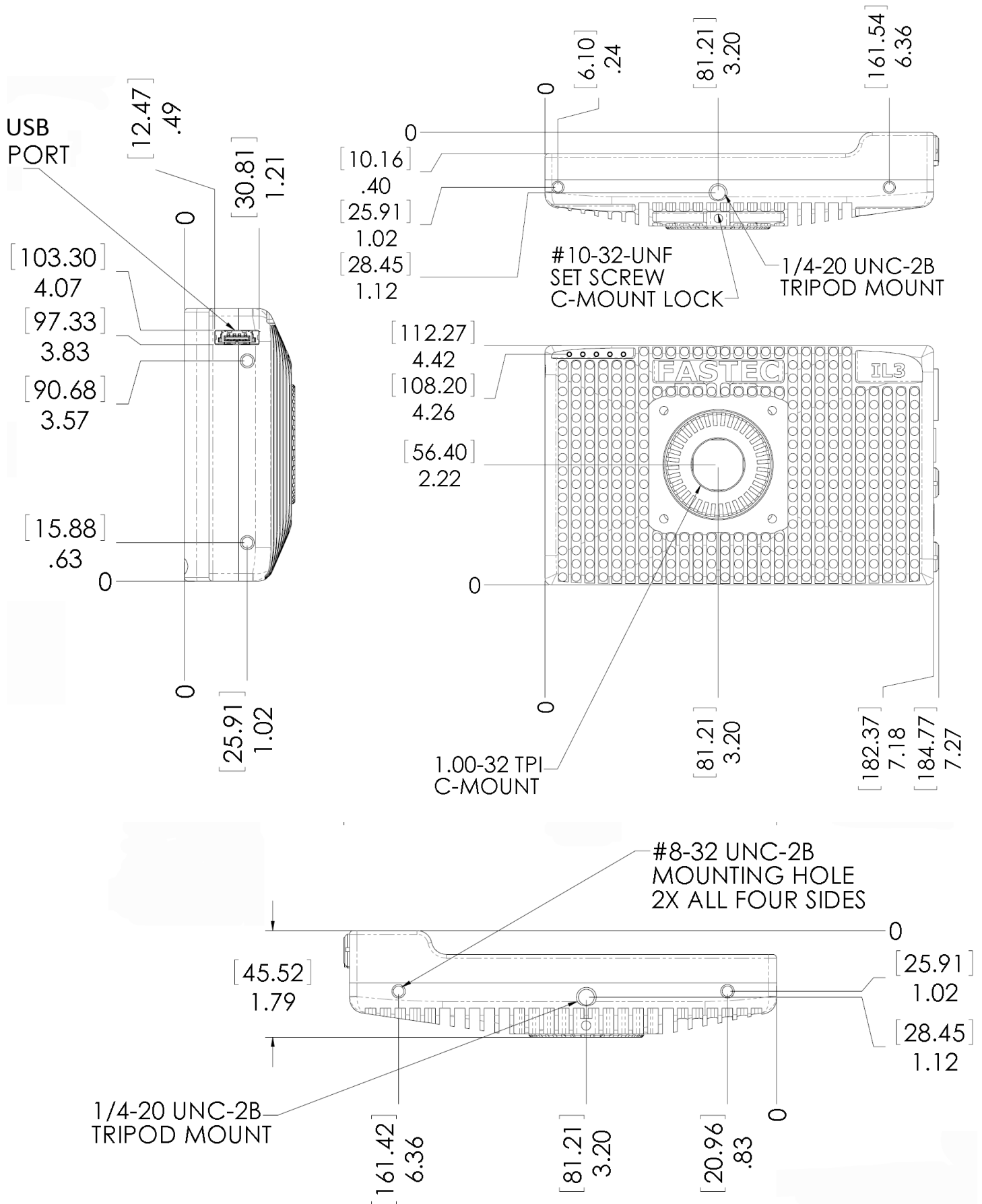
```
C:\Windows\System32\cmd.exe
Insert new disk for drive F:
and press ENTER when ready... The type of the file system is RAW.
The new file system is FAT32.
QuickFormatting 7579M
Initializing the File Allocation Table (FAT)...
Format complete.
  7.4 GB total disk space.
  7.4 GB are available.

  4,096 bytes in each allocation unit.
  1,936,382 allocation units available on disk.

  32 bits in each FAT entry.
Volume Serial Number is F6BC-64AC
```

## Appendix L: Physical Measurements

Figure 8-13: Physical Measurements





## Appendix M: Crop Factor

Crop Factor is a term used in digital photography that expresses the size of the sensor image plane as compared to that of 35mm film. In Figure 8-14 through Figure 8-16, below, the Black border represents the image on 35mm film, the Red border represents the image on the sensor using the same focal length lens.

$$\text{Diagonal of 35mm film} / \text{Diagonal of the Sensor area used} = \text{Crop Factor}$$

The diagonal of 35mm film is 43.3, compared to the 22.95mm diagonal of the ILx, you get a crop factor of 1.89:

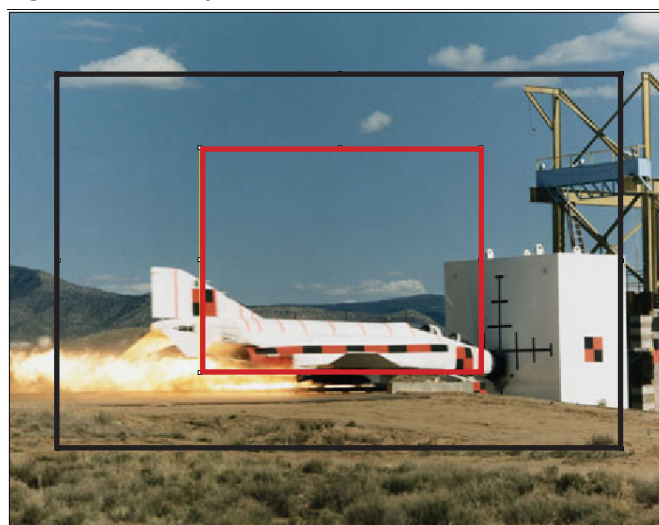
$$43.3\text{mm} / 22.95\text{mm} = 1.89$$

The photographic advantage of knowing the crop factor is that if you know the lens you would use for a given field of view with a 35mm camera, you can divide the crop factor into that number to give you the focal length of the lens with the same field of view for your IL3. For example, if you are using a 125mm lens on your 35mm SLR, you will need about a 65mm lens on the ILx at full resolution ( $125\text{mm} / 1.89 = 66.14$ ).

**Table 8-8: Crop Factor**

H-Res	V-Res	Diagonal	Crop Factor
1280	1024	22.95	1.89
1280	720	20.56	2.11
1024	1024	20.27	2.14
1280	256	18.27	2.37
800	600	14.00	3.09
1024	600	16.62	2.61
640	480	11.20	3.87
800	480	13.06	3.32
512	512	10.14	4.27
320	240	5.60	7.73
320	200	5.28	8.20
256	256	5.07	8.54

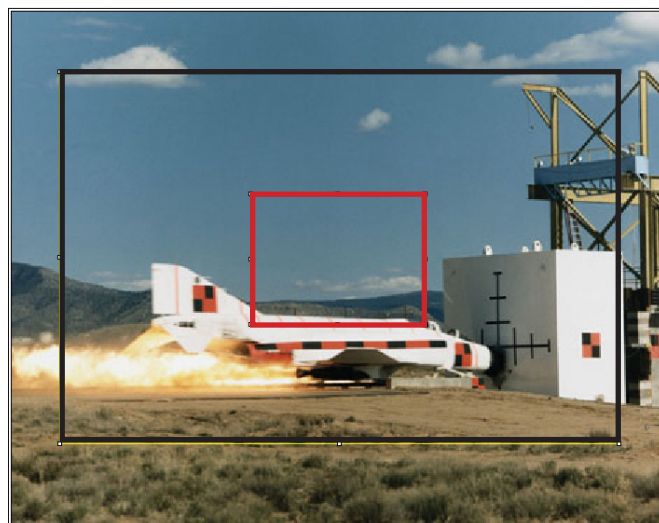
**Figure 8-14: Crop Factor 1280 x 1024**



**Figure 8-15: Crop Factor 1280 x 720**



**Figure 8-16: Crop Factor 800 x 600**



## Appendix N: Partition Capture (CAP) File Format

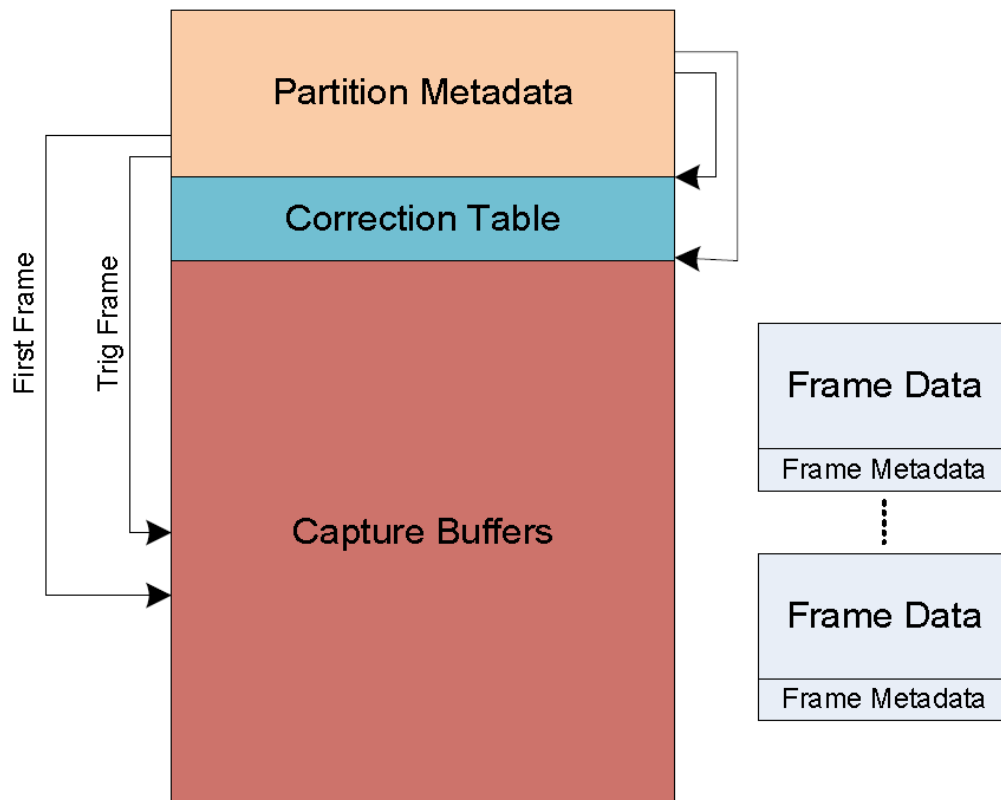
Partition Capture file format is a Fastec Imaging proprietary raw data format used to store image data gathered by the IL3 in one “Session” into the camera’s built-in SSD drive. The session length is set by the user (see “3-12 Storage Setup” on page 24) to any multiple of 256MB up to the memory capacity of the camera, which is either 4GB or 8GB. The actual length of a recorded session may vary, however, depending on whether the full allotment of pre-trigger frames were captured before the trigger was asserted (see “Application Note 3: Trigger Position and the Circular Buffer” on page 81).

There are three major distinguishing benefits of CAP files:

1. CAP file transfer time from DRAM to SSD is the shortest of all of the uncompressed file types.
2. CAP files are the only files that may be copied back into DRAM from the SSD and played back from the camera or on a PC via the camera.
3. CAP files are the only uncompressed single file format available from the camera.

Note: CAP files are only available on cameras with SSDs, SN A0 and higher.

**Figure 8-17: CAP File Diagram**



**Table 8-9: CAP File Format**

Field	Size	Description
Manufacturer's name	32	"FASTEC".
Model name	32	"TS3100SC8064" for example.
Serial number	16	"0.0.122.A3" for example.
Application version	32	"1.5.8" for example.
Camera name	16	"FastecA4-7A" for example.
Ethernet MAC address	6	The MAC address of the camera.
Bit selection	1	0:Low8, 1:Mid8, 2:High8, 3:10Bits
Sensor gain	1	The gain used by the sensor (analog gain).
FPGA version	4	FPGA version information.
ROI x-offset	2	Left side of the ROI window.
ROI y-offset	2	Top side of the ROI window.
ROI width	2	Width of the ROI window.
ROI height	2	Height of the ROI window.
Frames per second	4	Number of frames per second.
Shutter speed	4	Exposure time in microseconds.
Sensor type	4	Type of sensor used, "L13C" for example.
GPS location	64	GPS location information.
Frame count	4	Total number of frames captured.
Frame size	4	Size of the frames in quadwords.
First frame	4	Frame number of the first frame in the capture buffer.
Trigger frame	4	Frame number of the trigger frame in the capture buffer.
Trigger time seconds	4	Linux time of the trigger event.
Trigger time nanoseconds	4	Nanoseconds of trigger event from last second.
Start of video	4	Start of capture buffer, in quadwords.
As-shot neutral	12	The AsShotNeutral value.
Matrix coefficients	36	IPM matrix coefficients.
White balance gains	12	IPM white balance gain settings.
Multislope settings	2	LUPA 1300-2 multislope settings.
Trigger settings	1	Trigger position setting in percent, or 127 if position was specified by frame count instead of percent
SyncIn settings	1	
SyncOut settings	1	
Brightness	1	0-255 centered around 128.
Contrast	1	0-255 centered around 128.
Gamma	1	0-250 centered around 100.
RGB gain settings	3	Red, green, blue gain settings.
FPN settings	1	Off, sensor or pixel correction.
Correction table offset	4	Offset to the correction table.
Correction table length	4	Size of the correction table, in quadwords.
Reserved	16	Reserved for future use
Trigger frame setting	4	Post-trigger frame count setting, if setting is not by percent
Comment	64	User comment

## Appendix O: Day Number Calendar Conversion

Time stamps on the ILx are written in the following format:

YY:DDD:HH:MM:SS.xxxxxx

For example, 13:206:15:36:13.987304 = 2013, 206th day, 15th hour, 36th minute, 13.987304 seconds, which is July 25, 2013 at 3:36 in the afternoon + 13.987304 seconds

Table 8-10 and Table 8-11 convert calendar dates to day numbers.

**Table 8-10: Dates and Day Numbers (non leap-years)**

JAN		FEB		MAR		APR		MAY		JUNE		JUL		AUG		SEPT		OCT		NOV		DEC	
1/1	1	2/1	32	3/1	60	4/1	91	5/1	121	6/1	152	7/1	182	8/1	213	9/1	244	10/1	274	11/1	305	12/1	335
1/2	2	2/2	33	3/2	61	4/2	92	5/2	122	6/2	153	7/2	183	8/2	214	9/2	245	10/2	275	11/2	306	12/2	336
1/3	3	2/3	34	3/3	62	4/3	93	5/3	123	6/3	154	7/3	184	8/3	215	9/3	246	10/3	276	11/3	307	12/3	337
1/4	4	2/4	35	3/4	63	4/4	94	5/4	124	6/4	155	7/4	185	8/4	216	9/4	247	10/4	277	11/4	308	12/4	338
1/5	5	2/5	36	3/5	64	4/5	95	5/5	125	6/5	156	7/5	186	8/5	217	9/5	248	10/5	278	11/5	309	12/5	339
1/6	6	2/6	37	3/6	65	4/6	96	5/6	126	6/6	157	7/6	187	8/6	218	9/6	249	10/6	279	11/6	310	12/6	340
1/7	7	2/7	38	3/7	66	4/7	97	5/7	127	6/7	158	7/7	188	8/7	219	9/7	250	10/7	280	11/7	311	12/7	341
1/8	8	2/8	39	3/8	67	4/8	98	5/8	128	6/8	159	7/8	189	8/8	220	9/8	251	10/8	281	11/8	312	12/8	342
1/9	9	2/9	40	3/9	68	4/9	99	5/9	129	6/9	160	7/9	190	8/9	221	9/9	252	10/9	282	11/9	313	12/9	343
1/10	10	2/10	41	3/10	69	4/10	100	5/10	130	6/10	161	7/10	191	8/10	222	9/10	253	10/10	283	11/10	314	12/10	344
1/11	11	2/11	42	3/11	70	4/11	101	5/11	131	6/11	162	7/11	192	8/11	223	9/11	254	10/11	284	11/11	315	12/11	345
1/12	12	2/12	43	3/12	71	4/12	102	5/12	132	6/12	163	7/12	193	8/12	224	9/12	255	10/12	285	11/12	316	12/12	346
1/13	13	2/13	44	3/13	72	4/13	103	5/13	133	6/13	164	7/13	194	8/13	225	9/13	256	10/13	286	11/13	317	12/13	347
1/14	14	2/14	45	3/14	73	4/14	104	5/14	134	6/14	165	7/14	195	8/14	226	9/14	257	10/14	287	11/14	318	12/14	348
1/15	15	2/15	46	3/15	74	4/15	105	5/15	135	6/15	166	7/15	196	8/15	227	9/15	258	10/15	288	11/15	319	12/15	349
1/16	16	2/16	47	3/16	75	4/16	106	5/16	136	6/16	167	7/16	197	8/16	228	9/16	259	10/16	289	11/16	320	12/16	350
1/17	17	2/17	48	3/17	76	4/17	107	5/17	137	6/17	168	7/17	198	8/17	229	9/17	260	10/17	290	11/17	321	12/17	351
1/18	18	2/18	49	3/18	77	4/18	108	5/18	138	6/18	169	7/18	199	8/18	230	9/18	261	10/18	291	11/18	322	12/18	352
1/19	19	2/19	50	3/19	78	4/19	109	5/19	139	6/19	170	7/19	200	8/19	231	9/19	262	10/19	292	11/19	323	12/19	353
1/20	20	2/20	51	3/20	79	4/20	110	5/20	140	6/20	171	7/20	201	8/20	232	9/20	263	10/20	293	11/20	324	12/20	354
1/21	21	2/21	52	3/21	80	4/21	111	5/21	141	6/21	172	7/21	202	8/21	233	9/21	264	10/21	294	11/21	325	12/21	355
1/22	22	2/22	53	3/22	81	4/22	112	5/22	142	6/22	173	7/22	203	8/22	234	9/22	265	10/22	295	11/22	326	12/22	356
1/23	23	2/23	54	3/23	82	4/23	113	5/23	143	6/23	174	7/23	204	8/23	235	9/23	266	10/23	296	11/23	327	12/23	357
1/24	24	2/24	55	3/24	83	4/24	114	5/24	144	6/24	175	7/24	205	8/24	236	9/24	267	10/24	297	11/24	328	12/24	358
1/25	25	2/25	56	3/25	84	4/25	115	5/25	145	6/25	176	7/25	206	8/25	237	9/25	268	10/25	298	11/25	329	12/25	359
1/26	26	2/26	57	3/26	85	4/26	116	5/26	146	6/26	177	7/26	207	8/26	238	9/26	269	10/26	299	11/26	330	12/26	360
1/27	27	2/27	58	3/27	86	4/27	117	5/27	147	6/27	178	7/27	208	8/27	239	9/27	270	10/27	300	11/27	331	12/27	361
1/28	28	2/28	59	3/28	87	4/28	118	5/28	148	6/28	179	7/28	209	8/28	240	9/28	271	10/28	301	11/28	332	12/28	362
1/29	29			3/29	88	4/29	119	5/29	149	6/29	180	7/29	210	8/29	241	9/29	272	10/29	302	11/29	333	12/29	363
1/30	30			3/30	89	4/30	120	5/30	150	6/30	181	7/30	211	8/30	242	9/30	273	10/30	303	11/30	334	12/30	364
1/31	31			3/31	90			5/31	151			7/31	212	8/31	243			10/31	304			12/31	365

Table 8-11: Dates and Day Numbers (leap-years)

JAN		FEB		MAR		APR		MAY		JUNE		JUL		AUG		SEPT		OCT		NOV		DEC	
1/1	1	2/1	32	3/1	61	4/1	92	5/1	122	6/1	153	7/1	183	8/1	214	9/1	245	10/1	275	11/1	306	12/1	336
1/2	2	2/2	33	3/2	62	4/2	93	5/2	123	6/2	154	7/2	184	8/2	215	9/2	246	10/2	276	11/2	307	12/2	337
1/3	3	2/3	34	3/3	63	4/3	94	5/3	124	6/3	155	7/3	185	8/3	216	9/3	247	10/3	277	11/3	308	12/3	338
1/4	4	2/4	35	3/4	64	4/4	95	5/4	125	6/4	156	7/4	186	8/4	217	9/4	248	10/4	278	11/4	309	12/4	339
1/5	5	2/5	36	3/5	65	4/5	96	5/5	126	6/5	157	7/5	187	8/5	218	9/5	249	10/5	279	11/5	310	12/5	340
1/6	6	2/6	37	3/6	66	4/6	97	5/6	127	6/6	158	7/6	188	8/6	219	9/6	250	10/6	280	11/6	311	12/6	341
1/7	7	2/7	38	3/7	67	4/7	98	5/7	128	6/7	159	7/7	189	8/7	220	9/7	251	10/7	281	11/7	312	12/7	342
1/8	8	2/8	39	3/8	68	4/8	99	5/8	129	6/8	160	7/8	190	8/8	221	9/8	252	10/8	282	11/8	313	12/8	343
1/9	9	2/9	40	3/9	69	4/9	100	5/9	130	6/9	161	7/9	191	8/9	222	9/9	253	10/9	283	11/9	314	12/9	344
1/10	10	2/10	41	3/10	70	4/10	101	5/10	131	6/10	162	7/10	192	8/10	223	9/10	254	10/10	284	11/10	315	12/10	345
1/11	11	2/11	42	3/11	71	4/11	102	5/11	132	6/11	163	7/11	193	8/11	224	9/11	255	10/11	285	11/11	316	12/11	346
1/12	12	2/12	43	3/12	72	4/12	103	5/12	133	6/12	164	7/12	194	8/12	225	9/12	256	10/12	286	11/12	317	12/12	347
1/13	13	2/13	44	3/13	73	4/13	104	5/13	134	6/13	165	7/13	195	8/13	226	9/13	257	10/13	287	11/13	318	12/13	348
1/14	14	2/14	45	3/14	74	4/14	105	5/14	135	6/14	166	7/14	196	8/14	227	9/14	258	10/14	288	11/14	319	12/14	349
1/15	15	2/15	46	3/15	75	4/15	106	5/15	136	6/15	167	7/15	197	8/15	228	9/15	259	10/15	289	11/15	320	12/15	350
1/16	16	2/16	47	3/16	76	4/16	107	5/16	137	6/16	168	7/16	198	8/16	229	9/16	260	10/16	290	11/16	321	12/16	351
1/17	17	2/17	48	3/17	77	4/17	108	5/17	138	6/17	169	7/17	199	8/17	230	9/17	261	10/17	291	11/17	322	12/17	352
1/18	18	2/18	49	3/18	78	4/18	109	5/18	139	6/18	170	7/18	200	8/18	231	9/18	262	10/18	292	11/18	323	12/18	353
1/19	19	2/19	50	3/19	79	4/19	110	5/19	140	6/19	171	7/19	201	8/19	232	9/19	263	10/19	293	11/19	324	12/19	354
1/20	20	2/20	51	3/20	80	4/20	111	5/20	141	6/20	172	7/20	202	8/20	233	9/20	264	10/20	294	11/20	325	12/20	355
1/21	21	2/21	52	3/21	81	4/21	112	5/21	142	6/21	173	7/21	203	8/21	234	9/21	265	10/21	295	11/21	326	12/21	356
1/22	22	2/22	53	3/22	82	4/22	113	5/22	143	6/22	174	7/22	204	8/22	235	9/22	266	10/22	296	11/22	327	12/22	357
1/23	23	2/23	54	3/23	83	4/23	114	5/23	144	6/23	175	7/23	205	8/23	236	9/23	267	10/23	297	11/23	328	12/23	358
1/24	24	2/24	55	3/24	84	4/24	115	5/24	145	6/24	176	7/24	206	8/24	237	9/24	268	10/24	298	11/24	329	12/24	359
1/25	25	2/25	56	3/25	85	4/25	116	5/25	146	6/25	177	7/25	207	8/25	238	9/25	269	10/25	299	11/25	330	12/25	360
1/26	26	2/26	57	3/26	86	4/26	117	5/26	147	6/26	178	7/26	208	8/26	239	9/26	270	10/26	300	11/26	331	12/26	361
1/27	27	2/27	58	3/27	87	4/27	118	5/27	148	6/27	179	7/27	209	8/27	240	9/27	271	10/27	301	11/27	332	12/27	362
1/28	28	2/28	59	3/28	88	4/28	119	5/28	149	6/28	180	7/28	210	8/28	241	9/28	272	10/28	302	11/28	333	12/28	363
1/29	29	2/29	60	3/29	89	4/29	120	5/29	150	6/29	181	7/29	211	8/29	242	9/29	273	10/29	303	11/29	334	12/29	364
1/30	30			3/30	90	4/30	121	5/30	151	6/30	182	7/30	212	8/30	243	9/30	274	10/30	304	11/30	335	12/30	365
1/31	31			3/31	91			5/31	152			7/31	213	8/31	244			10/31	305			12/31	366

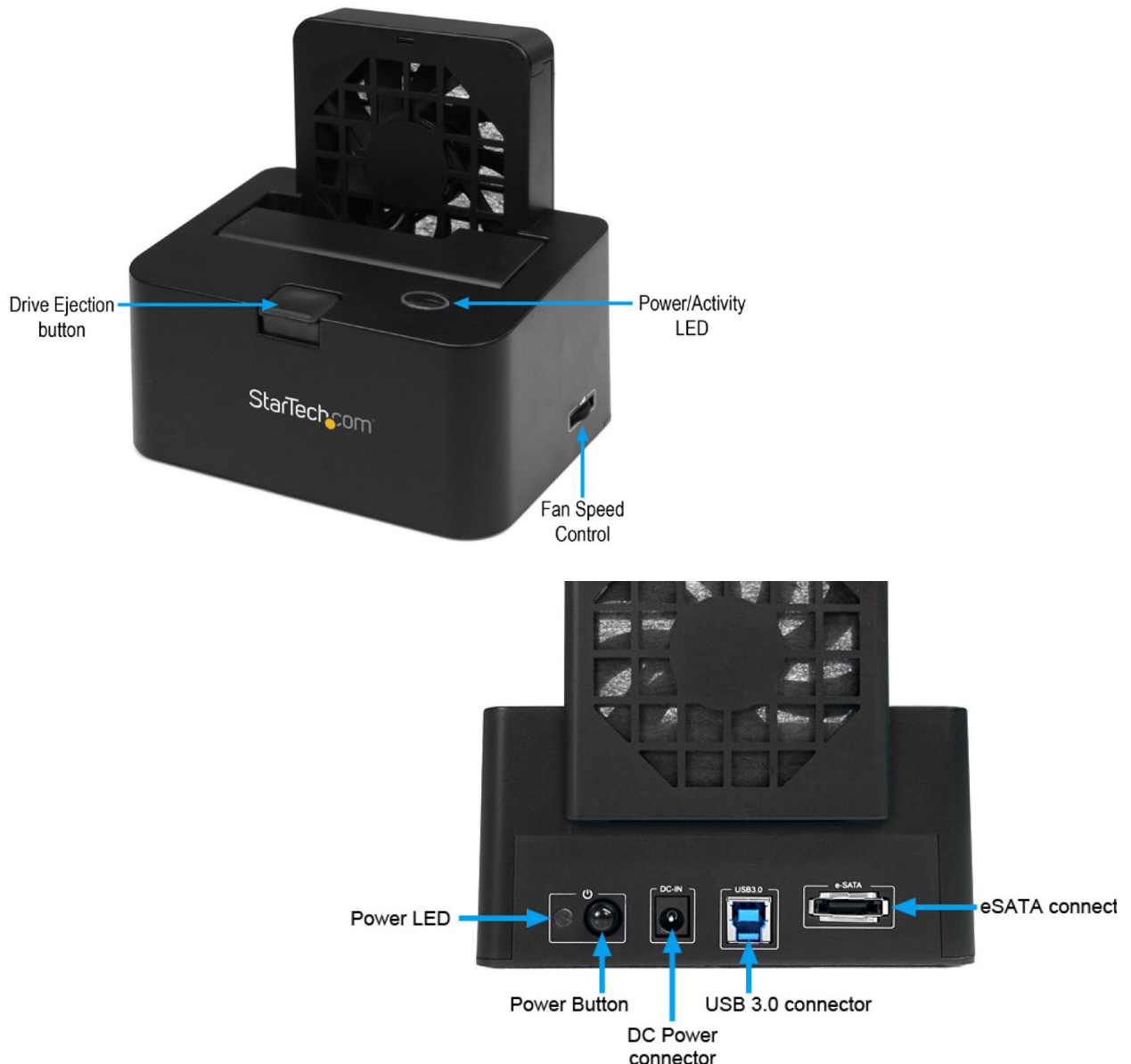
## Appendix P: IL5 with External SSD

The External SSD option is available for any IL5 camera without an internal SSD. It may be purchased with the camera or as an add-on.

### External SSD Basics:

- External SSDs operate as eSATA devices at SATA II speeds up to about 275MB/s, or about half as fast as the maximum for internal SSDs.
- External SSDs must be powered on and connected to the IL5 when the camera boots up in order for the drive to be recognized.
- When using an IL5 with an external SSD, the camera operation is exactly the same as with the internal SSD with respect to Format, Explore, Record Modes, etc. with the exception that maximum frame rates are slower in Long Record Modes at most of the higher resolutions. (See "Table 8-4: IL5 Resolutions, Rates, and Times" on page 106.)
- The External SSD must be connected to the IL5 via an eSATA cable (not USB cable).
- The External SSD may be connected to a PC via eSATA or USB3 cable, but cannot be connected to both a PC and IL5 at the same time.

**Figure 8-18: StarTech SSD Dock**





## Connecting the External SSD to the IL5

**WARNING!** SSDs and storage enclosures require careful handling , especially when being transported. If you are not careful with your hard disk, lost data may result. Always handle your hard drive and storage device with caution. Be sure that you are properly grounded by wearing an anti-static strap when handling computer components or discharge yourself of any static electricity build-up by touching a large grounded metal surface (such as the computer case) for several seconds.

1. Connect the external power adapter from the hard drive dock to an electrical outlet.
2. Insert the 2.5" SSD into the top loading slot. Make sure that the connectors on the drive are facing the same corner of the slot that has a cutout in the door. The label on the drive should face the front of the drive dock.
3. Connect the eSATA cable from the drive dock to the eSATA/USB combo port on the IL5.
4. Press the power button on the rear of the drive dock. The power LED next to the power button will light up. The blue Activity LED on the top of the dock will light up momentarily.
5. Power up the IL5. The blue "activity" LED on the top of the dock will blink intermittently as the IL5 boots up.

**Figure 8-19: IL5 eSATA Connection**



## Using the External SSD on the IL5

The external SSD supports all the features of the internal SSD, including:

- Saving Partition Capture files ("CAP" files), TIFF, JPEG, DNG (color cameras), or JPEG stacks while in Standard Basic, Basic with Autosave, or FasFire modes.
- Long Record Basic and FasCorder (ROC and BROCC) modes (on cameras with the "D" option)
- File Copies to and from SDcards
- Loading CAP files into camera memory for playback (via Review/Load)
- Transferring Files from SSD to PC via FasMotion (Note that, while this may be done just as with the internal SSD, the external SSD has the advantage that it may be directly connected to the PC, which allows much faster file transfers.

## Drive Dock Fan

The drive dock fan is designed to keep the SSD cool, which will help to optimize the drive life span and performance. It is especially important to run the fan when the IL5 is operating in Long Record mode as it will be writing to the drive incessantly while recording.

## Formatting the External SSD

There are two file system formats used with the SSD:

- Long Record format, which is used to store only raw image data, calibration data and metadata
- Standard Record format, which is a modified FAT32 file system format that is used to store image stacks Partition Capture (CAP) files

**NOTE:** The external SSD should only be formatted by the IL5. Formatting the external SSD on a PC will not be helpful as it will need to be reformatted by the camera in order to be used again.

Selecting System/Storage/Format/SSD from the camera's touch display, or formatting the SSD through FasMotion or the Web-Application, will format the SSD appropriately for whichever mode the camera was booted in. If the camera was booted in Standard mode, the SSD will be formatted in the Fastec modified FAT32 system; and if the camera was booted in Long Record mode, the SSD will be formatted in the Long Record format.

NOTE: For Standard Mode recordings, formatting the drive is the only recommended method of removing files from the SSD. While this may be inconvenient, it is the only way to ensure that the drive will not become fragmented and begin to lose data.

### **Removing the External Drive from the IL5**

1. IMPORTANT!: Always power down the camera "politely" before removing the external SSD. This may be done by selecting "Power Down" from the Camera menu in FasMotion, or by depressing the Power button on the back of the IL5. In either case, it will take a little time for the camera to save its configuration and shut down. Please wait for all of the camera LEDs to turn off.
2. Once the camera is powered down, turn off the SSD using the Power button on the back of the drive dock.
3. Remove the eSATA connector from the IL5.

### **Connecting the External SSD to a PC using the eSATA connection:**

1. Begin with the PC powered down.
2. Connect the power adapter to the drive dock.
3. Insert the SSD into the drive dock.
4. Connect the eSATA cable from the drive dock to the PC eSATA connector.
5. Press the Power button on the back of the drive dock to power up the SSD.
6. Boot up the PC. (When using the eSATA connection, the SSD must be powered up and connected BEFORE the PC boots.)

### **Connecting the External SSD to a PC using the USB-3 connection (preferred):**

1. Begin with the PC running.
2. Connect the power adapter to the drive dock.
3. Insert the SSD into the drive dock.
4. Connect the USB-3 cable between the drive dock and a USB-3 connector on the PC
5. Press the Power button on the back of the drive dock to power up the SSD.

## Using the External SSD with a PC

The external SSD may be connected to a PC in order to directly access all types of image data written by the IL5. In the case of image stacks and Capture partitions written in Standard recording modes, the image data may be directly copied to the PC via Windows File Explorer. In the case of images streamed directly to the SSD via Long Record modes, the images will only be accessible via FasMotion software.

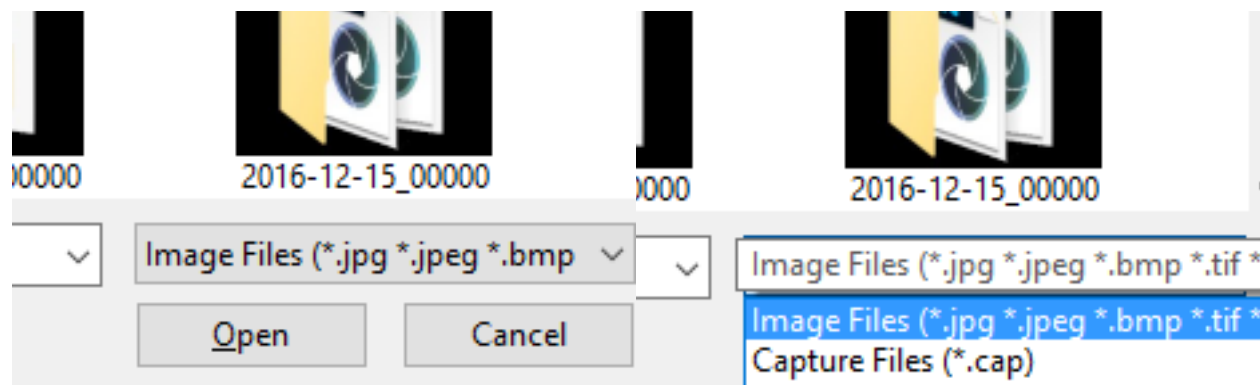
### Accessing Image Stacks and CAP files on the External SSD

If the SSD has been used in Standard mode (not Long Record) it will appear to a PC as any other drive with a FAT32 file system. Files may be copied from the external SSD directly using File Explorer to any other storage connected to the PC. Copying files directly in this fashion is a very good way to use this system as transfer rates are very fast.

The other method of accessing images data on the external drive connected to a PC is through FasMotion. This is done using File/Open Video File... (Ctrl+O) in FasMotion. See “4-20: Playback from File and Transcoding” on page 57.

NOTE: When using FasMotion File/Open, the file browser does not list CAP files by default. To list CAP files click on the down arrow on the Image Files selector and click on “Capture Files (\*.cap).”

**Figure 8-20: FasMotion Image File Selection**



### Accessing Long Record images on the External SSD

Long Record images may only be accessed from the external SSD via FasMotion. First, you must run FasMotion as administrator:

- Right-click on a FasMotion shortcut and select “Run as administrator”
- Select “Open Fastec Drive...” from the FasMotion File menu

The image window will now open in Playback displaying the video captured on the SSD. You will be able to play, search, save, etc. just as you would from the IL5.

### Saving Images to the External SSD in Standard Mode

- Best use of the Internal SSD in Standard mode, especially for rapidly occurring events, is to save CAP files. The CAP files are then processed by the camera internally and images are transferred to the PC via FasMotion--usually as AVI files or DNG stacks.
- Best use of the External SSD in Standard mode is to save whatever file type you will ultimately wish to transfer to the PC: Save JPEG stacks if you will be saving AVI files or JPEG stacks, save TIFF stacks, or DNG stacks, etc. Then the files may be transferred to the PC directly. The reason not to save CAP files is that on the PC, the CAP files must be rendered by the PC's processor, which takes quite a bit of time, whereas if the CAP file is rendered by the camera (from the internal SSD) it is done in camera hardware, which is much faster.