FASTEC IMAGING™

Fastec InLine Camera

User's Manual

FASTEC IMAGING™

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Using this Guide

The purpose of this document is to:

- Provide an introduction to the InLine high-speed digital camera.
- Provide guidance through camera setup and configuration.
- Describe camera operational procedures.

Additional Resources

Refer to the following documents for additional information about the Fastec Imaging systems and software.

Document Number	Title
Version 3.0.4	FIMS Fastec InLine Software User Guide 3.0 (Xcitex, Inc)
Version 2.1.7	Midas 2.0 Player (Midas Software Utility, Xcitex, Inc)


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1. InLine Camera Overview

1.1. Introduction to the Fastec Camera System (FCS)

The InLine family of high-speed cameras includes both monochrome and color models with 8-bit pixel resolution for mono and Bayer filtered 24-bit color models. These cameras have various high-speed digital image recording capabilities using a wide range of recording rates, sensor resolutions, and on-board memory options.

InLine cameras are equipped with a standard C-mount lens mount, and three 1/4-20 tripod mounts, top and bottom. InLine cameras are also available with memory capacities from 256MB to 2GB.

InLine cameras must be connected to a host PC to operate. The following various application software programs can be used with each InLine camera:

- Fastec InLine Monitoring System (FIMS) 3.0 for camera control.
- FIMS Demo.
- FIMS ADU.

1.2. InLine Cameras

The InLine camera housing is made of machine-finished aluminum. This camera is equipped with a Hirose 12 pin connector. A cable with a mating Hirose connector is provided with connections for an external trigger (BNC), and power input connector. The camera is specially designed for host computer operation. A 5 VDC power converter supplies power.

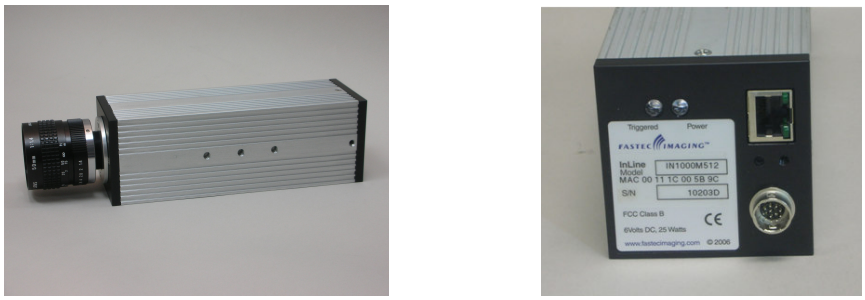


Figure 1-1: InLine Camera

Table 1-1: InLine and InLine HR Operational Specifications

Component	Specification
Record Frames per Second (fps)	InLine: 60, 125, 250, 500, 1000
CMOS Sensor Resolution	InLine: 320x240, 440x330, 640x240, 640x480
On Board SODIMM Memory	InLine: 256MB, 512MB, 1GB, 2GB
Manual and Remote Triggers	Start, 25%, 50%, 75%, End, or User Selectable
Frame Storage	InLine 256MB: 1,096 though 4,368 Frames InLine 512MB: 2,184 through 8,736 Frames InLine 1GB: 4,368 through 17,472 Frames InLine 2GB: 8,736 through 34,944 Frames
Record Time (sec)	InLine 256MB: 4.3 through 73.8 seconds InLine 512MB: 8.7 through 174.7 seconds InLine 1GB: 17.5 through 349.4 seconds InLine 2GB: 34.9 through 698.9 seconds

1.2.1. InLine Camera Back Panel Indicators and Connectors

Figure 1-2 shows the InLine camera back panel, indicators and connectors.

Table 1-2 provides a brief description of each item.

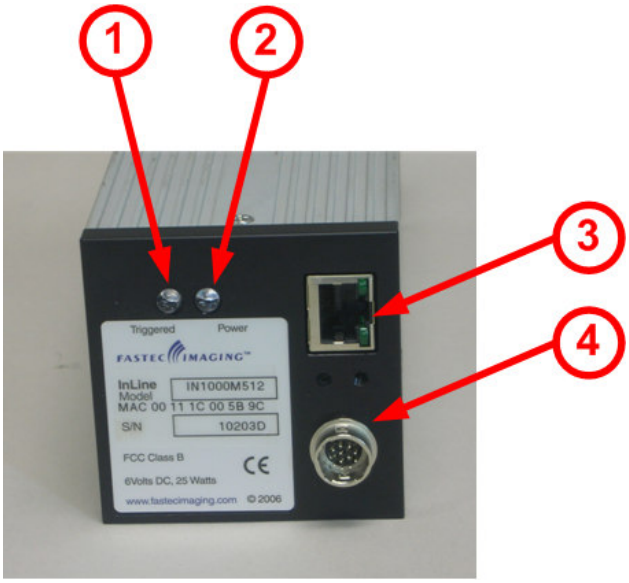


Figure 1-2: InLine Camera Back Panel

Table 1-2: InLine and InLine HR Back Panel

Back Panel	Description
1. Triggered LED	Illuminated red when the camera has been triggered. Camera must be re-armed remotely.
2. Power LED	Illuminated green when camera is receiving power (5 VDC).
3. RJ45 Gigabit Ethernet Port	Camera control commands, status, and data are passed through the Ethernet port.
4. Hirose Multifunction DC Input Connector	5 VDC Camera power input. External TTL trigger signal input.

1.2.2. InLine Multiple I/O Cable

Figure 1-3 shows the InLine camera Multiple I/O Camera Interface cable. Table 1-3 provides a brief description of each item.

Table 1-3: InLine Multiple I/O Cable

Connector Panel	Description
1. Hirose Connector	Apply 5 VDC power and external trigger signal to the camera.
2. DC Power Jack	5 volt DC power input.
3. External Trigger BNC Connector	External trigger signal input (red wire).
4. Sync IN BNC Connector	Camera sync input (green wire).
5. Sync OUT BNC Connector	Camera sync output (blue wire).
6. Pulse Out	NEED DESCRIPTION.

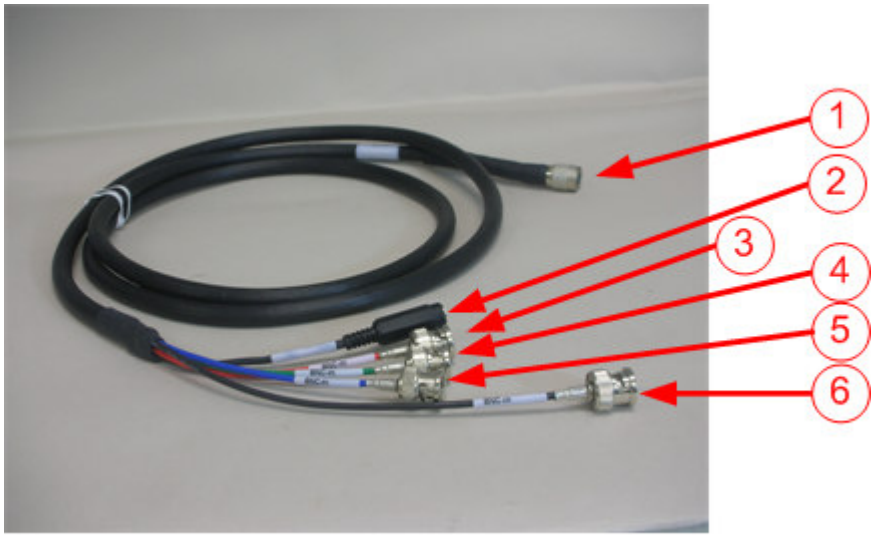


Figure 1-3: Multiple I/O Camera Interface Cables

2. Camera Setup

2.1. Unpack the Camera

When you unpack your shipping box you should find the following items:

- High-Speed InLine Digital Camera.
- Multiple I/O Camera Interface Cable.
- CD ROM containing the Camera Operator's Manual and InLine Camera Software Suite.
- Additional items may be purchased from local distributors (i.e.: lens, batteries, etc.).

2.2. Getting Started

Before operating the camera, the following items must be available:

- Lens.
- Power source.
- PC (to load software).

2.2.1. Setup an InLine Camera for Host PC Operation

Step 1 Remove the lens receptacle cover from the camera's C-mount.

- The cover is installed at the factory to protect the image sensor.

Step 2 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".
- As a starting point for recording, open the lens aperture about half way and set the lens focus to infinity.

Step 3 Connect the Ethernet ports on your camera and computer using a CAT 5E patch cable.

Step 4 Connect the Trigger/Power cable to the Hirose connector on the camera's connector panel.

Step 5 Connect the external power cable of the AC adapter to the power input connector on the Trigger/Power cable.

Step 6 Plug the 5V AC/DC Power Adapter into a 115/230 VAC source.

NOTE: If the Power LED doesn't illuminate:

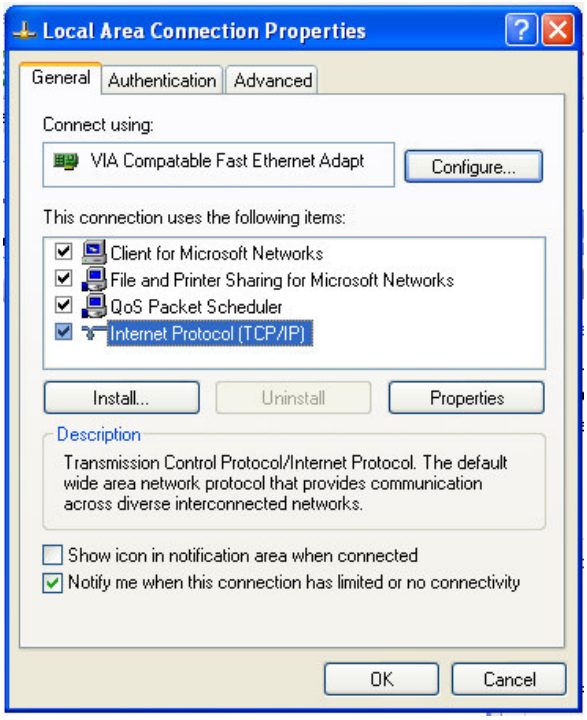
- Recheck cable connections.
- Ensure that the AC/DC 5 volt power adapter is plugged into an AC power source.

2.2.2. Set Up Host PC Network Connection

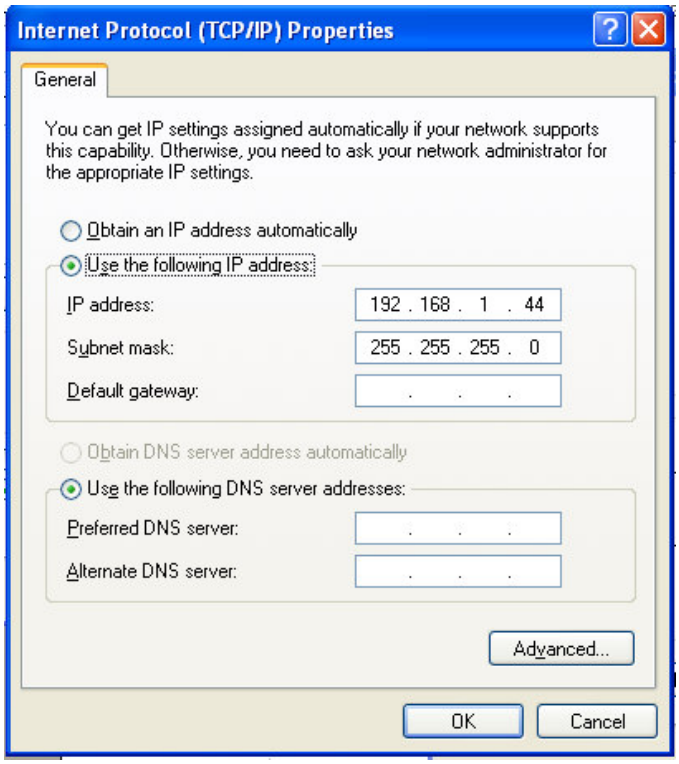
Step 1 Open the Control Panel and click on Network Connections.

Step 2 Double-click on **Local Area Connection** (or the appropriate name given to the Ethernet controller you plugged into), and click on the **Properties** button. The *Local Area Connection Properties* window is displayed.

Step 3 Double-click on the **Internet Protocol (TCP/IP)** connection. The Internet Protocol (TCP/IP) Properties window is displayed.



Step 4 Select the **Use the following IP address** radio button.



Step 5 Set the IP address to **192.168.1.44** (User selectable address).

CAUTION:

Consult your network administrator for a compatible IP address (the values in the above example will work only if you are connected directly to a camera and are not on a network).

Be careful not to choose an IP address that will conflict with any existing IP addresses on the network. Designating identical IP addresses on the same network WILL interfere with all Ethernet communications including those of other computers and/or cameras already online.

Step 6 Set the Subnet mask to: **255.255.255.0**.

CAUTION:

Consult your network administrator for compatible subnet mask (these values will work only if you are connected directly to a camera and are not on a network).

Step 7 Click the **OK** button.

2.2.3. Network Addressing Scenario 1: Manual

IP addressing assigns a unique IPv4 number set between a particular computer and a device. These numerical identification addresses may be assigned manually, as shown in Figure 2-1, telling the computer that the device has a number such as 192.168.2.1 that the computer will then identify as the camera.

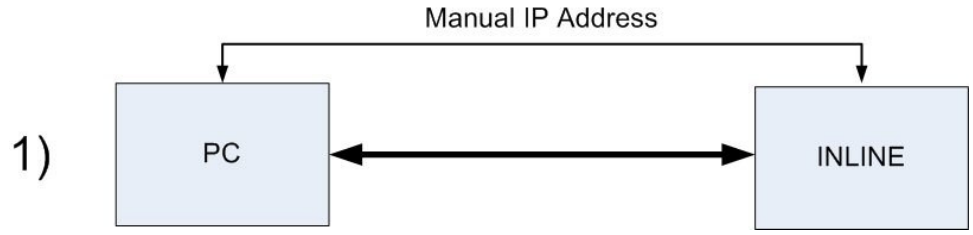


Figure 2-1: Manual IP Address

2.2.4. Network Addressing Scenario 2: Auto – Manual

A camera device in a computer network, shown in Figure 2-2, may be manually assigned a static IP address by an administrator. This allows the address to be configured in one place without specifically configuring each computer on the network.

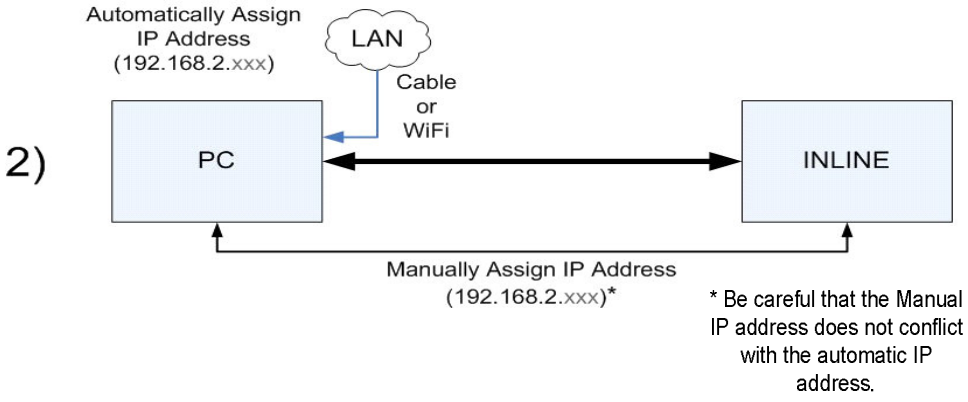


Figure 2-2: Auto – Manual IP Address

2.2.5. Network Addressing Scenario 3: Auto – Auto

Automatic IP address assignments (dynamic addressing), shown in Figure 2-3, are most frequently assigned on LANs and broadband networks by Dynamic Host Configuration Protocol (DHCP) servers. Dynamic IP addressing eliminates the need to assign specific static addresses to each network device.

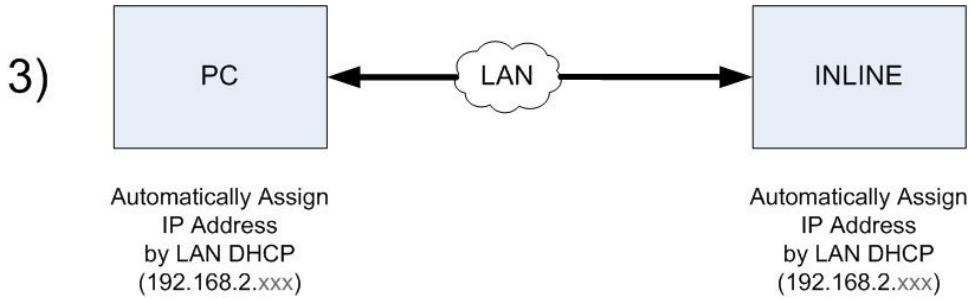


Figure 2-3: Auto – Auto IP Address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3. Camera Configuration

3.1. Technical Keypoints

3.1.1. Shutter Multiplier Setting

The shutter multiplier setting determines the camera shutter speed. Shutter speed is defined as the inverse value of the frame rate times the shutter multiplier.

For example:

- **Frame Rate** = 250 fps (inverse value is 1/250 or .004 seconds).
- **Shutter Multiplier** = A setting of 4X (inverse value is 1/4th or .25).
- **Shutter Speed** = .004 x .25 or .001 seconds.

The following table displays shutter speeds based on selected frame rates and shutter multipliers.

Table 3-1: Shutter Speed Settings

Shutter Multiplier (Reciprocal)	60 (.0167)	125 (.008)	250 (.004)	500 (.002)	1000 (.001)
1X	.016700	.008000	.004000	.002000	.001000
2X (.500)	.008333	.00400	.002000	.001000	.00050
3X (.333)	.005560	.002670	.001330	.000667	.000333
4X (.250)	.004170	.002000	.001000	.000500	.000250
5X (.200)	.003330	.001600	.000800	.000400	.000200
10X (.100)	.001667	.000800	.000400	.000200	.000100
20X (.050)	.000833	.000400	.000200	.000100	.000050

Changing the shutter speed does not change record rate or frame resolution. Faster shutter speeds reduce object blur.

3.1.2. Record Time Matrix

The event record time and maximum number of frames stored is determined by the following factors:

- Recorded frames per second.
- Sensor resolution selection.
- Onboard camera memory.

Table 3-2: InLine Record Time Matrix for 256 MB, 512 MB, 1 GB, 2 GB Memory

Record		256 MB		512 MB		1 GB		2 GB	
Rate	Resolution	Frames	Time (Sec.)	Frames	Time (Sec.)	Frames	Time (Sec.)	Frames	Time (Sec.)
60	640 x 480	1,096	18.3	2,193	36.6	4,387	73.1	8,774	146.2
125	640 x 480	1,096	8.8	2,193	17.5	4,387	35.1	8,774	70.2
250	640 x 480	1,096	4.4	2,193	8.8	4,387	17.5	8,774	35.1
60	640 x 240	2,202	36.7	4,405	73.4	8,811	146.9	17,623	293.7
125	640 x 240	2,202	17.6	4,405	35.2	8,811	70.5	17,623	141.0
250	640 x 240	2,202	8.8	4,405	17.6	8,811	35.2	17,623	70.5
500	640 x 240	2,202	4.4	4,405	8.8	8,811	17.6	17,623	35.2
60	440 x 330	2,310	38.5	4,622	77.0	9,243	154.1	18,487	308.1
125	440 x 330	2,310	18.5	4,622	37.0	9,243	73.9	18,487	147.9
250	440 x 330	2,310	9.2	4,622	18.5	9,243	37.0	18,487	73.9
500	440 x 330	2,310	4.6	4,622	9.2	9,243	18.5	18,487	37.0
60	320 x 240	4,599	76.7	9,198	153.3	18,396	306.6	36,792	613.2
125	320 x 240	4,599	36.8	9,198	73.6	18,396	147.2	36,792	294.3
250	320 x 240	4,599	18.4	9,198	36.8	18,396	73.6	36,792	147.2
500	320 x 240	4,599	9.2	9,198	18.4	18,396	36.8	36,792	73.6
1000	320 x 240	4,599	4.6	9,198	9.2	18,396	18.4	36,792	36.8

3.1.3. Camera Internal Trigger

Image capture is referenced to the last frame captured the moment you click on the camera **Stop** button (or a remote trigger input is detected by the camera). This frame is called the trigger point and is always labeled as frame 0000.

The trigger point is expressed as a percentage of the total frames captured, or as the Start (beginning) or End of the video frame capture. Images captured before a trigger frame are labeled with negative numbers. Images captured after a trigger frame are labeled with positive numbers.

In other words, a trigger point is an auto stop for an image capturing sequence. Figure 3-1 below shows the image recording function of the camera when an internal trigger point of 25% was selected. The first 25% of the image capturing sequence would be retained in memory, while the remaining 75% of the image capturing sequence will continue recording new images.

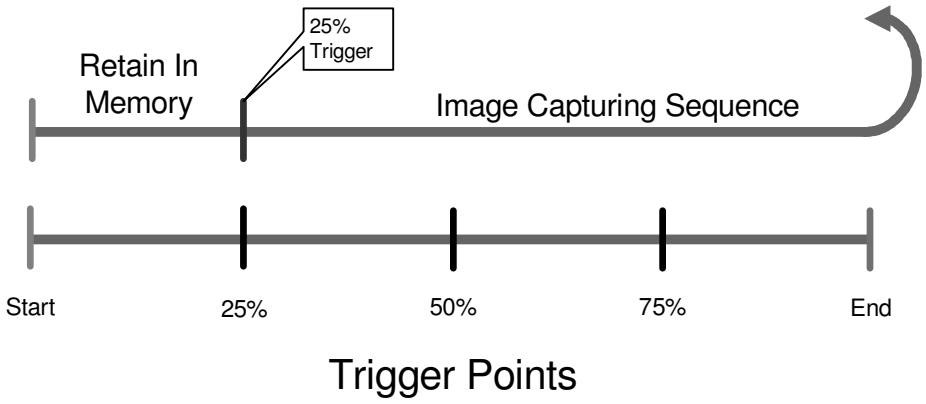

Figure 3-1: Camera Capture Function Using Internal Trigger Points

NOTE: InLine cameras may also be given a specific trigger delay position. Depending on software capabilities, it may also be possible to specify exactly how many frames are saved "pre-trigger" and "post-trigger.

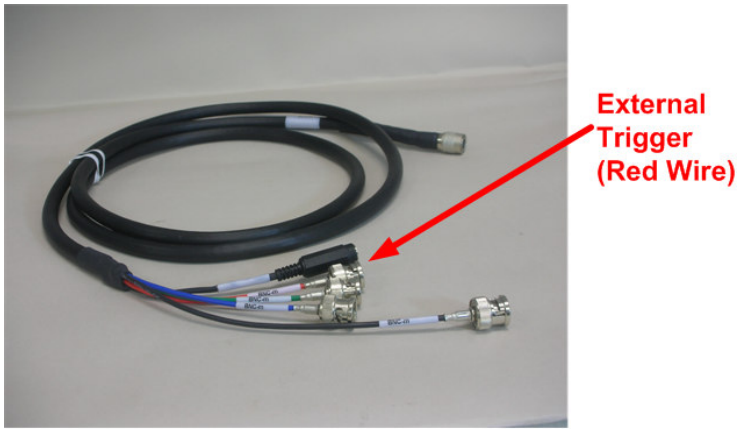

Figure 3-2: Multiple Remote I/O Camera External Trigger Interface Connector

Table 3-3: Trigger Points and Functions

Trigger	Function
Start	Begin capturing image frames in camera memory when the trigger point is detected. ❑ Make the trigger point the first frame captured.
25%	Retain 25% of the frames captured before the trigger point was detected. ❑ Record new frames in the remaining 75% of camera memory.
50%	Retain 50% of the frames captured before the trigger point was detected. ❑ Record new frames in the remaining 50% of camera memory.
75%	Retain 75% of the frames captured before the trigger point was detected. ❑ Record new frames in the remaining 25% of camera memory.
End	Stop capturing frames in camera memory once the trigger point is detected. ❑ Retain all frames recorded in camera memory up to the moment of the trigger.
User Selectable	Any frame number of the total available for the resolution and amount of memory in the camera can be entered by the user as the trigger frame. Camera will retain all frames recorded in camera memory before and after the trigger frame except when a value of 0 is entered.

NOTE: With some software applications (e.g.: FIMS), settings of 25%, 50%, and 75% or any other "pre-trigger" point (a trigger signal received before camera has filled the memory with video data), may cause the PC display to "freeze" at the point of triggering. The camera, however, will continue to fill the remainder of the memory with frames until the buffer is full.

3.1.4. Remote Trigger Input

The REMOTE TRIGGER IN signal is input through the BNC connector on the Multiple I/O cable labeled Trigger (see Figure 1-3).

The REMOTE TRIGGER IN signal is a low true (less than .7 volts DC) input to a type SN74LVC14A inverter. It can be grounded through a simple normally open momentary switch or be driven actively. The input can tolerate +/- 5V TTL levels or below.

3.1.5. Trigger vs Sync Out Relationship

An InLine camera may be synced when a rising trigger waveform is applied to the I/O cable. The sync is edge sensitive and fires the sensor as soon as it sees a rising edge. The triggering source for syncing may be either a momentary switch as mentioned above, or a sync signal generated from another camera (see Figure 3-3). The Triggered LED will illuminate when a trigger signal is applied (see Figure 1-2).

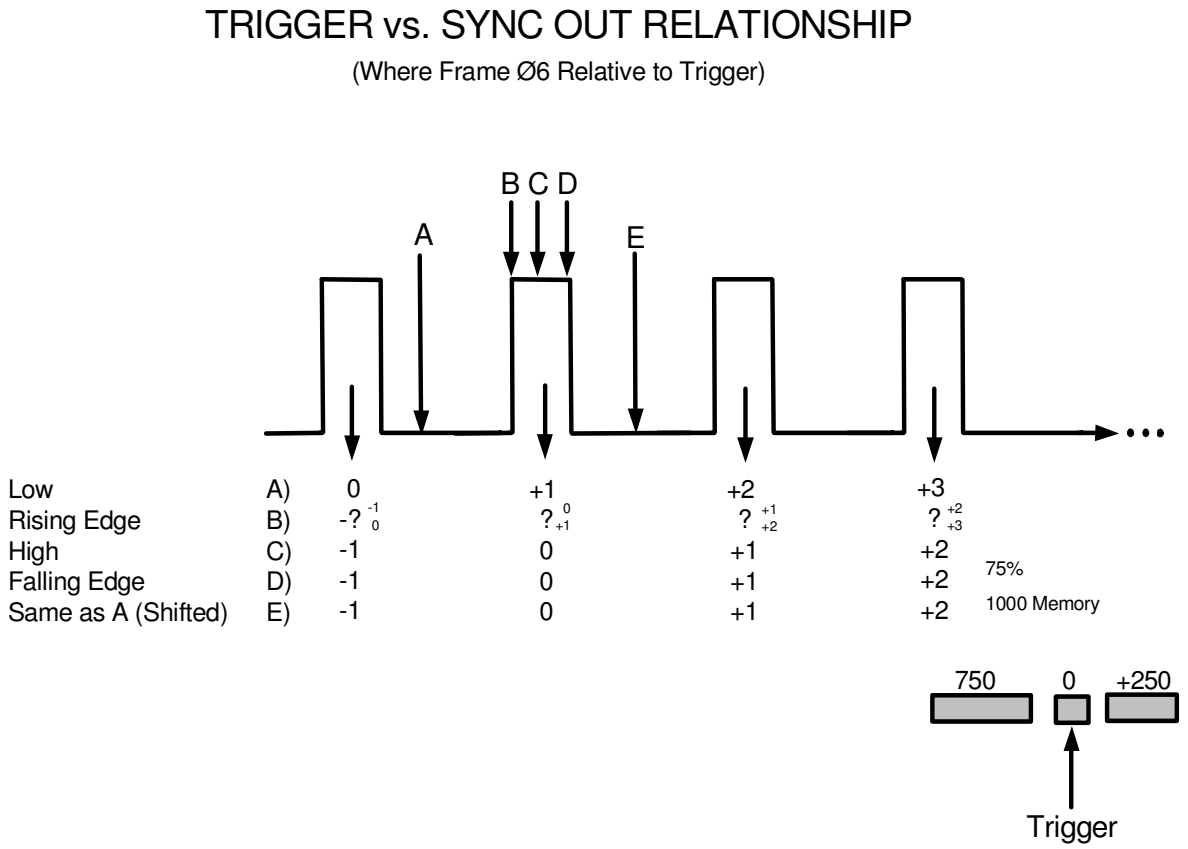

Figure 3-3: Trigger vs Sync Out Relationship

3.1.6. Camera Lens Back-Focus Adjustment

The C-mount on the InLine camera is adjustable to allow you to perform a lens back-focus adjustment. When you perform a back-focus adjustment you change the distance between the flange mount surface of the lens and the CMOS sensor array.

In most cases, changing the lens on your camera will not require a lens back-focus adjustment.

To perform a lens back-focus adjustment:

Step 1 Attach the lens to front of camera.

Step 2 Aim the lens at target that is a measured distance from the C-mount surface. (5 ft in this example).

Step 3 Power up the camera.

Step 4 For maximum light sensitivity, set camera record speed to 25 frames per second.

Step 5 Adjust the lens opening for ambient light.

Step 6 Adjust lens focus until target appears focused on the LCD display.

Step 7 Observe the lens foot reading.

If the feet number reading on lens is low (less than 5 feet), go to *Step 9* and adjust the C-mount ring out/away from camera (counter-clockwise if facing front of camera).

- Counter-clockwise rotation increases lens focal length.
- Clockwise rotation decreases lens focal length.

Figure 3-4: Focal Length too Low

Step 8 If the feet number reading is high (greater than 5 feet), go to *Step 9* and adjust the C-mount ring into the camera (clockwise, if facing the front of camera).

Figure 3-5: Focal Length too High

Step 9 Using a Philips screwdriver, loosen the 2 screws on the aluminum lens mount plate, adjust the C-mount ring and retighten the screws.

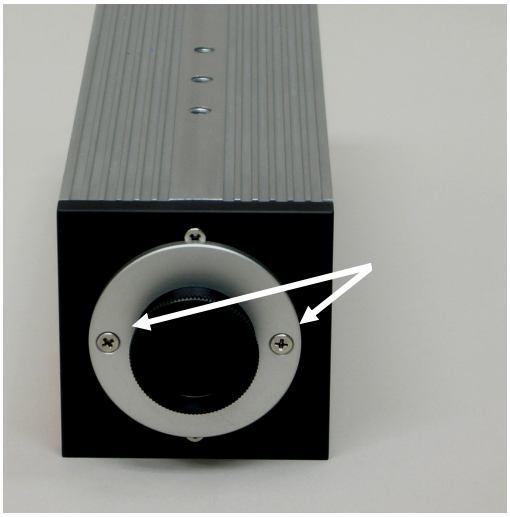

Figure 3-6: Back-Focus Ring Retaining Screws


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4. InLine Camera Operations

This chapter contains InLine camera operational procedures. Before you begin any of the following procedures, ensure that your camera has been setup. If you need to review camera configuration procedures, refer to *Chapter 2, Camera Setup, and Chapter 3, Camera Configuration*.

4.1. Camera Operational Procedures

The following procedures contain instructions for setting up an InLine camera for remote operation.

4.1.1. Load and Start the Software Program

Step 1 Install the software program to your computer desktop, (or desired location on your hard drive). This step is performed one time.

NOTE: Any software suite made for this type of camera can be used. This section describes features common to them all.

Step 2 Remove the lens receptacle cover and install a C Mount lens.

- Shorter focal length lens = greater field of view, lower magnification, and larger depth of field.

Step 3 Set the lens iris to the fully open position.

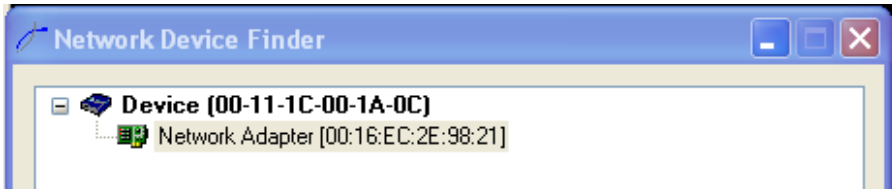
- Smallest number on the lens aperture ring.

Step 4 Start the software program (i.e. Midas 2.0, FIMS 3.0, etc.).

Step 5 Click on the Connections menu and select the Open Camera option.

NOTE: The name of the menu item or button may vary depending on the software program used.

Step 6 When the Network Device Finder window is displayed, select the desired Network Adapter and click the OK button. The selected camera is now controlled from that device.



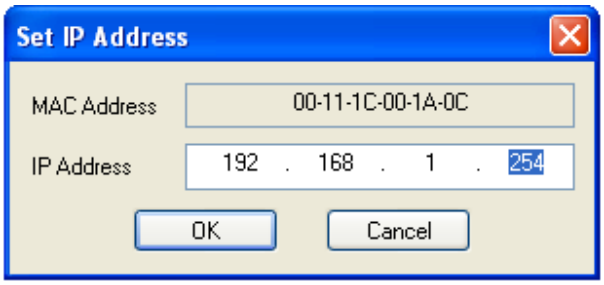
NOTE: More than one network adapter may be seen below any given camera. Select the actual network adapter that is being physically used.

Step 7 Set The IP address of the Camera:

When/if the following dialog is displayed, set the camera IP address to 192.168.1.200, (User selectable address), and click the OK button.

CAUTION:

Consult your network administrator for a compatible IP address (this address will work only if you are connected directly to a camera and not on a network). Be certain NOT to set two cameras to the same IP address, or to the same address as the host PC.



NOTE: After a camera is assigned a unique IP address, it will be displayed in the list of cameras found when the software program is opened again (unless the camera is powered down). Each time a camera is re-set it loses its IP address.

4.1.2. Adjusting Camera Fixed Pattern Noise

The first time a camera is used, the InLine camera fixed pattern noise must be adjusted. Fixed pattern noise usually manifests as vertical lines in the image or ghost images. The example below shows vertical lines in the image.

NOTE: The Dark frame information is usually stored in a file located in the same folder as the software application. The file will be named xx-xx-xx-xx-xx-xx.DAT where the x's match the MAC address of your camera. Every time the software opens, the camera it will look for this .DAT file and open it if one is present. The fixed pattern noise only needs to be adjusted once.

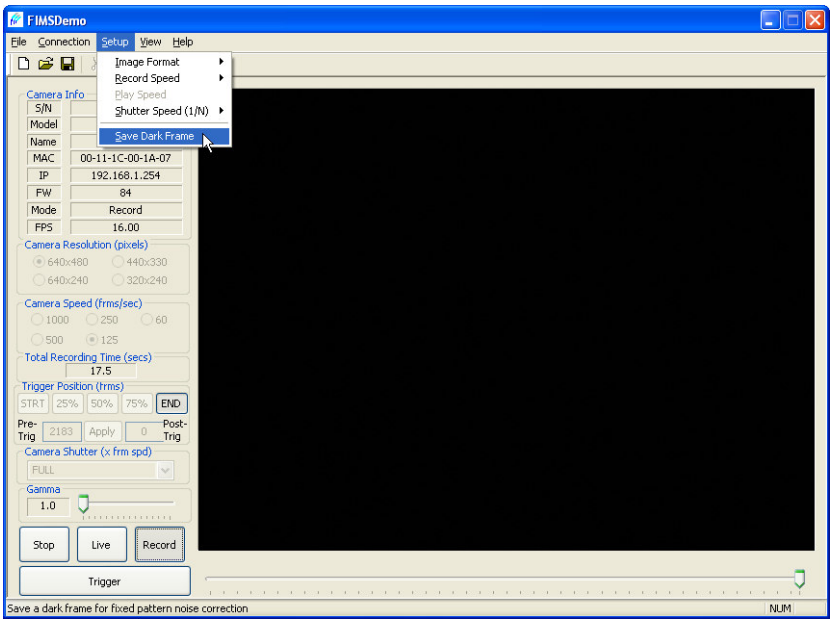
Figure 4-1: Example of Fixed Pattern Noise

Step 1 Connect to the camera following the procedures in Section 4.1.1.

Step 2 Set the lens iris to the **fully closed** position or place a lens cover on the lens.

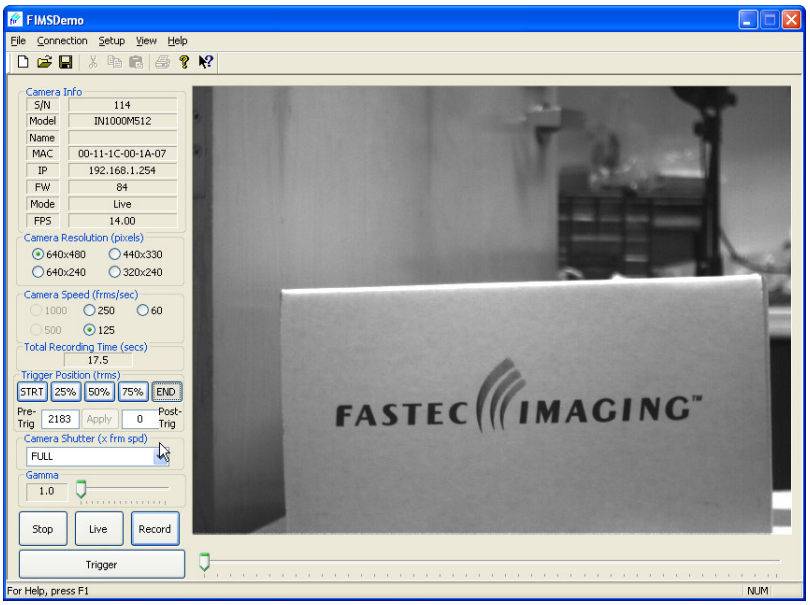
Step 3 Select the **Setup** menu, click on the **Save Dark Frame** option.

NOTE: These steps are illustrated using FIMS Demo. The name of the menu item or button may vary depending on the software program used.



Camera video (if any) should pause momentarily then resume.

Step 4 Remove the lens cap and open the iris as required to view the adjusted image. Below is an example of an image, which has been corrected for fixed pattern noise.



4.1.3. Live Mode of Operation

The figure below shows a camera that is in the Live Mode of operation. In this mode of operation, the camera is displaying a LIVE image. The external trigger is not operational.

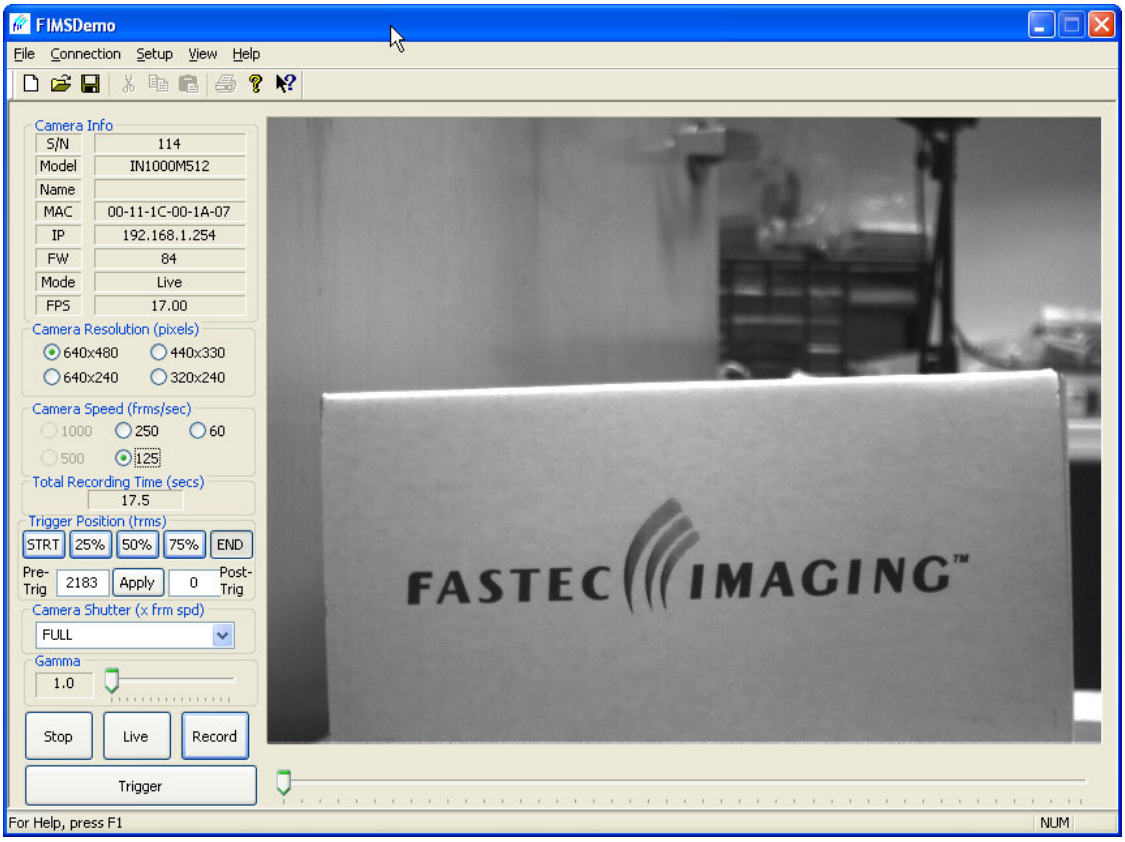


Figure 4-2: Live Mode

4.1.4. Live Mode Camera Operational Parameters

NOTE: Camera must be in "Live" mode in order to change any settings (e.g.: Speed, Resolution, Shutter, etc.)

NOTE: These steps are illustrated using FIMS Demo. The name of the menu item or button may vary depending on the software program used.

Step 1 Set the **Camera Resolution**.

Step 2 Set the **Camera Speed (frames/sec)**.

Step 3 Set the camera **Shutter Position (x frame speed)**. If a fast moving subject appears blurred, open the lens iris and increase the camera shutter speed, (2X, 4X, ...). More light may be required.

Step 4 Set the desired **Trigger Position (frames)**. Refer to Section 3.1.3 for further information regarding the use of triggers.

4.1.5. 0Record Mode of Operation

The figure below shows a camera that is in the Record Mode of operation. In this mode, all camera settings are locked down and cannot be changed. The camera will record continuously into camera memory and wait for a Trigger Signal on the External Connector (or a press of the **Trigger** button on the screen). When the trigger occurs, the camera will continue recording additional Post-Trig Frames (whatever it has been set to) and then it will change to Playback Mode. Refer to Section 3.1.3 for further information regarding the use of triggers.

NOTE: Camera must be in "Live" mode in order to change any settings (e.g.: Speed, Resolution, Shutter, etc.).

NOTE: These steps are illustrated using FIMS Demo. The name of the menu item or button may vary depending on the software program used.

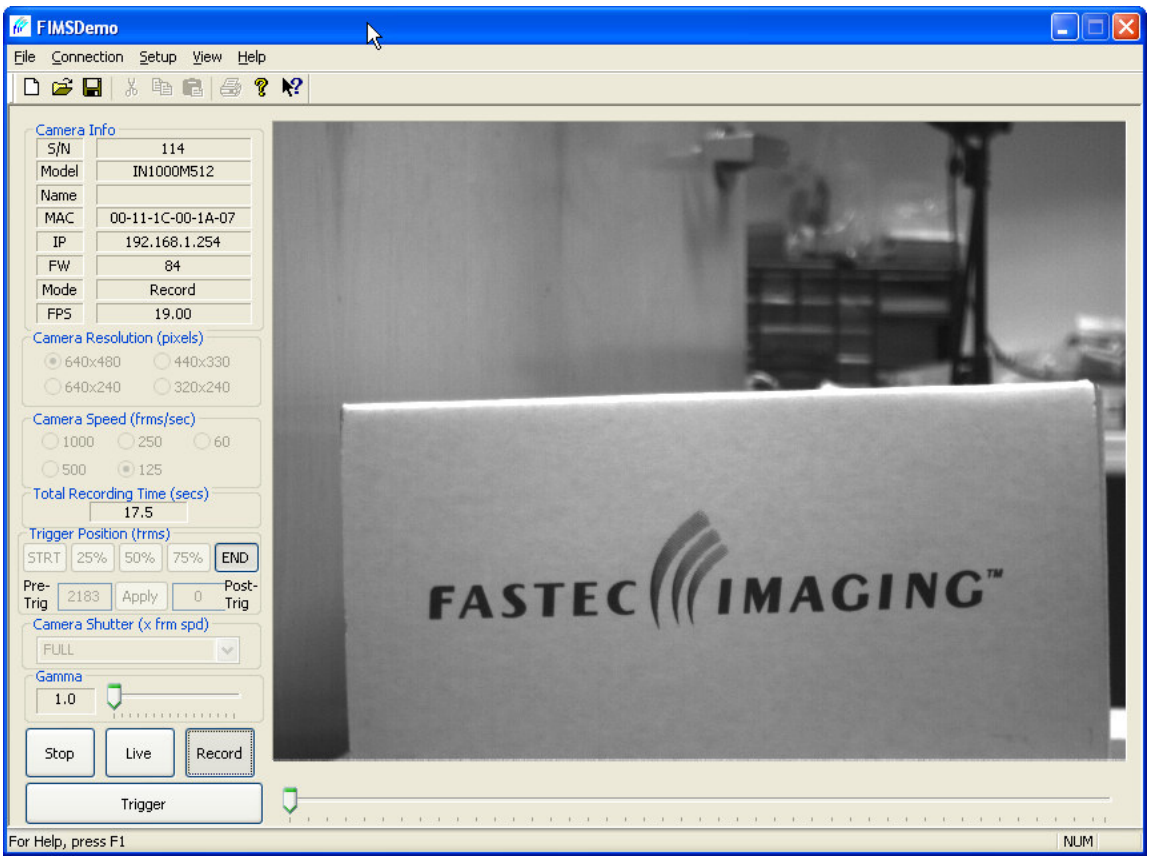


Figure 4-3: Record Mode

5. Frequently Asked Questions

5.1. Questions and Answers

5.1.1. Triggering

Question

If the trigger works only every other time, why does moving the cable start triggering every time?

Answer

Floating grounds can create this problem. For example, if the BNC connectors make contact with nearby equipment, the electrical noise can create false or missing triggers.

Question

If the camera is triggered before the buffer (onboard memory) is completely full, will the camera keep recording to fill up the buffer, then dump it to the hard drive, or instantly dump the "shorter" video?

Answer

If the camera is triggered before it can fill the preset pre-trigger frames, the recording will be shortened.

Also, the start frame and stop frame may be set so that the software only saves the frames of video desired to the hard drive. For example, save frames -10 to +30 to the hard drive.

5.1.2. Trigger Delay

Question

Is there any delay between trigger signal and when the camera dumps the memory to HD?

Answer

This depends on trigger position. If, for instance, the camera is set to record 2-seconds of post-trigger frames, there will be a second delay.

5.1.3. "0" Frame

Question

Which frame is the "0" frame? How precise is the mechanism of marking "0" frame?

Answer

The "0" frame is set by determining its position in the frames recorded. If the trigger position is set at 50% of the frame range and the camera has a capacity of 4386 frames (1Gbyte of memory), when the camera is running at 250 frames/second at full resolution, the "0" frame will be in the middle with 2193 frames before and 2193 frames after the trigger.

5.1.4. Syncing

Question

How precise and reliable is the "sync" signal from the camera?

Does the dropping frame or rising frame mark exactly the point in time when the frame is acquired or is there some variability?

Answer

The sync is edge sensitive and fires the sensor as soon as it sees a rising edge. There is a small latency period (<5 µSecs), but the latency period is fixed.

5.1.5. TTL Signal

Question

When switching to 250 fps from TTL wave, the sync signal becomes spikes. What are the details about how the synchronization takes place in this mode?

Answer

The signal is still TTL; the wave just comes out as small pulses. This behavior was built into the FPGA whenever the sensor is being run at MAX speed. In other words, you should see a small pulse at 640x480x250, 440x330x500, 640x240x500 and 320x240x1000. Any speeds that are lower will result in the pulse to become fat because the FPGA inside the camera basically "pauses" the sensor whenever it needs to achieve slower speeds.

5.1.6. Frame Rates

Question

Would it be possible to acquire video with lower frame rates in case longer acquisition times are needed?

Answer

Yes. In normal (Master) mode frames per second (fps) can drop down to 60 or 125 fps. In slave mode, fps may be anywhere between 60 and 249.9 depending on the incoming sync signals.

5.1.7. Connection Problems

Question

Why is the IP address lost when camera power is reset?

Answer

This is normal. Unless there is a Dynamic Host Control Protocol (DHCP) server to assign IP addresses automatically, the IP address must be reset manually when camera power is reset.

5.1.8. IP Address "Disappears"

Question

Why does the camera IP address set in the Network Finder "disappear?"

Answer

Perhaps the firewall is blocking TCP/IP communications. Try temporarily disabling the firewall to see if the camera reappears. Consult firewall documentation to find the proper way to make an "exception" to the software package being used (FIMS, FIMS Demo, Midas, OS, etc.)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6. Index


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