PHOTRON

MOTION TOOLS

User's Guide
Software Version 1.2.0

PHOTRON MOTION TOOLS DOCUMENTATION AND LEGAL NOTICES

Contents

Overview

Photron Motion Tools is a full-featured software package that is supplied with each Photron FastCam PCI and FastCam 1280 PCI camera. Photron Motion Tools provides functionality for controlling and synchronizing multiple cameras, for synchronizing cameras with external hardware and timing generators, for analyzing motion within an image and for documenting your work. Photron Motion Tools is modular software. The basic software includes the camera control and image playback functions. Optional modules are available to increase the functionality.

Every Photron Motion Tools installation includes the following components:

(1) A software disk that contains the following components:

      a.   Photron Motion Tools application software

      b.   Photron Motion Tools License Manager

      c.   Camera drivers

      d.   Documentation

(2) a dongle (also known as a key tag or Hardlock)

(3) a license code.

All the software is installed via the install program built into each Photron Motion Tools disk. The drivers must be loaded separately. Instructions for loading the software under various Windows operating systems are provided below.

The key tag is a physical device that attaches to the USB port of your computer. Photron Motion Tools frequently seeks out the existence of the key tag to confirm that you are a licensed user of Photron Motion Tools. The key tag also provides a method for Photron Motion Tools to keep track of which optional modules or features you have licensed.

The license code is a 16-digit number supplied by Photron. This number unlocks the various components of Photron Motion Tools that you have licensed (e.g. purchased), using the Photron Motion Tools License Manager. You can always add features by contacting Photron – we will simply supply you with a new license code (unlock code). The optional modules are unlocked using the License Manager.

Photron Motion Tools upgrades and updates can be downloaded from the Photron web site at http://www.photron.com or by clicking on the Photron logo in the upper left corner of Photron Motion Tools interface.

Available Modules for Photron Motion Tools

Photron Motion Tools standard software provides the foundation for adding any of the optional Photron Motion Tools modules. The following optional modules are available for Photron Motion Tools:

- Automated Download

- Enhanced 2-D Analysis

- Annotation

- Synchronized Data Acquisition

- IRIG/GPS/NASA Time Synchronization

Specifications

Photron Motion Tools

- Maximum number of cameras (hardware permitting).. 4
- Record Settings: record speed, shutter, and trigger.
- Playback Settings: continuous loop, block playback, and synchronous play
- Save Settings: file format, recording portion, destination, compression codecs
- Analysis Settings: calibration, units, coordinate system orientation
- Number of tracking points per frame.. 4
- Number of automatic tracking points per frame 1
- Display options: distance and velocity, file description
- Image manipulation: non-linear contrast, gamma, brightness, RGB, negative.
- Operating systems: Windows NT and Windows 2000.
- Desktop: ability to insert a small bitmap logo into the application frame.

Synchronized data acquisition

- Included hardware: DAQ card for PCI bus, cable, breakout box
- Maximum data sample rate: ....200 ks/second
- Maximum number of inputs: .... 8 DI/ 16 SE
- Data Input Resolution.. 12 bits
- Save Format: export to Excel, tab-delimited text
- Display: live, auto-gain, waveform display all channels, signal level
- Playback: Forward, Reverse, Single Step, Cursor Control, Jump
- Calibration: Scale (units/volt), offset (volts), unit scale

Enhanced 2-D motion analysis

- Number of tracking points per frame.. 32
- Number of automatic tracking points per frame 32
- Compatibility: Microsoft Excel
- Reticle Display: x,y position from image edge; x,y in pixels from user-defined origin
- Calibration Parameters: units, scale factor, coordinate system, savable.
- Repeatability:
  Manual: < 2 display pixels typical
  Automatic: ~0.2 display pixels

Synchronization to IRIG/GPS time sources

- Receive Formats: IRIG A, IRIG B, NASA, 1344IEEE
- Displays: time, trigger time, latitude, longitude and altitude, valid input, clock source, time signal stability, satellite strength indicators.
- Includes: timing card for PCI bus, BNC cable connector, GPS antenna and cable

Installing Photron Motion Tools

To start using Photron Motion Tools, first check that you have received the components required. The Photron Motion Tools software is protected by a USB key tag (also known as a keylock, Hardlock or dongle). PhoMoTo will install on Windows NT, 2000 and XP operating systems. Please note that the FastCam PCI R2 and FastCam-X 1280 PCI camera only work on Windows 2000 and XP operating systems.

The proper procedure for installing PhoMoTo is as follows:

- Set the jumpers on your cameras

- Install and interconnect the cameras into your computer.

- Install the hardware drivers for your cameras.

- Install Photron Motion Tools application.

- Enter your License Key Code.

Set the Jumpers on your Cameras

It is recommended that all cameras in the computer be set to SLAVE mode.

If your camera is a model *FastCam PCI*, make sure that the SLAVE jumper pins have the "jumper" connector installed as shown in the following picture:
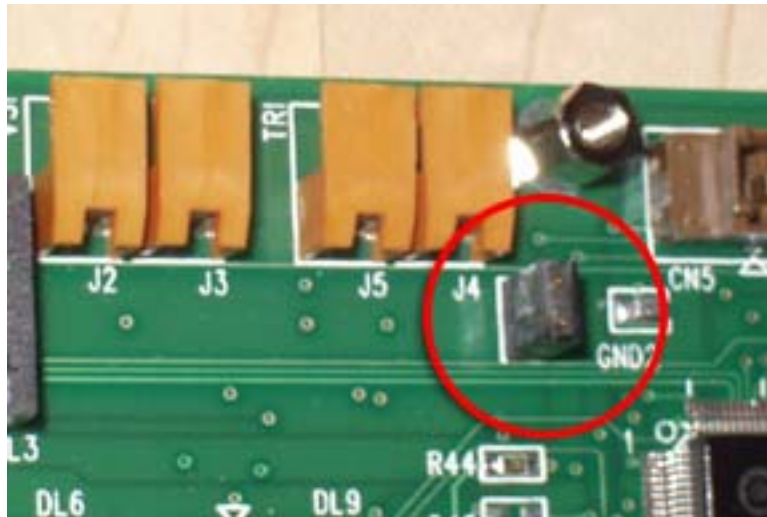
If your camera is a model *FastCam PCI R2*, make sure that dip switch #4 in the dip switch block is set to ON and that dip switches 1,2,and 3 are set to OFF, as shown in the following picture:

If your camera is a model *FastCam-X 1280 PCI*, make sure that dip switch #3 in the dip switch block is set to ON, as shown in the following picture (jumpers 1,2 and 4 are shown here in the OFF position for clarity only – set these according to the hardware instructions that came with your camera):
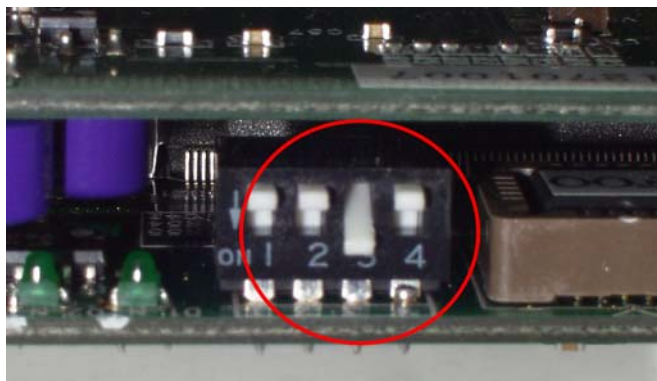
If your camera is a model *FastCam 512 PCI*, make sure that dip switch #4 in the dip switch block is set to ON, as shown in the following picture (jumpers 1,2 and 3 are shown here in the OFF position for clarity only – set these according to the hardware instructions that came with your camera):
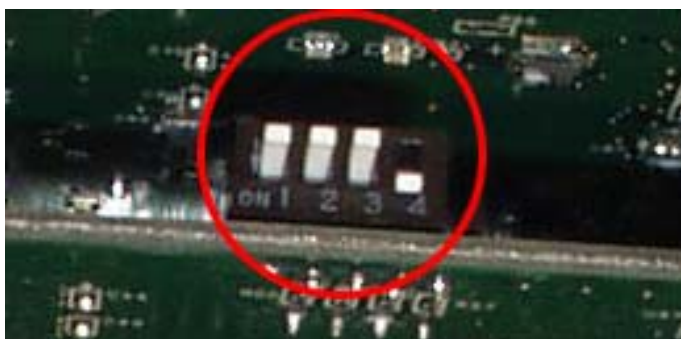
Install and Interconnect the Cameras

1. Turn off the computer.

2. Install all the camera boards into the computer.

3. If using multiple cameras, interconnect the synchronization cables.

If you are using model *FastCam PCI* cameras:

4. If using multiple FastCam PCI cameras, interconnect the TRO-to-TRI (trigger) and VSO-to-VSI (synchronization) cables inside the computer with the cables supplied with your camera(s). The TRO, TRI, VSO and VSI connectors are found on the camera cards.

5. If connecting to an external event trigger, connect the external event trigger to each camera in the computer using the split BNC connectors on the back panel of the camera card. Use the TS connection if the event trigger is a hand switch. Use the TT connection if the event trigger is a TTL source.

   If you have questions about interconnecting multiple cameras, consult the hardware installation guides supplied with your camera or contact Photron.

   The following schematic shows the (external trigger and internal sync) interconnections for one or more **FastCam PCI cameras** in the computer:
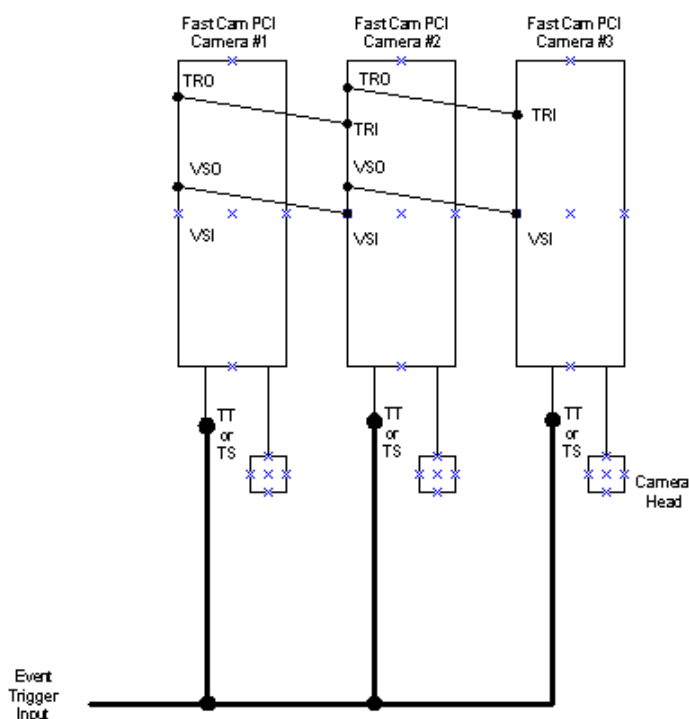
Note: the external trigger MUST be connected to the EACH FastCam PCI camera in the computer.

6. Attach your camera heads and pigtail connectors.

7. Attach your Photron Motion Tools security dongle to your computer USB port.

If you are using model *FastCam PCI R2* cameras:

4. If using multiple FastCam PCI R2 cameras, interconnect the SYNC OUT and SYNC IN breakout cables that are supplied with each camera. These cables attach to the back panel of the camera board.

5. If connecting to an external event trigger, connect the external event trigger to each camera in the computer using the split BNC connectors on the back panel of the camera card. Use the TS connection if the event trigger is a hand switch. Use the TT connection if the event trigger is a TTL source.

   If you have questions about interconnecting multiple cameras, consult the hardware installation guides supplied with your camera or contact Photron.

The following schematic shows the (external trigger and external sync) interconnections for one or more **FastCam PCI R2 cameras** in the computer:
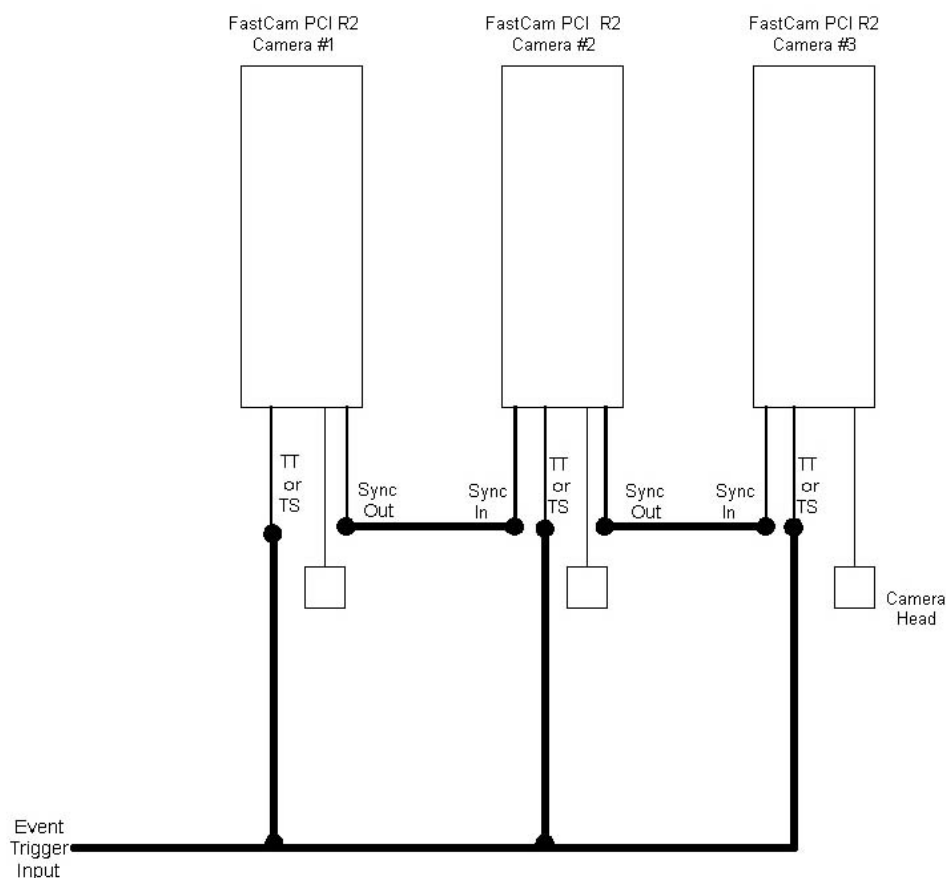
Note: the external trigger MUST be connected to the EACH FastCam PCI camera in the computer.

6. Attach your camera heads and pigtail connectors.

7. Attach your Photron Motion Tools security dongle to your computer USB port.

If you are using model *FastCam-X 1280 PCI* cameras:

4. If using multiple FastCam-X 1280 PCI cameras, interconnect the BD_OUT and BD_IN cables inside the computer with the cables supplied with your camera(s). The BD_OUT and BD_IN connectors are found on the camera cards.

5. If connecting to an external event trigger, connect the external event trigger to the first camera in the chain using the split BNC connectors on the back panel of the camera card.

   Note: While it is only necessary to connect the event trigger to the first camera in the chain, it is highly recommended to connect the trigger to each camera in the computer.

   If you have questions about interconnecting multiple cameras, consult the hardware installation guides supplied with your camera or contact Photron.

   The following schematic shows the recommended (external trigger and internal sync) interconnections for the **FastCam-X 1280 PCI camera**:
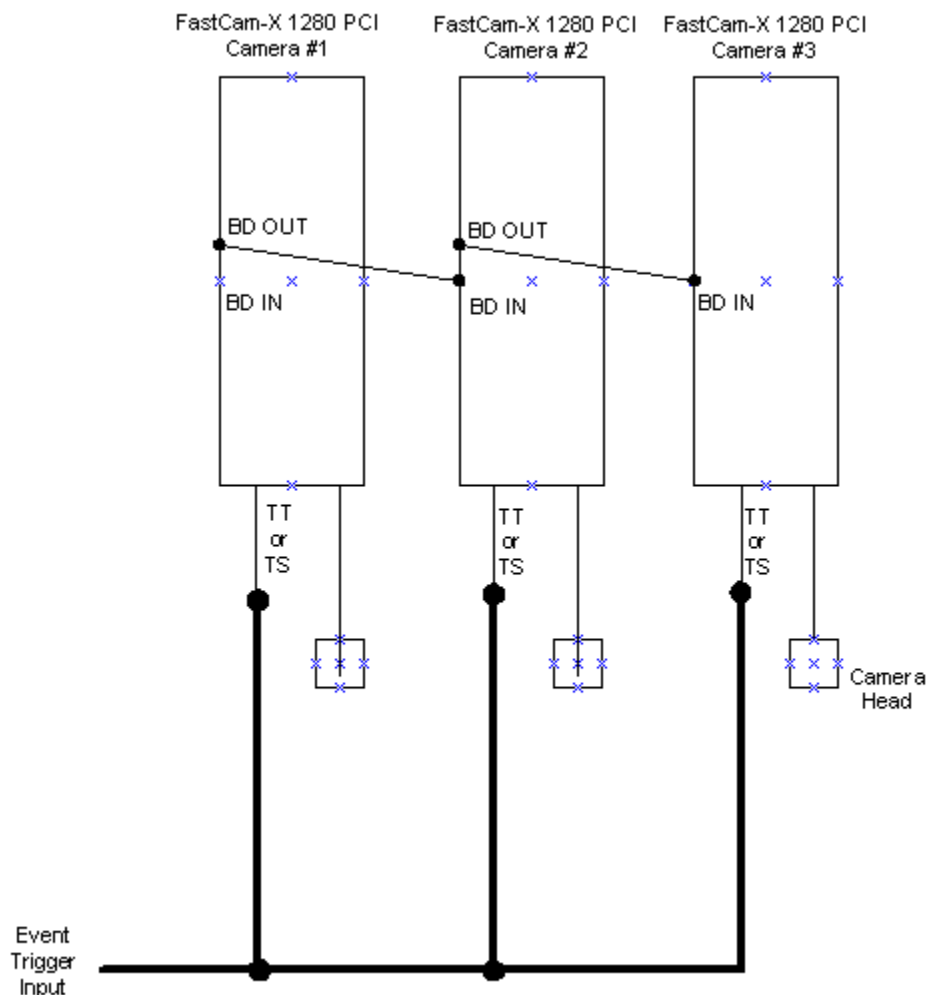
FastCam-X 1280 PCI
Camera #1

FastCam-X 1280 PCI
Camera #2

FastCam-X 1280 PCI
Camera #3

BD OUT

BD OUT

BD IN

BD IN

BD IN

TT
or
TS

TT
or
TS

TT
or
TS

Camera
Head

Event
Trigger
Input

6. Attach your camera heads and pigtail connectors.

7. Attach your Photron Motion Tools security dongle to your computer USB port.

If you are using model *FastCam 512PCI* cameras:

4. If using multiple FastCam 512PCI cameras, interconnect the SYNC OUT and SYNC IN breakout cables that are supplied with each camera. These cables attach to the back panel of the camera board.

5. If connecting to an external event trigger, connect the external event trigger to each camera in the computer using the split BNC connectors on the back panel of the camera card. Use the TS connection if the event trigger is a hand switch. Use the TT connection if the event trigger is a TTL source.

If you have questions about interconnecting multiple cameras, consult the hardware installation guides supplied with your camera or contact Photron.

The following schematic shows the (external trigger and external sync) interconnections for one or more **FastCam 512PCI cameras** in the computer:
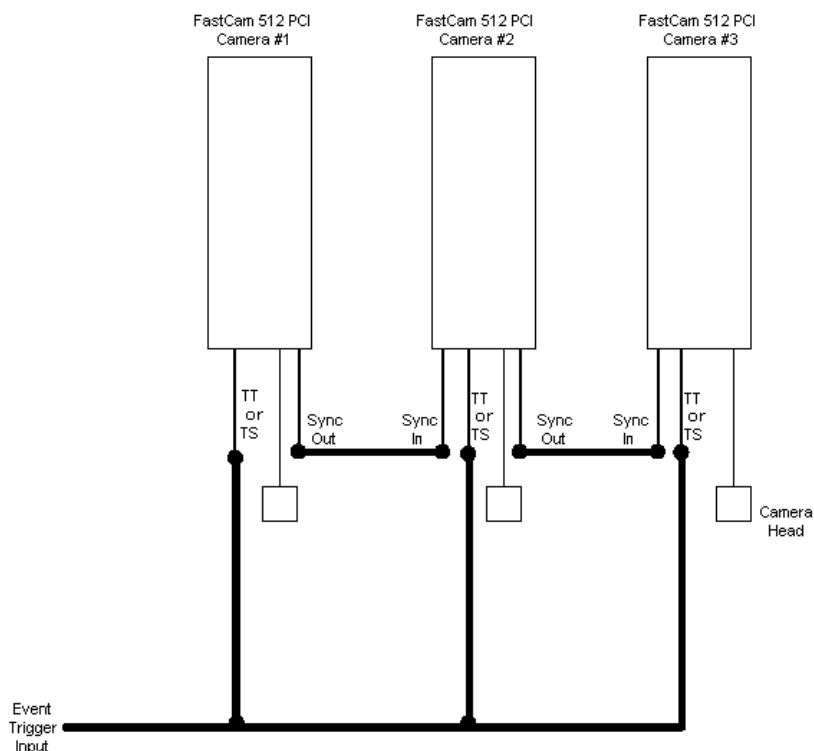
Note: the external trigger MUST be connected to the EACH FastCam 512 PCI camera in the computer.

6. Attach your camera heads and pigtail connectors.

7. Attach your Photron Motion Tools security dongle to your computer USB port.

Install the Hardware Drivers for your Cameras (Windows NT only)

The following instructions apply to users of FastCam PCI under Windows NT only. If you are using a FastCam PCI R2 or FastCam-X 1280 PCI or running under Windows 2000 or Windows XP, skip to the next section.

8. Start your computer. Log on as Administrator.

9. Insert the CD that contains the Photron Motion Tools software into your CD-ROM. If the CD automatically starts (e.g. auto-runs), cancel and close the installer.

10. Install the drivers. Double-click on the **INSTALL.BAT** file from within the NT sub folder within the **Drivers\FastCamPCI Driver\WinNT** folder located on your Photron Motion Tools CD. Alternatively, from the **RUN** prompt, type "**F:\ FastCamPCI Drivers\FastCamPCI Driver\WinNT\Install.bat**", where "**F**" is the letter of your CD drive.

11. If prompted, click **OK.**

12. Restart your computer.

Install the Hardware Drivers for your Cameras (Windows 2000 or Windows XP)

The following instructions apply to users of FastCam PCI, FastCam PCI R2 and FastCam-X 1280 PCI running under Windows 2000 or Windows XP only.

7. Start your computer. Log on as Administrator.

8. Insert the CD that contains the Photron Motion Tools software into your CD-ROM. If the CD automatically starts (e.g. auto-runs), click on cancel and close the installer.

9. The Windows 'Found New Hardware' window will appear. If it does not (and you have already installed cameras in your computer) skip to step 20.

10. Click **NEXT.**

11. Windows will prompt you that it has found new Multimedia Controller hardware, and ask to find the appropriate hardware driver.   It will inform you that it cannot find a Digital Signature Card.
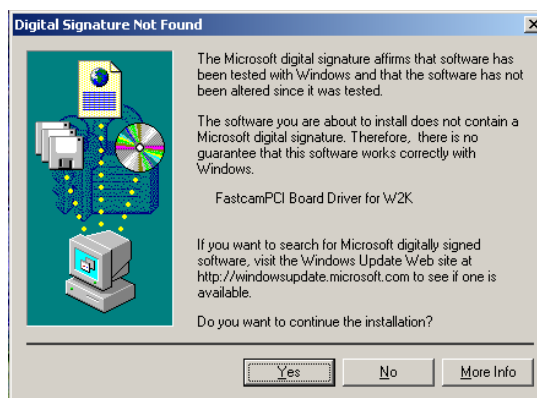
12. Click **YES.**

13. Depending on your camera model, Windows will inform you that it needs to find the appropriate hardware drivers (*.sys files).
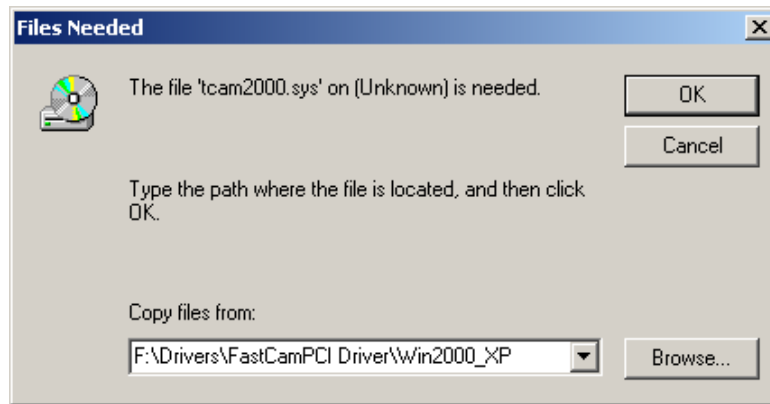
14. Click on Browse.

15. Navigate the file explorer until you locate the drivers in the following folders on the CD drive, depending on which camera you are using:

> **"F:\ Drivers\FastCamPCI Driver\Win2000_XP\"** or
>
> **"F:\ Drivers\FastCam-X1280PCI Driver\ Win2000_XP\"** or
>
> **"F:\ Drivers\FastCamPCI R2 Driver\ Win2000_XP\".**
>
> where **F**: is the letter of your CD Drive.

16. Click **OK.**

17. Windows will install the appropriate hardware drivers. When complete, it will inform you that it has completed the 'Found New Hardware Wizard'.

18. Click **FINISH.**

19. Restart your computer.

Install Photron Motion Tools Application

20. Re-insert the CD that contains the Photron Motion Tools software into your CD-ROM. The Photron Motion Tools software installer should automatically start. If it does not, from the **RUN** prompt, type **F:\SETUP**, where "**F**" is the letter of your CD drive. If the following screen appears, the installer has located a previous version of Photron Motion Tools, and you should skip to Step 41.
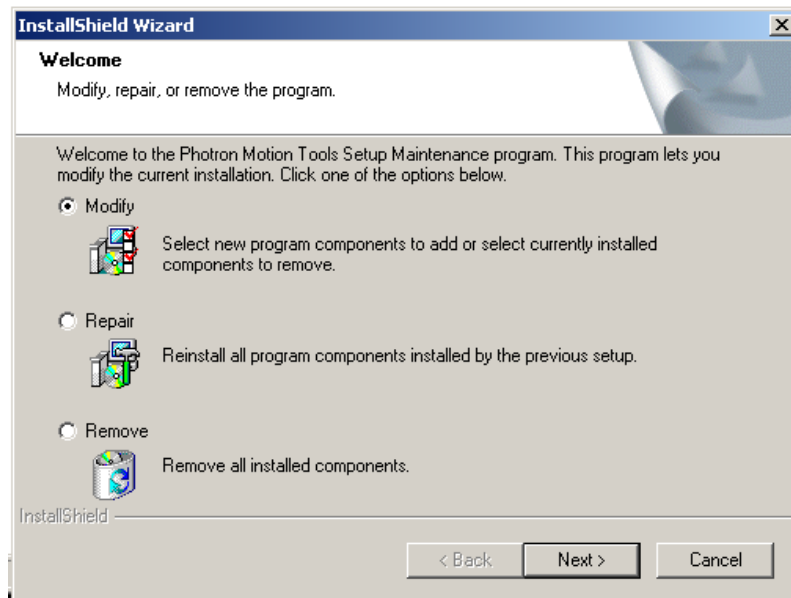
21. The installer Welcome screen, will appear.
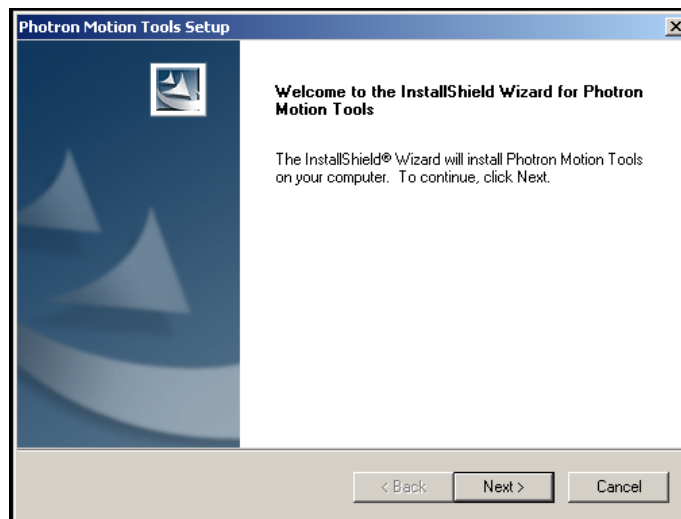
22. Click **NEXT**

23. The Photron Motion Tools License Agreement will pop up. Read the agreement carefully.
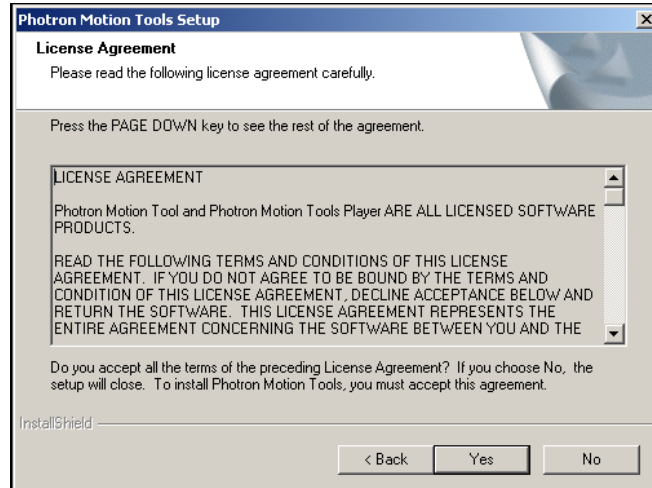
24. If you agree to the license terms, click **YES**.

25. The installer will prompt you for your name and affiliation.
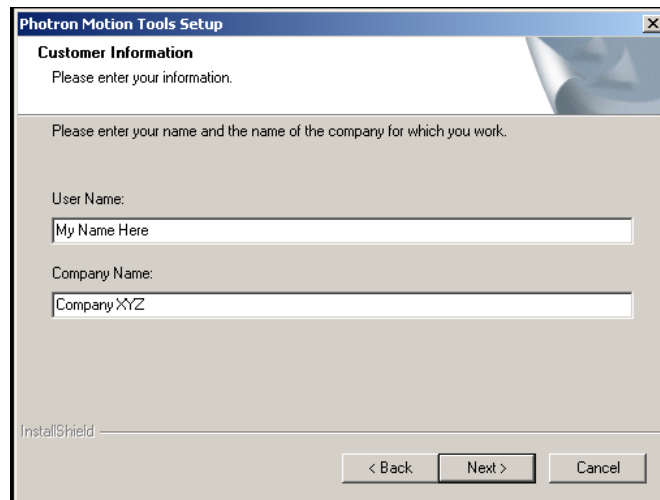
26. Click **NEXT** .

27. The installer will prompt you to choose the destination folder. Unless you have a special configuration, select the default **C:\...\PHOTRON\PHOTRON MOTION TOOLS**.
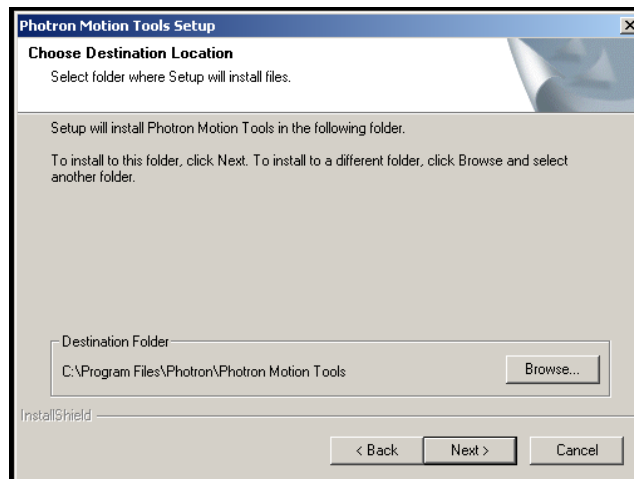
28. Click **NEXT**.

29. The installer will prompt you to select the components of Photron Motion Tools you desire to install. Select all the files available.
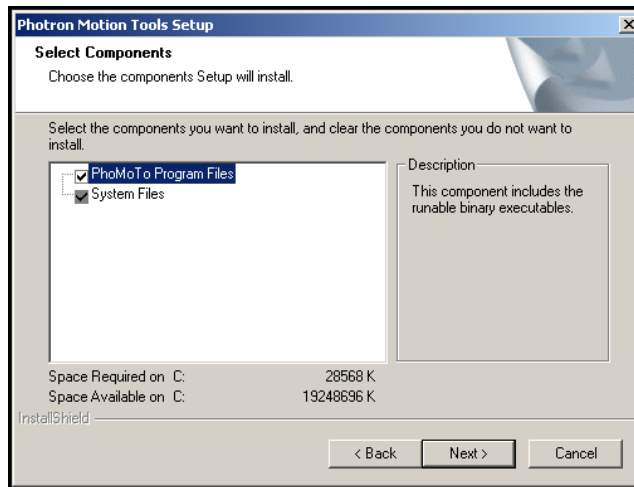
30. Click **NEXT**

31. At the Component Installation Summary screen, confirm that Photron Motion Tools and the License Manager will be installed.
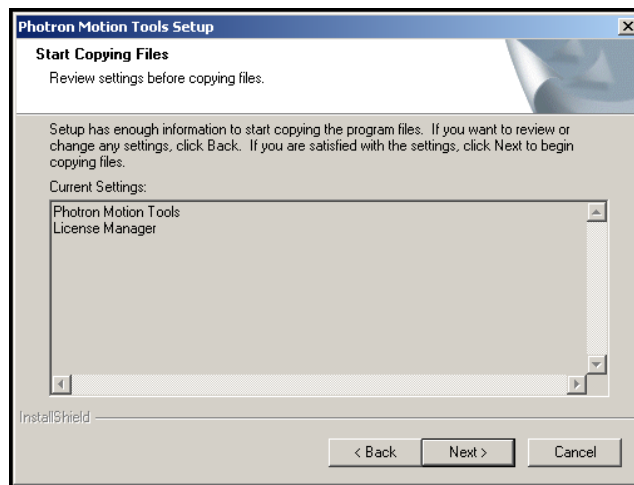
32. Click **NEXT**

33. The installer will then install the application and all the appropriate files. During the installation process, which could take many minutes, a status box will appear.
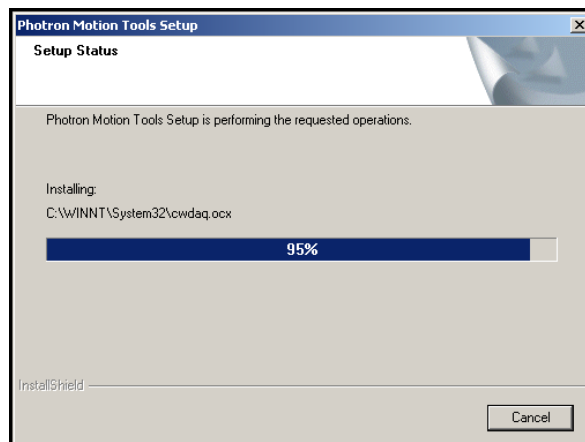
34. The installer will then start the security device driver Installer.

35. Click **NEXT**. The security drivers will be installed.

36. Click **FINISH**.

37. The installer will then complete the installation.
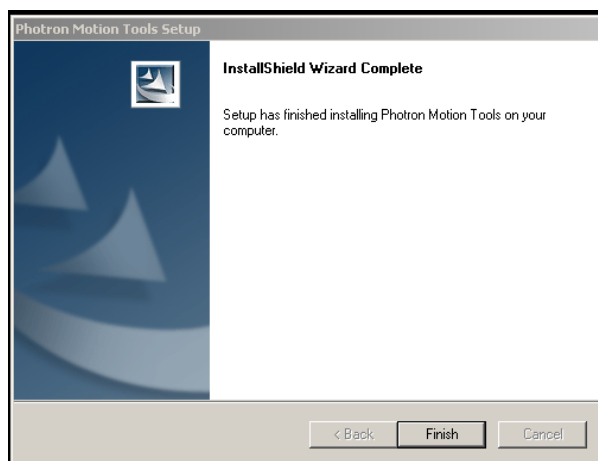
38. At the Setup complete screen, click **FINISH**.

39. Remove the CD-ROM from your CD drive.

40. Restart your computer.

41. Enter your License Key Code, as explained in step 55

If you are upgrading from previous versions of Photron Motion Tools…

Note: it is not necessary to uninstall previous versions of Photron Motion Tools.

42. During the installation procedure, the installer will automatically detect that you are upgrading a previous version of Photron Motion Tools software. You will see the following screen.
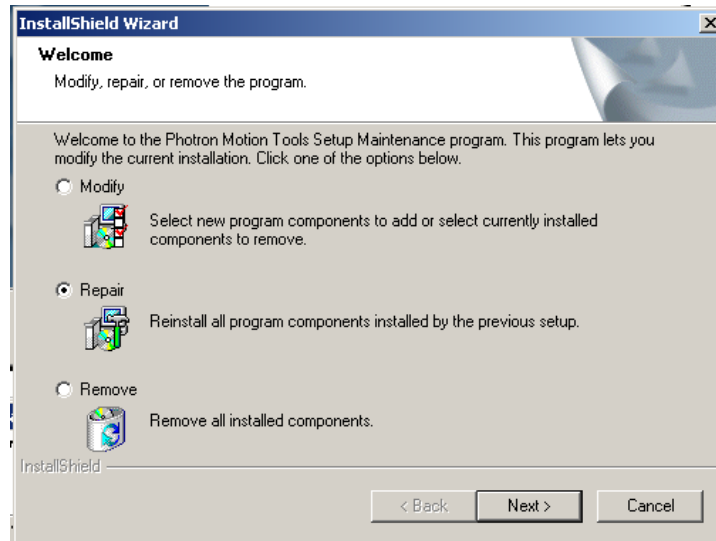
43. Select the Repair option.

44. Click **NEXT**.

45. The installer will then install the new application and all the appropriately modified files. During the installation process, which could take many minutes, a status box will appear.
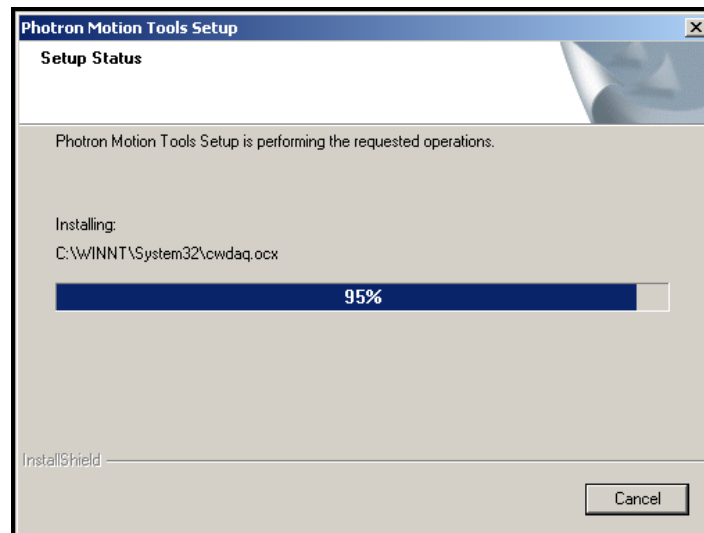
46. The installer may prompt you that it has detected a READ ONLY file, and ask you if you wish to overwrite this file.

47. Click **YES**.

48. At the installer Welcome screen, click on the **REPAIR** radio button.

49. If a Hardlock driver is required, the installer will start the Hardlock driver installer. Click **NEXT**. The drivers will be installed.

50. When complete, the maintenance complete window will appear.
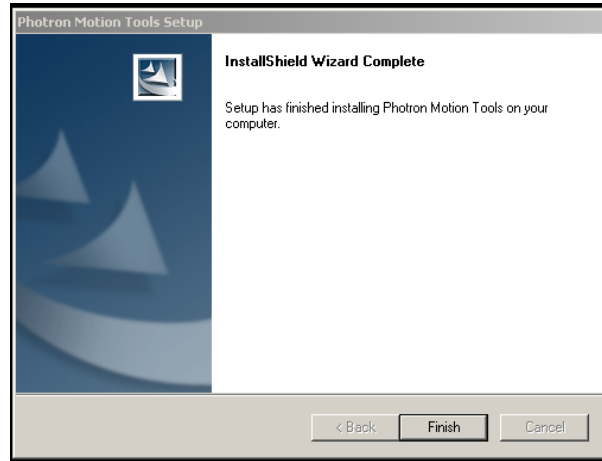
51. Click **FINISH**.

52. Remove the CD-ROM from your CD drive.

53. Restart your computer.

54. Re-enter your License Key Code, as explained in step 55

Entering your License Key Code

55. Click on the Windows **START** button, then **PROGRAMS**, then **PHOTRON MOTION TOOLS**, and then **LICENSE MANAGER**.

56. Enter the 16-digit license code in the New License section. You can find the license code on your Registration Card.

57. After you have entered your license code, click on **CHECK LICENSE**. If you have entered the license correctly, information about the key tag, and a list of the features of Photron Motion Tools that you have purchased will be listed and the **ENABLE LICENSE** button will also become highlighted.

58. Press the **ENABLE LICENSE** button.
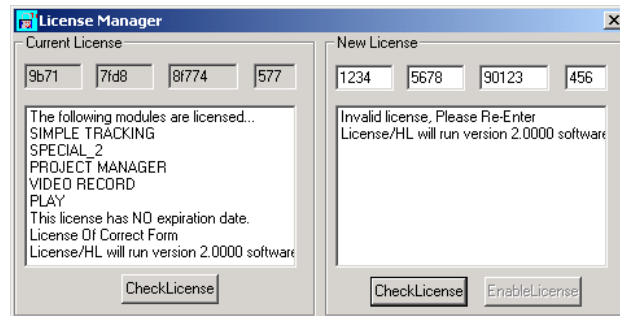
Congratulations. You are now ready to use Photron Motion Tools.

Interface Features

The Photron Motion Tools default window has the following appearance.
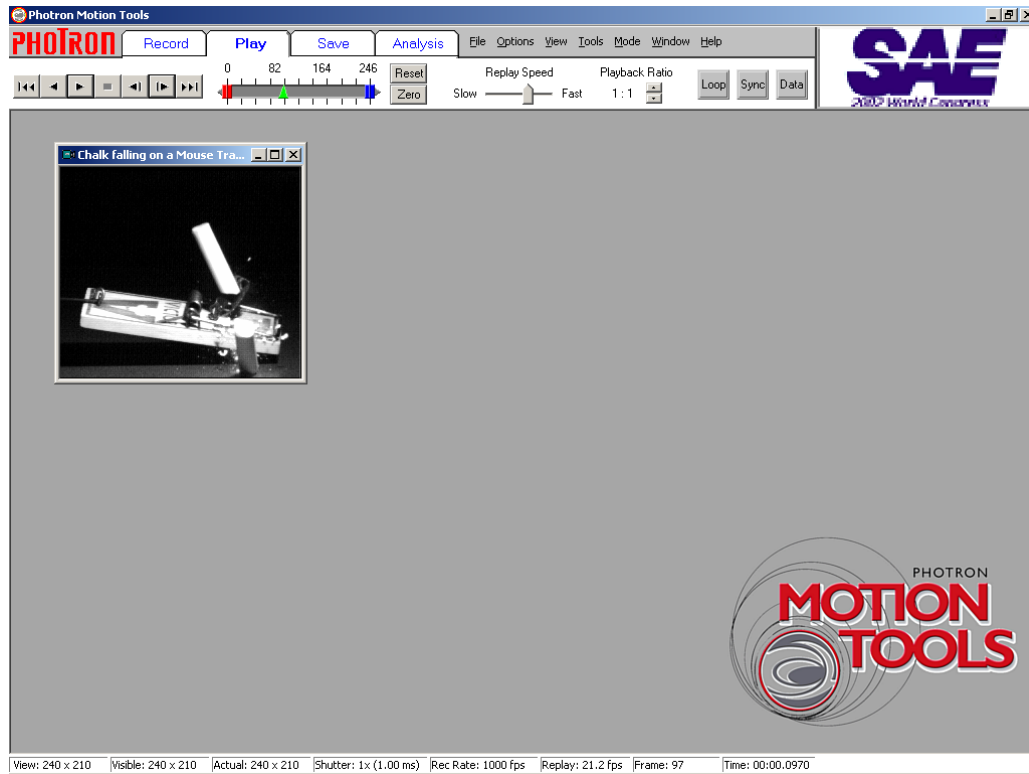
The top portion of the Photron Motion Tools window is termed the "Control Bar". The Control Bar has the Photron logo to the left, 4 tabs (Record, Save, Play, Analysis) across the middle, a small menu bar, and a corporate logo area to the right, as shown in the above diagram.

The bottom portion of the Photron Motion Tools window is termed the "Status Bar". The Status Bar contains all the information about your recording and playback.

The "Workspace" is between the two bars. The live, record and playback windows are in this area.

For optimum viewing area and to view images at their highest resolution, set your display to SVGA mode – 1024x768 pixels with a minimum of 24-bits of color. Photron Motion Tools is designed to operate on an 800x600 pixel display minimum and will generate an error message if your color depth is not set to High Color (16-bits) or above.

Throughout the Photron Motion Tools desktop, you will also find ScreenTips. These helpful messages or phrases describe the various functions within Photron Motion Tools. To view a ScreenTip, simple slide the mouse cursor over the function without clicking.

Changing the Appearance of Photron Motion Tools

To move or hide the Control Bar, double-click to the right of the Help menu item. This will undock the Control Bar from the application window.
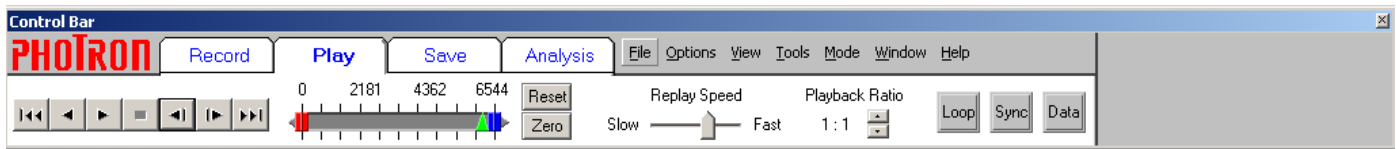
You may move the Control Bar anywhere on the screen. To restore a hidden Control Bar, click on the **Menu** button in the upper left corner of the window, then on **View**, then **Control Bar**. To dock the Control Bar to the application window, simply slide it up to the top (or bottom) and it will automatically dock.

To change the color theme of the application, select **Options**, then **Color Scheme Selection**. The following box appears:
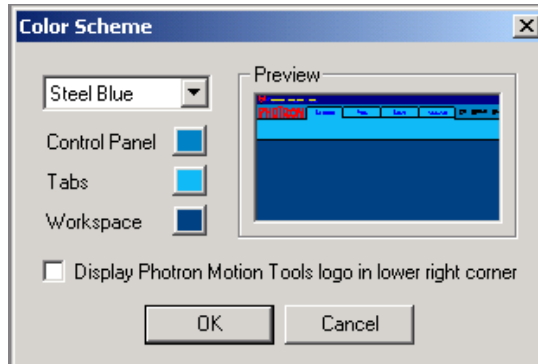
To select one of the preset color schemes, use the combination box. You may also change either the Control Bar, Tabs or Workspace colors individually using a standard Windows palette.

Menu Commands

The Menu Bar contains a list of commands and selections that are used in the configuration, recording, playback, analysis and saving of video.

The command descriptions are as follows:

File

Open File	Open a previously saved file, such as an AVI movie or series of bitmaps, JPEG files or TIFF files.
Open Camera	Open a camera that is installed in the computer and registered. Photron Motion Tools lists all available cameras in the menu flyout.
Save Annotations	Save annotations for the current opened video.
Load Analysis	Load previously saved tracked point information from an analysis data file (*.pmttrack)
Save Analysis	Save the tracked point information to an analysis data file (*.pmttrack)
Most Recent Opened…	Displays the 10 most recently opened files
Exit	Closes Photron Motion Tools and saves the configuration information

Options

Configuration Options	Displays a list of system features and options that can be selected (checked) or deselected (unchecked)

Automatically overwrite existing files	When selected, Photron Motion Tools will prompt before overwriting previously saved files.
Auto-load data when loading video	When selected, Photron Motion Tools will automatically look for and, when present, load associated data with video.
Automatically update GPS information	When selected, Photron Motion Tools will update the GPS location information every second. This feature may effect live view rate.
Disable web hyperlinks from logos	When selected, Photron Motion Tools will not open the computer browser when the operator clicks on one of the hyperlink logos in the application.
Automatically display filenames for image sequences	When selected, Photron Motion tools will display the name of the file that is associated with the image being displayed. This applies only when the video is loaded from a sequence of image files.
Reduce flicker in live and playback view	When selected, Photron Motion Tools will reduce the refresh flicker in the view windows. This feature may moderately slow down the live refresh rate and the maximum achievable playback rate.
Prompt before closing camera playback views	When selected, Photron Motion Tools will ask for verification before closing a camera playback view so that any modifications or associated analysis will not be lost.
Enable Overheat Protection	When selected, Photron Motion Tools will enable the automatic overheat circuitry for the open cameras. This circuitry reduces the frame rate and resolution when the camera reaches an overheat state. This feature protects the camera from permanent damage.
Show Play Controls under Video Window	When selected, the Play control bar will appear beneath each playback video window.

Record Options	Displays a list of recording features and options that can be selected (checked) or deselected (unchecked)
Live data graphing while recording	When selected, Photron Motion Tools will display a live data graphing (if module is licensed) while recording video. Deselect this feature if degradation of computer performance is noticed during recording.
Live video while recording	When selected, Photron Motion Tools will display live video while recording. Deselect this feature if degradation of computer performance is noticed during recording.
Automatically synchronize playback views	When selected, Photron Motion Tools will automatically synchronize all playback views to the trigger frame when doing a multi-camera recording.

	Apply settings to all cameras simultaneously	When selected, Photron Motion Tools will send any camera parameter (e.g. frame rate, shutter) changes to all open cameras simultaneously.
Analysis Options		Displays a list of analysis features and options that can be selected (checked) or deselected (unchecked)
	Show Features	Allows the user to display feature information in the current frame or in all frames. Also allows users to open separate tracking zoom boxes for features 1, 2, 3 and 4. Tracking zoom boxes follow the object(s) being tracked during the auto-tracking process.
	Auto Advance	When selected individually, Photron Motion Tools will automatically advance to the next feature and/or the next frame when a feature is selected during analysis. If selected, auto-advancing allows for faster manual analysis.
	Lines Between Features	When selected individually, Photron Motion Tools will draw lines between the visible features in the current frame or in all frames.
	Export Settings	When selected individually, Photron Motion Tools will default to exporting track data to a text file, a blank Excel spreadsheet or to a pre-defined Excel Template (Enhanced version only).
	Automatically enable reticle	When selected, Photron Motion Tools will automatically enable the drawing of a reticle for every file that is opened.
Color Selection Scheme		Allows the user to change the appearance of Photron Motion Tools application window, Control Bar and Workspace.

View

Control Bar	When selected (checked), displays the Control Bar
Status Bar	When selected (checked), displays the Status Bar
View Max	Maximizes the viewable area of the current video window within the workspace
View 400%	Sets the viewable area of the current video window to be 400% of the actual size
View 200%	Sets the viewable area of the current video window to be 200% of the actual size
View Actual	Sets the viewable area of the current video window to be actual recording size. For example, if the video was recorded at 512x512 pixels, it will be displayed at 512 x 512 pixels. If the full image does not fit on the screen, the window will zoom in on a portion of the video that will fit on the screen at the actual recording size.
View 50%	Sets the viewable area of the current video window to be 50% of the actual size
View 25%	Sets the viewable area of the current video window to be 25% of the actual size

the actual size

Fit in Window	Resets the viewable area of the current video window to fill the window. If the video is zoomed, it will de-zoom the window to full size.
Zoom Image	When selected, puts Photron Motion Tools into a mode where the mouse motion zooms and de-zooms the video image. When the mouse cursor is moved upwards on the image, zooms the image. When the mouse cursor is moved downwards on the image, de-zooms the image. To return to normal mouse functionality, de-select zoom image from the menu.
Pan Image	When selected, puts Photron Motion Tools into a mode where the mouse motion pans the video image. When the mouse cursor is moved in any direction, the viewable portion of the image follows the mouse motion. To return to normal mouse functionality, de-select pan image from the menu.
Enable Reticle	When selected, places a reticle on the screen.
Show Reticle Position	Opens a small window that displays the X and Y position of the reticle, in pixels measured from the upper left corner of the image.
Zoom Map Location	When the image is zoomed, a zoom map is drawn to show the current visible area and the complete image area. You can set the location for the zoom map to be in any of the four corners or the image, or hidden.
Info Display Location	General information about the video can be displayed over the image. You can set the location for the information display to be in any of the four corners or the image, or hidden.

Tools

Synchronized Data…	Opens a window that allows a user to set up synchronized data acquisition.
GPS/IRIG Timing…	Opens a window that allows a user to set up recording of synchronized time from an external time generator.
Automated Download…	Opens a window that allows a user to set up the Automated Download feature
Annotation…	Opens a window that allows a user to set up the Annotation feature.
Video Measurements…	Opens a window that displays the location, distance, displacement and velocity of the tracked points.
Description…	Opens a window that allows a user to enter a short text description of the file. The description is saved with the video file and reloaded with the file.
Camera Settings	Opens a window that allows a user to set up and label the camera.
Image Settings	Opens a window that controls the image processing settings.
Sync all videos on zero frame	Synchronizes all open videos to one another based on their zero frames.

Mode

Record Video Only	Sets Photron Motion Tools to record video only
Record Video and Data	Sets Photron Motion Tools to record synchronized data with video. This option is available only if the Data Acquisition module is licensed.
No Time Sync.	Sets Photron Motion Tools to only use the camera and operating system clocks for labeling time.
GPS/IRIG Time Sync.	Sets Photron Motion Tools to look for and, if present, record timing information from an external generator.
Record on Trigger	Sets Photron Motion Tools to record a single video sequence when an external trigger is received or the user presses the **Trigger** button. Uses the trigger percent information entered by the user on the Record Tab to set the recording parameters.
Burst Record on Trigger (BROC)	Sets Photron Motion Tools to record a burst of frames whenever an external trigger is received or the user presses the **Trigger** button. The operator sets the number of burst frames from a small window that opens when this mode is selected.
Trigger Using Hand-Switch	Sets Photron Motion Tools to expect a trigger signal using a contact-closure hand-switch.
Trigger Using External Logic	Sets Photron Motion Tools to expect a trigger signal using a TTL signal.

Window

Cascade All	Overlays all the open windows in a standard Windows cascade pattern.
Tile All	Tiles all the open windows in a standard Windows tile pattern.
Tile Cameras	Tiles only the open camera windows either horizontally or vertically.
Tile Videos	Tiles only the open video windows either horizontally or vertically.
Arrange Icons	Arranges all the minimized window icons in a standard Windows stack.
Maximize	Maximizes the Photron Motion Tools application on your Windows desktop.
Minimize	Minimizes the Photron Motion Tools application to a small icon on the Windows desktop
Restore	Restores minimized Photron Motion Tools icons to previous size.
Close All	Closes all open windows.
Open Windows	Lists all the open windows. The currently active window is checked.

Help

Keyboard Accelerators	Displays a summary of the keyboard accelerators for Photron Motion Tools.
About Photron Motion Tools	Opens the About box to show the version number and other information.

Contextual Commands

Most commands and features that are available in the Control Bar, Menu Bar and tabs can also be accessed through Contextual Commands – right clicks. The contextual commands change depending on where you click. Contextual menus are valuable when the Control Bar is hidden.
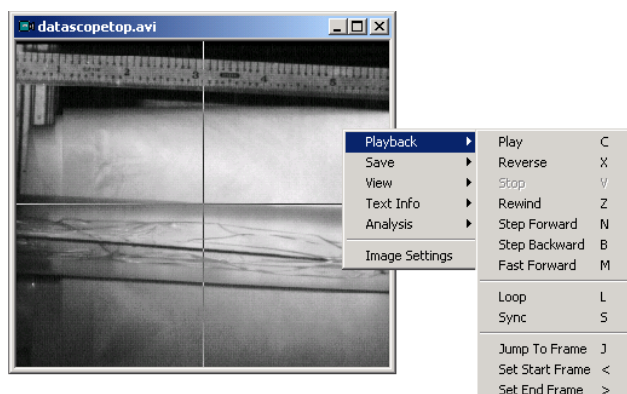
Keyboard Shortcuts

Many of the commands and features that are available in the Menu Bar can be accessed through Keyboard Shortcuts. Each command has one underlined letter or number in its title. To navigate the menu bar with keyboard shortcuts, hold down the **ALT** button and click on the top-level menu item (e.g. **F** for File, **V** for View, **M** for Mode, etc.). This will display the submenu. To access any of the submenu items, click on the associated submenu shortcut. For example, to set the current image to actual size, hold down the **ALT** key and press **V**, then **3**.
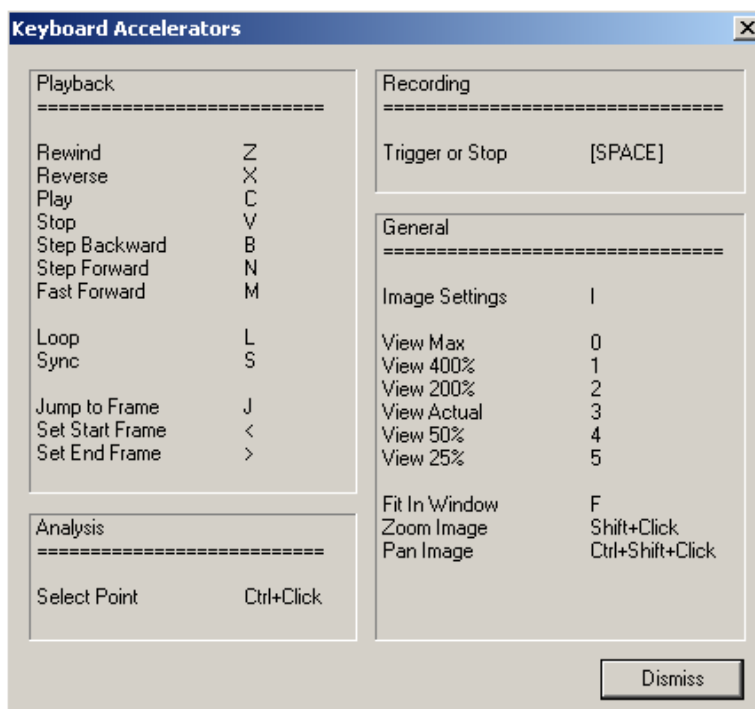
Keyboard Accelerators

Many commands and features that are available in the Control Bar, Menu Bar and tabs can also be accessed through Keyboard Accelerators. In addition to standard Windows accelerators, the list of additional accelerators is shown below. This window can be displayed by selecting **KEYBOARD ACCELERATORS** from the **HELP** menu.

Corporate and User Logo

Each user may insert a logo into the Photron Motion Tools application. Logos must be 215x85 pixels (long x tall) RGB color bitmap (*.bmp) files. To insert a logo:

1. Create the logo using a standard graphics program such as Adobe Photoshop ®.

2. Save the logo in Windows bitmap form (*.bmp)

3. Copy the bitmap file into the same folder that contains the file **PHOMOTO.EXE** (typically **C:\PROGRAM FILES\PHOTRON\PHOTRON MOTION TOOLS**\).

4. Rename the bitmap file as **CORPLOGO.BMP**

5. Open a text file using a standard word processor program such as MS Word or MS Notepad.

6. Type the internet hyperlink destination, in the form http://www.url.com.

7. Save the text file in Windows text form (*.txt)

8. Copy the text file into the same folder that contains the file **PHOMOTO.EXE** (typically **C:\PROGRAM FILES\PHOTRON\PHOTRON MOTION TOOLS**\).

9. Rename the text file as **CORPLOGO.TXT**

Internet Hyperlinks

Photron Motion Tools contains four (4) Internet hyperlinks, as follows:

Photron Logo | When a user clicks on the Photron logo, Photron Motion Tools opens the default system internet browser and directs the browser to http://www.photron.com/motiontools.html

Corporate Logo | When a user clicks on the corporate logo, Photron Motion Tools opens the default system internet browser and directs the browser to the link found in the file **CORPLOGO.TXT**.

Tech support | When a user clicks on the tech support link in the About box (under Help), Photron Motion Tools opens the default email system and prepares an email to techsupport@photron.com.

Photron Link | When a user clicks on the Photron link in the About box (under Help), Photron Motion Tools opens the default system internet browser and directs the browser to http://www.photron.com.

Displaying Images in Standard Windows

Photron Motion Tools can display images in two views –standard windows or in frames. To flip between windows viewing and frame viewing, use the Minimize, Restore and Maximize buttons located to the upper right of the window (window view) or to the right of the menu bar (frames viewing).

In standard windows view, the video image is contained within a standard window, as shown below:

In this view (Photron Motion Tools default), the user can change the image size (magnification) in two ways:

1. Grab the corner of the window and drag

2. Use the zoom view feature.

If the image is larger than the window container (e.g. the image is zoom magnified within a window), then the view size will be larger than the visible size, as shown in the Status Bar. The visible size will never exceed the view size -- there is no black space around the image.

Changing the view sizes from the menu bar or context menus sets both the image and the window container to be equal and to the desired size.
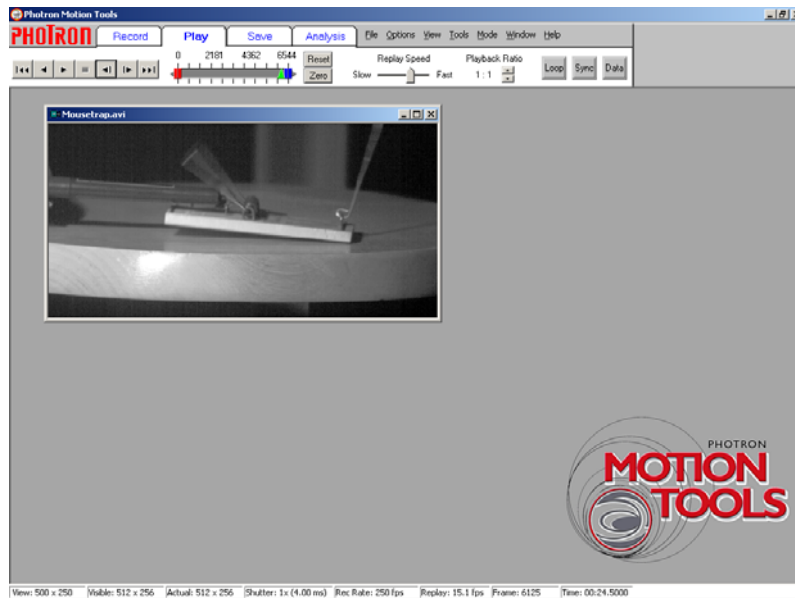
Displaying Images in Frames

In maximized viewing mode, only one image at a time is visible on the screen, as shown below:

To magnify or minify the image within the frame, simply use the View options or zoom options. The visible resolution (number of pixels) will be displayed in the status bar.

If the visible resolution exceeds the view resolution (e.g. the image is magnified), a small zoom map will be displayed that illustrates the current visible size and position relative to the overall view size and location. The zoom map position may be moved to any corner of the screen by right clicking within the window and selecting **ZOOM MAP LOCATION**, then selecting the location or selecting **HIDE ZOOM MAP**.
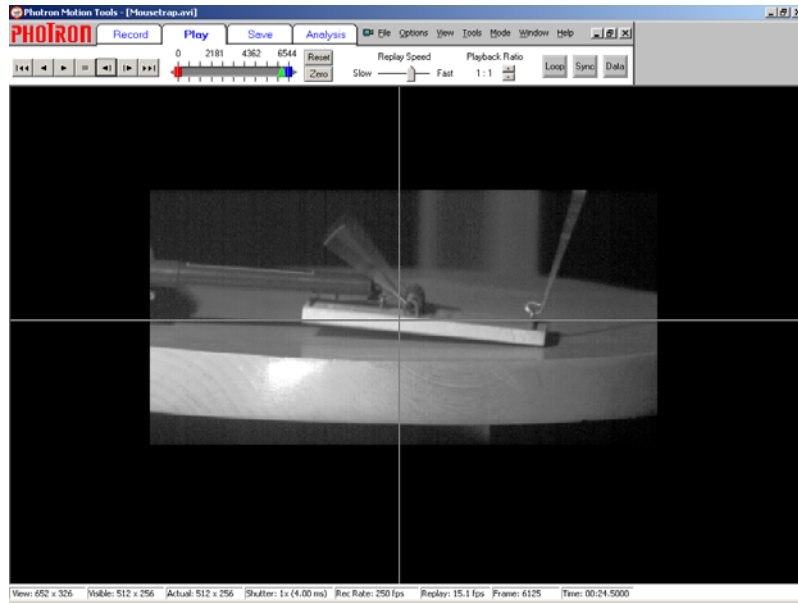
Displaying Timing Information

To view timing information associated with a video, right click within the image, select **TEXT INFO** and then the desired information.

Timing	The universal time. If an external time code generator is enabled, the time from that generator is displayed. If no external time code generator is attached or if phase lock is lost, the local time from the computer OS will be displayed. In addition, the source of the time is displayed.
Trigger	The trigger time, in universal time. If an external time code generator is enabled, the time that the trigger was received is displayed. If no external time code generator is attached or if phase lock is lost, the local time from the computer OS will be displayed.
Location	The latitude, longitude and altitude, as recorded from the GPS system.

Displaying Play Controls under each Video Window

To display the standard play controls under each video window, select **OPTIONS** and then check this feature. When selected, the Windows standard play controls will be appended to the bottom of each playback window.
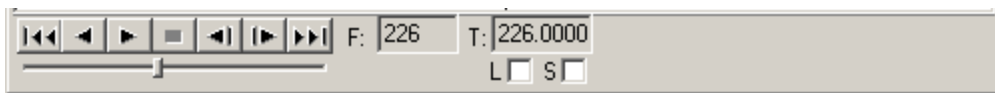
Recording Video

Acquiring video is the fundamental component of Photron Motion Tools. This section contains the basic video acquisition theory and the instructions for acquiring video in stand-alone mode. You are referred to the above chapters for more information on advanced recording modes.

In a simplistic form, Photron Motion Tools controls video cameras, instructing them how and when to acquire pictures and what to do with the acquired information.

Master/Slave and Position In Chain

When using a camera in combination with another camera or other device (e.g. Data Module or GPS/IRIG Module), each camera must be set to be in "Slave" mode. There are different methods for setting this mode, depending on your camera type. Refer to your camera hardware manual for specific instructions.

In addition to setting the cameras to "Slave" mode, synchronization connections must be made between the cameras or between the other devices and the cameras. See the camera hardware manual for camera interconnections and see the Data or GPS/IRIG sections of this manual for external interconnections. Remember the order in which the connections are made. The series of connections between devices forms a chain.

If only cameras are present, then the camera occupying chain position 1 is considered the "master" camera and the subsequent cameras are synchronized to the master camera clock source. In other words, subsequent cameras only capture a frame when the master camera (chain position 1) sends a synchronization pulse to the other cameras. If another device is present, such as the Data or GPS/IRIG module, this device should be the first in the chain. This device is then the master and all cameras are slaves. See the Data or GPS/IRIG sections for more information regarding these recording configurations.

Opening Camera(s)

Photron Motion Tools knows which camera(s) are properly installed in the computer. It will label the cameras correctly for your selection. To open a series of cameras:

1. Click on **FILE**, then **OPEN CAMERA**.

2. Click on the master camera.

Open subsequent cameras by simply opening the cameras in the sequence that they are connected on the hardware chain.

3. Click on **FILE**, then **OPEN CAMERA**.

4. Click on the next camera in the chain.

After you open each camera, the title bar above the live camera frame will display the camera label and the position on the daisy chain.

Setting up a Recording

In the Control Bar, the Record tab contains the important information to set up a recording.
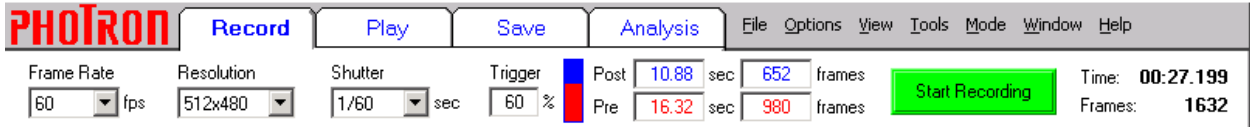
To record a video image, you must configure the camera from within Photron Motion Tools. The software settings for the record functions are found on the record tab and in contextual menus, as follows:

Frame Rate	The frame rate drag-down box displays the available video frame rates. The rates are determined by the camera hardware in the computer.
Resolution	The available resolution settings for the camera. For each frame rate chosen, only certain resolutions are available. Choose the desired resolution from the list shown.
Shutter Speed	Select the shutter speed from the drag down box. The shutter speed denotes the amount of time that the electronic shutter remains "open" during each frame. Shorter exposure times reduce blur within each frame, but at the expense of light collecting ability. The shutter speeds and exposure times are determined by the camera hardware in the computer. The default is set to the inverse frame rate (open shutter).

To optimize the image quality or to change the camera label that appears in the title bar, click on **TOOLS**, then **CAMERA SETTINGS**. The following dialog box appears.
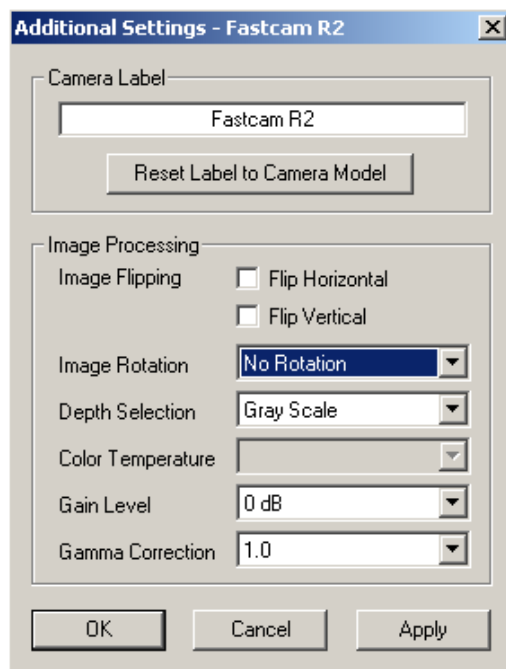
You can also access this dialog box by right-clicking within the window and selecting **CAMERA SETTINGS**.

The settings and display information on the Additional Settings window are as follows.

Camera Label	The camera label is used to describe the camera in all Photron Motion Tools window title bars and drag down lists. To change the camera label, simply type the new label in the white box. The label in the title bar will change immediately. The label of the camera in the menu drop down box will change the next time you launch Photron Motion Tools.
Image Flipping	Select Flip Horizontal and/or Flip Vertical to flip your image. This flipping is analogous to putting a mirror between you and the image. Flipped images are saved in their flipped format.
Image Rotation	Image rotation is used to simply rotate the view. The aspect ratio is preserved. Select from No Rotation, Rotate +90 deg, Rotate +180 deg, Rotate +270 deg. Rotated images are saved in their rotated format.
Gamma Correction	Gamma correction affects the brightness of the resulting image. A gamma of 1.0 indicates that the system is precisely reproducing the brightness of the scene. Gammas of less than 1.0 cause the curve to shift downward, resulting in softer edges and more contrast.
Color Temperature	Allows the user to apply standard color temperature filters to the displayed video.
Depth	The depth parameters determine which colors are displayed. The options are as follows:
	Red Only – displays the red pixels only
	Green Only – displays the green pixels only
	Blue Only – displays the blue pixels only
	Grayscale – converts color or multi-bit cameras to 8-bit monochrome grayscale
Gain Control	Applies an amplification factor to the camera, boosting the signal and noise levels. Gain is primarily used to compensate for low light or bright light levels.

Setting up the Trigger

The video and data is collected into synchronized revolving memory buffers in a first-in-first-out basis. Therefore, the most recently streamed information is always available in the memory buffer. Photron Motion Tools will continue to infinitely record into the revolving memory buffers until a trigger event is received. A trigger event is either a software trigger or a hardware trigger.

Triggering causes two events to happen:

1.   Stop the recording at the desired time.

2.   Isolate the exact point in time that the trigger input was received by Photron Motion Tools hardware.

The user sets the Trigger Percent (on the Record tab) to tell Photron Motion Tools when to stop the recording and where to put the Reference Frame 0 (video) and the Reference Datum 0 (data). The trigger percentage is the pre-trigger percentage of the total acquisition. For example, a trigger percentage of "0%" instructs the Photron Motion Tools software to (1) continue to acquire one full buffer of images (acquire 0% before the trigger and 100% after the trigger) and (2) to put the Reference Frame 0 at the beginning of the sequence. Alternatively, a trigger percentage of "100%" instructs the Photron Motion Tools software to (1) stop acquisition

immediately upon receipt of a trigger input (acquire 100% before the trigger and 0% after the trigger) and (2) to put the Reference Frame 0 at the end of the sequence.

In the resulting captured sequence, frames with negative numbers are BEFORE the trigger pulse was received and frames with positive numbers are AFTER the trigger pulse was received.

Photron Motion Tools places the Reference Frame 0 and the Reference Datum 0 per the following rules. The term "buffer" refers to the revolving memory buffer, "Trigger" refers to either clicking on the **TRIGGER** button or executing an external trigger, and "Abort" refers to clicking on the **ABORT** button.

If...	What is returned...	Reference Frame is ...
Buffer has been filled prior to Trigger	A full buffer of video/data	On the frame corresponding to when the trigger was received.
Buffer has not been filled prior to a Trigger	All frames acquired prior to Trigger and the desired number of post-trigger frames. For certain cameras that are only capable of recording full buffers (e.g. Fastcam PCI), the pre-trigger frames that were not filled prior to a Trigger will be from a previous recording or random.	On the frame corresponding to when the trigger was received.
Buffer has not been filled, Trigger executed, then Abort	All frames acquired prior to pressing Abort	On the frame corresponding to when the trigger was received.

The software settings for the Photron Motion Tools trigger functions are found on the record tab and in contextual menus, as follows:

Trigger Percent	Trigger percentages are selectable using the vertical scroll bar from 0% to 100% in 1% increments. You may also type in a value into the trigger box
Pre-Trigger Time	Display only. The amount of record time to be acquired prior to the trigger input.
Post –Trigger Time	Display only. The amount of record time to be acquired after the trigger input.
Pre-Trigger Frames	Display only. The number of frames to be acquired prior to the trigger input.
Post-Trigger Frames	Display only. The number of frames to be acquire after the trigger input.

Photron Motion Tools works with both the Hand Switch (TS) or External Logic (TT) triggers. For highest accuracy, you must select where the trigger is connected. To select the trigger mode:

1. Select **MODE**, and select either **TRIGGER USING HAND SWITCH (TS)** or **TRIGGER USING LOGIC (TT)**, depending on where you have connected the external trigger cable to the cameras.

✓	Trigger Using Hand-Switch
	Trigger Using External Logic
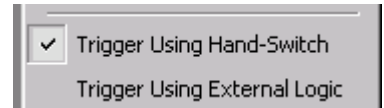
Recording a Video Image:

In Photron Motion Tools, the camera is always updating the live image on the screen, except when the video window is minimized. After opening up the cameras and setting up both the record parameters and trigger parameters per the above instructions, you are ready to record a video.

1. Click on the green **RECORD** button. The button changes to yellow and says **AWAITING TRIGGER**. During this state, Photron Motion Tools is continuously streaming video to the camera revolving memory buffer.

2. To stop the recording, either (a) click on the AWAITING TRIGGER button or (b) send an external trigger pulse to the cameras. Either of these functions has the same effect – to stop record function per the trigger settings (pre-record time and post-record time) and place the Reference Frame 0 at the trigger point of the sequence. After a trigger has been received, no other action is necessary. After a trigger has been received, the button changes to a red ABORT RECORDING button.

3. To abort a recording after having sent a trigger, simply click on the ABORT RECORDING button. Photron Motion Tools will immediately stop recording and return the video already captured prior to receiving the abort command, including the correct trigger point.

The following information is displayed on the status bar during recording:

View	Shows the current image size, in pixels.
Visible	Shows the current size of the viewable area, in pixels.
Actual	Shows the record resolution, in pixels.
Shutter	Displays the shutter speed, in inverse ratio to the record rate (1x, 2x, etc.) and the exposure time in milliseconds.
Automated Download Mode status	Shows whether Automated Download mode has been selected (on) or not (off)
Record Mode	Shows the current record mode (Record on Trigger or Burst Record on Command)
Trigger status	Shows the current trigger status. When an external trigger or a software trigger pulse is received, this selection changes from "No Trigger" to "Trigger Activated"
Live	Shows the current camera mode. In Photron Motion Tools, the camera is always updating the live image on the screen ("Live"), except when the video window is minimized ("Idle").

Image Settings

To modify the appearance of the image during recording, click on **TOOLS**, then **IMAGE SETTINGS**. The following screen appears:

This screen allows you to set all the parameters about the image, save your settings and restore them for later use. Note that there are the same sets of sliders for color and monochrome (black and white) images. For the color settings, the individual red, green and blue channels of the color images can be independently adjusted or, if linked, adjusted as a group. The channel sliders for red, green, and blue can be hidden or kept fixed by clicking on the R, G, and B buttons above each column.

The various image settings are:

Brightness	Adjusts the brightness of the image. The brightness of the image is the maximum white level.
Contrast	Adjusts the contrast of the image. The contrast of the image is the normalized ratio of whites minus blacks.
Gamma	Adjusts the gamma of the image. The gamma of the image affects the brightness of the displayed result on your monitor.
Exp./Log.	Adjusts the exponential/logarithmic palette function. With a normal palette, '0' is black and '255' is white and the ratio of the input to output is linear. That is, input 134 maps to output 134. By adjusting this value, you can change the slope of the input/output curve to be either exponential (more blacks) or logarithmic (more whites).
Reverse	Changes the color palette such that whites and blacks are reversed.
Convert to B&W	Converts color images to monochrome images using the conversion factors indicated by the R, G, and B sliders.
Reset	Sets all the functions to their default levels.
Load from File	Allows previously stored image settings to be loaded for this image.
Save to File	Allows you to save certain image settings into an LUT (Look Up Table) format for later retrieval.
Dismiss	Closes the window with the current settings.

Aborting a Recording

To abort a recording at any time.

1. Right click within the recording window.

2. Select Record.

3. Select Abort Recording

Record	▶	Start Recording
View	▶	Send Trigger
Camera Settings		Abort Recording
View Last Recording		Frame Rate ▶
Image Settings I		Resolution ▶
		Shutter ▶
		Trigger ▶
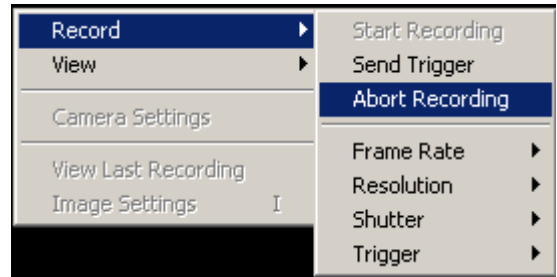
Rescuing a Previous Recording

Occasionally, you will need to access the video images that are stored in the camera memory. This may be because a camera is not interconnected properly or you forgot to save the images.

To access a recording from memory:

1. Right click within the recording window.

2. Select View Last Recording.

Record	▶
View	▶
Camera Settings	
View Last Recording	
Image Settings I	

Playing Recorded Video

When the recording is complete:

      (1) the Play tab will appear on the Control Bar,

      (2) a Video Playback window will automatically appear for each camera in the recording, and

      (3) the live video display window is minimized for later use.

The Play Tab

This tab controls all the playback functions from within Photron Motion Tools, whether they include stored images residing in the memory of the frame grabber boards for single or multiple cameras, saved video sequences on hard drives, saved sequences of images on hard drive, or synchronized data located on the hard drive. Photron Motion Tools Play tab synchronizes multiple images and allows users to seamlessly interface with all the data in one simple format.
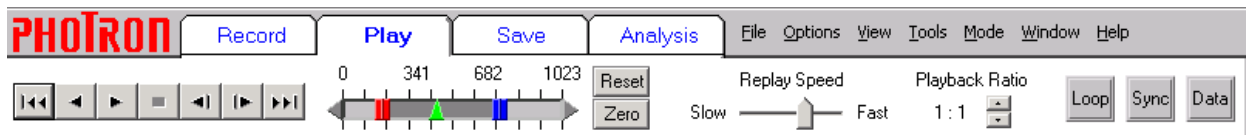
Playback control is established using the following features of the Play tab:

Controls	The following controls are available:	
	• Skip backward to beginning	
	• Play Backward	
	• Play Forward	
	• Fast Rewind	
	• Fast Forward	
	• Stop (square box)	
	• Skip forward to trigger point, then to end	
Slide Bar	The slide bar allows the operator to quickly move to a specific part of the playback cycle. Just click on the center triangle (green) of the slider and, holding down the left mouse button, drag the slider to the desired position. The frame numbers are displayed directly above the slide bar. The active area is displayed in red. The inactive area is displayed in gray.	
Slide Bar Range Brackets	The slide bar range brackets are used to establish the beginning and end of the playback range. The range brackets are two squares (blue) with a red interior. To approximately select the beginning of the playback range, click on the left square and, holding down the left mouse button, drag the slider to the desired position. To fine-tune your range, click on the arrows at the end of the slide bar.	
Reset	Resets the slide bar range brackets to the beginning and end of the recording.	
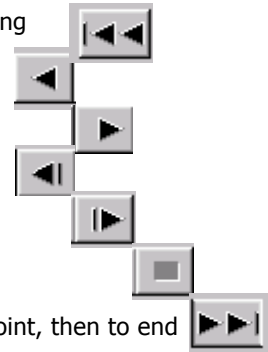
Zero	By clicking the **ZERO** button, the current frame of the video playback is reset to become the Reference Frame 0 and the current datum is reset to become the Reference Datum 0. Set Current Frame to Zero cannot be undone from within Photron Motion Tools.
Replay Speed	The actual playback rate on the computer screen is determined by many factors, including the number of synchronized images, the video RAM and the speed of the computer processor. Therefore, Photron Motion Tools provides a slider between "slow" and "fast". Set the relative speed of playback by clicking on the center post of the slider and, holding down the left mouse button, drag the slider to the desired position. Read the actual playback rate in the box below.
Playback Ratio	This feature allows the operator to speed up the display update rate by skipping frames. Default is 1:1, indicating that every frame of the video is displayed when playing.
Loop	By clicking on this button, the playback is continuously looped between the playback brackets. When this button is not selected, the playback stops at the end of the selected range.
Sync	To synchronize multiple images in playback, set each video image to be synchronized to its desired location. Highlight each video by clicking anywhere within the image, then click on the **SYNC** button. Repeat for each video you wish to synchronize. To remove the synchronization, simply highlight the playback window of the file and deselect the **SYNC** button.
Data	By clicking this button, synchronized data is displayed with video, if present.

The following displays are found on the Play tab during playback:

View	Shows the current image size, in pixels.
Visible	Shows the current size of the viewable area, in pixels.
Actual	Shows the record resolution, in pixels.
Shutter	The shutter speed of the original recording, in inverse ratio to the record rate (1x, 2x, etc.) and the exposure time in milliseconds.
Recorded Frame Rate	The rate at which the video was originally recorded, if available.
Average Replay Rate	The rate at which the video is actually being played on your display, in frames per second. .
Frame Number	The current frame number
Time	The time associated with the current frame

Image Settings

To modify the appearance of the image during playback, click on **TOOLS**, then **IMAGE SETTINGS**. The following screen appears:

This screen allows you to set all the parameters about the image, save your settings and restore them for later use. Note that there are the same sets of sliders for color and monochrome (black and white) images. For the color settings, the individual red, green and blue channels of the color images can be independently adjusted or, if linked, adjusted as a group. The channel sliders for red, green, and blue can be hidden or kept fixed by clicking on the R, G, and B buttons above each column.

The various image settings are:

Brightness	Adjusts the brightness of the image. The brightness of the image is the maximum white level.
Contrast	Adjusts the contrast of the image. The contrast of the image is the normalized ratio of whites minus blacks.
Gamma	Adjusts the gamma of the image. The gamma of the image affects the brightness of the displayed result on your monitor.
Exp./Log.	Adjusts the exponential/logarithmic palette function. With a normal palette, '0' is black and '255' is white and the ratio of the input to output is linear. That is, input 134 maps to output 134. By adjusting this value, you can change the slope of the input/output curve to be either exponential (more blacks) or logarithmic (more whites).
Reverse	Changes the color palette such that whites and blacks are reversed.
Convert to B&W	Converts color images to monochrome images using the conversion factors indicated by the R, G, and B sliders.
Reset	Sets all the functions to their default levels.
Load from File	Allows previously stored image settings to be loaded for this image.
Save to File	Allows you to save certain image settings into an LUT (Look Up Table) format for later retrieval.
Dismiss	Closes the window with the current settings.

Displaying Play Controls under each Video Window

To display the standard play controls under each video window, select **OPTIONS** and then check this feature. When selected, the Windows standard play controls will be appended to the bottom of each playback window.
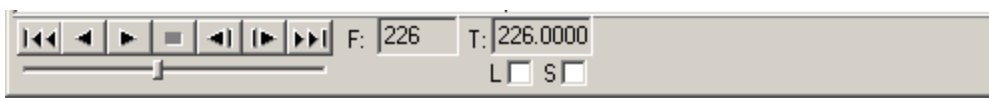
Displaying Playback Information inside the Window

To display a summary of the playback information overlaid on top of the video window, right-click, select **VIEW** and then select **INFO DISPLAY LOCATION**. Then select where in the video you want the information to be displayed (e.g. upper left corner, upper right corner, lower left corner, lower right corner). When selected, the Windows standard play controls will be overlaid on the window during display only. To turn this display off, simply select **HIDE**.
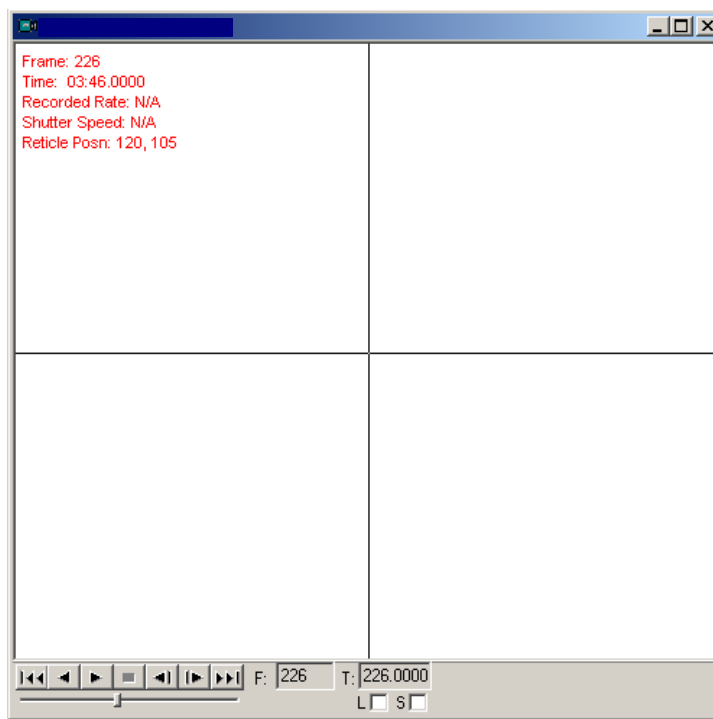
Saving Video

The Save Tab

The Save tab contains many of the same features of the Play tab with the following exceptions/additions:

Start Frame	The first frame number of the region of images to be saved. This is also defined as the left slide bar range bracket.
Stop Frame	The last frame number of the region of images to be saved. This is also defined as the right slide bar range bracket.
File format	The video save format, as follows:
	AVI -- Windows video (AVI) format
	JPG – series of sequentially numbered JPEG image files (one per frame)
	BMP – series of sequentially numbered bitmap image files (one per frame)
	TIFF – series of sequentially numbered tiff image files (one per frame)
	Data will automatically be saved in a tab-delimited text format with video.
Estimated files size	Display only. Shows the estimated amount of hard drive space required prior to compression.

To Save Video and Data

1. Set the save parameters per the above settings.

2. Click on the green **SAVE** button. The following window appears.
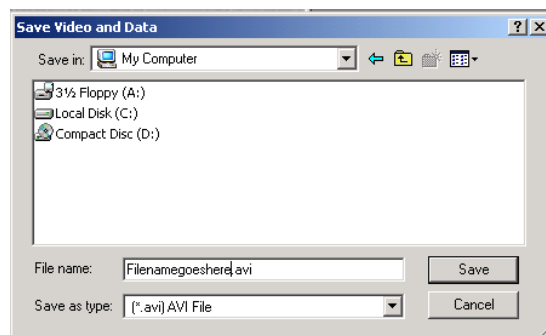
3. Select the destination folder.

4. Type in the file name. Photron Motion Tools adds the file extension.

5. Change the file type, if not correct.

6. Click **SAVE**.

Applying Video Compression Codecs

If you have selected to save a video to an AVI file, Photron Motion Tools will present you with the Video Compression Dialog window. The various codecs listed in this dialog are provided by your operating system.

To use video compression:

1. Under the menu item labeled Compressor, select one of the AVI codecs that is listed.

2. Press **OK**.

Note that most compression codecs are "lossy". This means that in order to achieve a level of compression, the exact information from each video frame is not reproduced. The result may be acceptable, but will not be identical to the original uncompressed version.
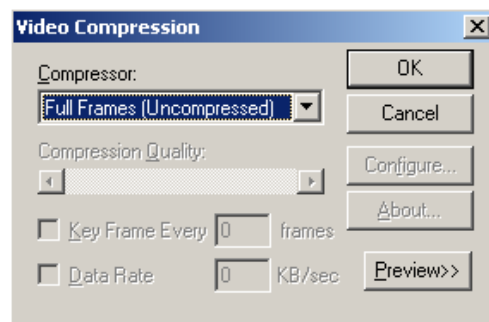
Loading and Importing Files

Using the **OPEN** command under the FILE menu brings up the following screen.

In this dialog window, you may type in the file name to load, or you can click on the specific AVI file.

For loading a sequence of image files, you can click on any image in the sequence and Photron Motion Tools will load the complete sequence of image files that match the same pattern. For example, if you select *Image_001.BMP*, Photron Motion Tools will load all files that match the pattern *Image_ *.BMP*, where "*" is replaced by a frame number only.

The option "Display last real frame…" determines how to handle missing frames in a sequence of image files. If this option is checked, whenever a missing frame (missing file in a sequence) is encountered, the last real frame is displayed instead. If this option is not selected, then missing frames will be ignored and skipped during playback.
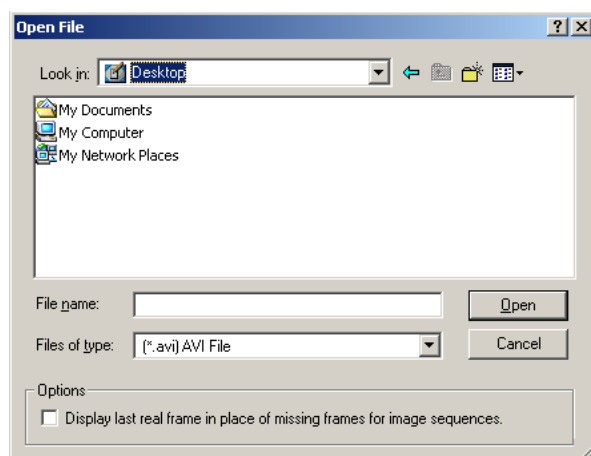
The Photron Motion Tools File Formats

With each Photron Motion Tools measurement you make and save, Photron Motion Tools creates numerous files on your hard drive. It is important to copy all the Photron Motion Tools files when archiving or moving the information. The files are as follows:

AVI	Standard Microsoft Windows Video format. Photron Motion Tools can save video into AVI file format.
BMP	Standard bitmap file format. Photron Motion Tools can save video as a series of sequential BMP images.
TIF	Standard tag image file format. Photron Motion Tools can save video as a series of sequential TIFF images.
JPG	Standard jpeg compressed file format. Photron Motion Tools can save video as a series of sequential JPG images. Note that jpeg compression is "lossy". (see note above on use of codecs)

PMT   Photron Motion Tools configuration file. This file contains configuration information about your measurement so that when you open a measurement back up, Photron Motion Tools or the Photron Motion Tools Player knows the frame rate, shutter speed, etc. of the original recording. This file cannot be edited.

PDT   Photron Motion Tools data files. Tab-delimited text files that contain all the data from a measurement.

PBF   Photron Motion Tools binary file. The Photron Motion Tools Binary File contains the following information in a structured fast access format.

> Annotations
>
> IRIG Timing Information
>
> Trigger Timing Information
>
> GPS Timing Information
>
> GPS Position Information

This file cannot be edited.

CIH   Photron Motion Tools reads CIH files, but does not create a CIH file.

PMTTRACK   Photron Motion Tools file that contains tracking information. This file cannot be edited.

LUT   Look up table information for image settings. This file cannot be edited.

Simple Motion Analysis

NOTE: *This chapter is for users who have installed the default* **Simple Analysis Module** *with Photron Motion Tools. Users who have purchased and installed the* **Enhanced Analysis Module** *should skip to the next chapter, "Enhanced Motion Analysis."*

Tracking Basics

Tracking is the ability to select a distinct feature and determine its frame-by-frame motion characteristics (e.g. position, velocity, etc.) over time, with respect to the plane of the image.

There are two general methods of tracking:

Automatic (Auto) Tracking asks the user to select the feature location in a single initial frame. Auto Tracking then does all the work of stepping through subsequent frames, while automatically finding and tracking the feature along the way. This method is effective for most applications.

Manual Tracking requires the user to step through the video one frame at a time, using the mouse to select the location of the feature in each frame. This method is preferable for low-quality images or very irregular feature paths not suitable for Auto Tracking.

Simple vs. Enhanced Tracking Modules

The **Simple Analysis Module**, explained in this chapter, provides the following basic functionality:

- Manual Tracking of up to 4 features at once

- Auto Tracking of 1 feature

- Standard image calibration with Quick Calibration

- Exportation of tracking data to Microsoft™ Excel spreadsheets

The optional **Enhanced Analysis Module**, explained in the next chapter, provides the following additional benefits:

- Manual tracking of up to **32 features** at once

- Auto Tracking of up to **32 features** at once

- **Feature Editor** – A legend-based control for easy management of feature properties (select, show/hide, Auto Track, Auto Advance-Feature)

- Enhanced image calibration (saving/loading calibration values to/from disk, and **Quick Settings** for setting typical calibrations quickly and easily)

- Saving/loading raw tracking data in addition to exportation to Microsoft™ Excel or to a text file.

- Reverse tracking

- Tracking Zoom Windows

- Exporting analysis data to Excel Templates

Analysis Tab

The **Analysis Tab**, within the Control Bar, contains various controls for assisting in tracking and recording manipulation.
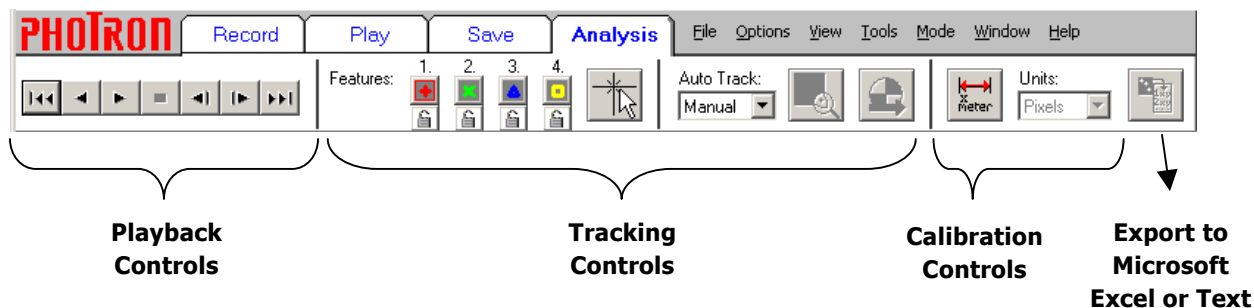
Playback Controls – Identical to those in the Play Tab, these controls are useful for seeking through frames and temporally pinpointing key features for tracking.

Tracking Controls – This is the heart of the Analysis Tab. Here you will find everything you need for both Manual and Auto Tracking, including:

- Choosing among up to four independent feature markers

- Locating and marking features on individual frames

- Selecting regions for Auto Tracking

- Executing the Photron Motion Tools Auto-Tracking algorithm.

Calibration Controls – Calibration gives meaning to the measurements generated by the tracking process. Use these controls to define scales, units of measurement, and coordinate system parameters.

Export to Microsoft Excel or Text – Photron Motion Tools provides the option of exporting your tracking data to Microsoft Excel format or to a tab delimited text file, for easy analysis and presentation. The choice of Excel or Text is selected from the Options menu.

Start Analysis -- To start analysis, click on the Start Analysis icon . This icon appears whenever a new file or recording is opened.

The functions available through the Analysis Tab interface may also be called via other shortcuts, such as right-click contextual menus and keyboard accelerators. These other interfaces can be used at any time, even when the Analysis Tab is not shown (e.g. you can Select and Track a feature during Play mode, using the context menus).

Manual Tracking

The Simple Analysis Module allows the user to track up to four independent features using the markers above. Manual tracking is performed on a per-frame basis; the user cycles through each relevant frame and manually marks the feature locations by clicking the mouse.

1. Select **MANUAL** from the Auto Track droplist to set the current operating mode to Manual Tracking.

2. Unlock the boxes below the features that you wish to include in the Auto Advance-Feature loop. If Auto Advance-Feature is ON, then whenever you mark a feature on the image, Photron Motion Tools will automatically select the next checked feature, skipping over those that are locked.

3. Navigate through the video to the desired frame, using either the playback controls or the keyboard shortcuts.

4. Select the active feature marker by clicking on the feature's icon in the Analysis Tab (e.g 🔲 for feature #2). The active feature is denoted by a red outline around the icon.

5. Locate the feature's position within the current frame. Use the zoom view or zoom window, along with the reticle, to position the crosshairs on the desired feature with single-pixel precision.

6. Click on the **SELECT POINT** icon 🔳. This places the active feature marker on the selected location for this frame. The blue circle ⊕ denotes the marker(s) associated with the current frame. **NOTE:** If you do not see a blue circle, the frame may have advanced automatically; try going back a frame to verify the selection.

7. Repeat steps 4-6 for the current frame. You can change the active feature manually by clicking on the next feature in the Feature Editor, or you can set Auto Advance-Feature to ON (see below) and let Photron Motion Tools select the next feature for you.

8. Once you are done marking the current frame, advance to the next frame and repeat steps 4-7. If Auto Advance-Frame is on, then Photron Motion Tools will advance the frame for you after you have finished marking the current frame.

The following is a summary of the interface shortcuts described above, for quick reference:

Ctrl-click Feature Marking	Mark a track point (feature) quickly by holding down the control key and left clicking with the mouse.
Contextual Menu (right click)	Mark a track point by left clicking on the point, then right clicking and selecting **Analysis,** then **Select Point**.
Auto-Advance to Next Feature	Advance automatically to the next feature when you have marked the current feature. To enable, right click within the image, select **Analysis**, then **Options**, then **Auto-Advance**, then **Feature**.
Auto-Advance to Next Frame	This option will automatically advance the recording to the next frame when all relevant features have been selected in the current frame. To enable, right click within the image, select **Analysis**, then **Options**, followed by **Auto-Advance**, and finally **Frame**.

Automatic Tracking

Photron Motion Tools Auto-Tracking works on the principle of template matching. The user selects a tracking template – a group of pixels within the image. Tracking templates are also referred to as "features" or "regions" of an image. Once the user has selected a "region", Photron Motion Tools advances the video image to subsequent frames and executes a sophisticated correlation algorithm to find a match for the region. If a tracking template match is found in subsequent frames, Photron Motion Tools continues to advance. If no adequate match is found, Photron Motion Tools discontinues automatic tracking. In such a situation, the user can set a new tracking template in the frame in which the previous template was lost, and resume tracking.

To automatically track one region (feature):

1. Select a feature number (1-4) from the Auto Track combination box.

2. Click on the Set New Region icon .

3. Draw a box around the feature you wish to track.

4. Click on the Track icon . Photron Motion Tools will automatically track this region through subsequent frames, using the geometric center of the region as the marker location.

5. When tracking, the Track icon turns into a Stop Tracking icon , which you can click to abort tracking at any time. Otherwise, Photron Motion Tools will continue to track this feature until it can no longer find a good template match or until it reaches the end of the recording sequence.

If Auto Track stops due to a natural template loss, you may continue to track this point manually (please see the section on "Manual Tracking"). Alternatively, to resume Auto Tracking with a new template:

6. Click on the Set New Region icon .

7. Draw a new box around the feature you wish to track.

8. Click on the Track icon . Photron Motion Tools will ask if you wish to use the original template ("Track") or to use the new template ("Select and Track") for tracking from this point forward.

Note: If you change the Auto Track feature number, all previous tracking data is lost.

The following interface shortcuts are available to simplify and expedite the process of auto tracking:

Select Region	You can directly select an auto track region by right clicking anywhere in the image and selecting **Analysis**, then **Select Region**, then drawing a box around the region.
Select and Track	You can directly select an auto track region by drawing a box around the feature, then right clicking and selecting **Analysis**, then **Select & Auto-Track**.
Track Feature	This option will track a feature. Draw a box around the feature, then right clicking and selecting **Analysis**, then **Track Feature**.

Calibrating an Image

Calibrating an image serves the following functions:

1) **converts and scales pixel distances to real-world dimensions** (e.g. inches, meters, etc.)

2) **translates and rotates the coordinate system** to remove any tilt introduced by the camera head

Image calibration requires measurement information about some feature in the image. We suggest that you include a horizontal ruler in the picture or some equivalent frame of reference that has both a well-defined scale and known rotational orientation. After an image is calibrated, you can change the units of measure at any time by selecting from the drop-down list in the Analysis Tab.

Setting the Calibration Scale

To set the calibration scale:

1. Click on the **CALIBRATE** button . The Calibration dialog appears (below).

2. Within the video image, find a known frame-of-reference object. Left-click on one end of the object, using the reticle as a guide.

3. Click on **SET POINT #1** in the "Scale" section of the Calibration dialog.

4. Within the video image, left-click on the other end of the known object. In the Calibration dialog, click on **SET POINT #2**. Type the known unit size of this object into the **DIMENSION** text field, and choose the unit of measure from the drop-down list (e.g. inches, meters, etc.).

5. Click on **CALIBRATE SCALE** button to set the scale factor. The current values will now apply to the currently open recording, until the recording is closed.

Setting the Calibration Scale

To set the calibration scale:

1. Click on the **CALIBRATE** button [icon]. The Calibration dialog appears (see right).

2. Within the video image, find a known frame-of-reference object. Left-click on one end of the object, using the reticle as a guide.

3. Click on **SET POINT #1** in the "Scale" section of the Calibration dialog.

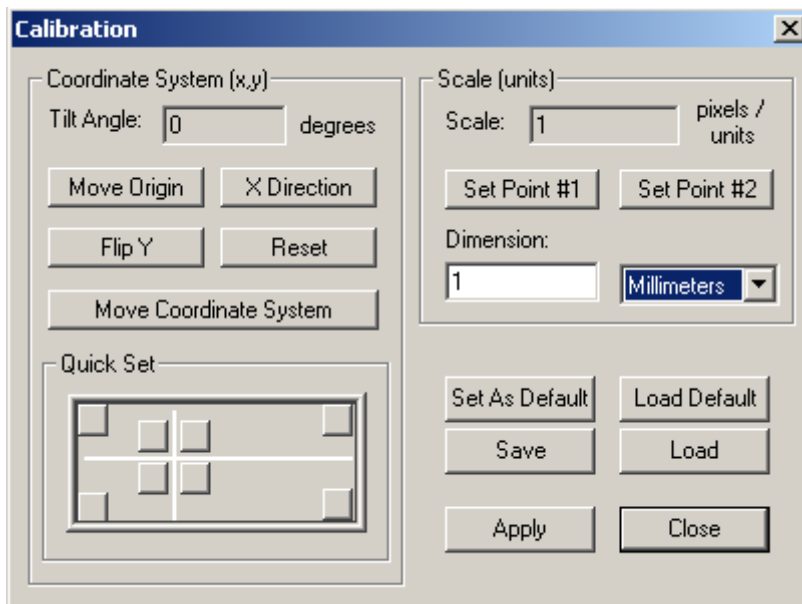4. Within the video image, left-click on the other end of the known object. In the Calibration dialog, click on **SET POINT #2**. Type the known unit size of this object into the **DIMENSION** text field, and choose the unit of measure from the drag-down list (e.g. inches, meters, etc.).

5. Click on **CALIBRATE SCALE** button to set the scale factor. The current values will now apply to the currently open recording, until either the recording is closed, or the calibration settings are saved or loaded (see below).

Calibrating the coordinate system

In addition to scaling calibration, the user may also customize the translation and rotation of a recording's coordinate system.

To calibrate the origin and axes of the coordinate system:

1. Choose a point in the image that will serve as the origin of your coordinate system. Left-click on the point and then click on **SET POINT #1**.

2. Determine the appropriate positive X-axis direction, and left-click anywhere in that direction. Click on **X-DIRECTION**. Photron Motion Tools will draw a line from Point #1 to the X-Direction point; this line represents the X-axis.

3. A default Y-axis will also be drawn at a right angle to the X-axis. To flip the Y axis (e.g. reverse the positive Y direction), click on the **FLIP Y** button.

4. To translate the entire coordinate system and set the origin (0,0) to another location, click on and move the crosshairs within the video to the new desired origin location. Left-click on the new location within the image. Click on **SET ORIGIN**. The coordinate system lines will rearrange themselves for the new 0.0 point.

5. Click on **CALIBRATE COORDINATE SYSTEM** to set the calibration.

6. Click **DISMISS** to finish the calibration sequence.

The Simple Analysis Module includes **Quick Settings**, which are shortcuts for certain common coordinate system configurations.

To use Quick Settings:

1. Click on any of the buttons in the corners of the Quick Set portion of the Calibration Dialog. The coordinate system will align itself to the corresponding corner of the image.

2. Alternatively, you can center the coordinate system at the reticle location in one of four default "quadrant" orientations by clicking on the appropriate quadrant's button in the center of the Quick Set dialog.

3. Click on **CALIBRATE COORDINATE SYSTEM** to set the calibration.

Saving and Loading Calibration Settings

The calibration values that are set using the **CALIBRATE SCALE** or **CALIBRATE COORDINATE SYSTEM** buttons only apply to the current recording, and even then, only until the recording is closed. To keep the values as

defaults for the application, click on **SET AS DEFAULT**. From that point on, any newly opened recording can have its calibrations set to the current default values by clicking on **LOAD DEFAULT**.

However, even if the values are set as the application defaults, closing and reopening a recording will still load the coordinate system in the upper left corner. In particular, you may wish to have different calibration settings for different recordings, rather than one default set.

You may save the current calibration values to disk at any time by clicking on **SAVE** in the Calibration dialog, and providing an appropriate name for the Photron Motion Tools Calibration (.pmtcal) file. The next time you open the recording, you may reload the corresponding calibration values by bringing up the Calibration dialog and clicking on **LOAD**.

Exporting to Excel or Text and other Programs

Photron Motion Tools can export the test and calibration information and the coordinates of each tracked point or feature to Microsoft Excel or to a tab delimited text file. From Excel, you can export to a variety of software packages and text word packages. Each row of the Excel spreadsheet corresponds to a frame. The Excel spreadsheet is print-ready.

To export your analysis to Excel

1. From the **OPTIONS** menu, unselect **EXPORT TO TEXT**.

2. Click on the Export icon . The data will be exported to Microsoft Excel. You must have Microsoft Excel installed on your computer.

To export your analysis to a text file:

1. From the **OPTIONS** menu, unselect **EXPORT TO TEXT**.

2. Click on the Export icon . The data will be exported to text file and opened by Notepad or your default text editor.

Calculating Distance and Velocity

Quick calculation of distance and velocity between points is available using the Video Measurements tool, accessible under the **TOOLS** menu or through the right-click contextual menu.

The information that is displayed (in user units):

Coordinates	X,Y position of the feature relative to the user-defined origin
Distance	Distance of the feature from the user-defined origin
Displacement	Location change (e.g. distance) from the previous frame or tracked point
Velocity	Displacement divided by time, in units/second.

Additional Analysis Options

The following additional features are available through the contextual menus. Right click within an image, then click on **ANALYSIS** and choose from the following features:

Clear All Features in All Frames	Clears all feature markers in the entire recording.
Clear All Features in Current Frame	Clears all feature markers in current frame.
Clear Current Feature from Current Frame Forward	Clears currently active feature marker (e.g. 1-4) from the current frame and from all other subsequent frames.
Clear Current Feature in Current Frame	Clears currently active feature marker (e.g. 1-4) from the current frame only
Show Current Frame	Displays the feature indicators only on the current frame
Show All Frame	Displays the feature indicators for all frames at all times.
Show Calibration Information	Displays the right-angle ruler that identifies the currently set origin, X-direction and Y-direction.
Show Feature Indicator	Displays a legend with the four feature indicators.
Lines Between Features	Enable drawing of lines between features in the current frame or in all frames.

Enhanced Motion Analysis

*NOTE: This chapter is for users who have purchased and installed the **Enhanced Analysis Module** for Photron Motion Tools. Users who have installed the default **Simple Analysis Module** should turn back to the previous chapter, "Simple Motion Analysis."*

Tracking Basics

Tracking is the ability to select a distinct feature and determine its frame-by-frame motion characteristics (e.g. position, velocity, etc.) over time, with respect to the plane of the image.

There are two general methods of tracking:

Automatic (Auto) Tracking asks the user to select the feature location in a single initial frame. Auto Tracking then does all the work of stepping through subsequent frames, while automatically finding and tracking the feature along the way. This method is effective for most applications.

Manual Tracking requires the user to step through the video one frame at a time, using the mouse to select the location of the feature in each frame. This method is preferable for low-quality images or very irregular feature paths not suitable for Auto Tracking.

Simple vs. Enhanced Tracking Modules

The **Simple Analysis Module**, explained in the previous chapter, provides the following basic functionality:

- Manual Tracking of up to 4 features at once

- Auto Tracking of 1 feature

- Standard image calibration

- Exportation of tracking data to Microsoft™ Excel spreadsheets

The **Enhanced Analysis Module**, explained in this chapter, provides the following additional benefits:

- Manual tracking of up to **32 features** at once

- Auto Tracking of up to **32 features** at once

- **Feature Editor** – A legend-based control for easy management of feature properties (select, show/hide, Auto Track, Auto Advance-Feature)

- Enhanced image calibration (saving/loading calibration values to/from disk, and **Quick Settings** for setting typical calibrations quickly and easily)

- Saving/loading tracked pointdata in addition to exportation to Microsoft™ Excel or to a text file.

- Reverse tracking

- Saving/loading image processing look-up tables (LUT)

- Tracking Zoom Windows

- Exporting analysis data to Excel Templates

Analysis Tab

The **Analysis Tab** within the Control Bar contains icons and checkboxes for simplifying tracking, along with the same playback controls found in the Play tab.
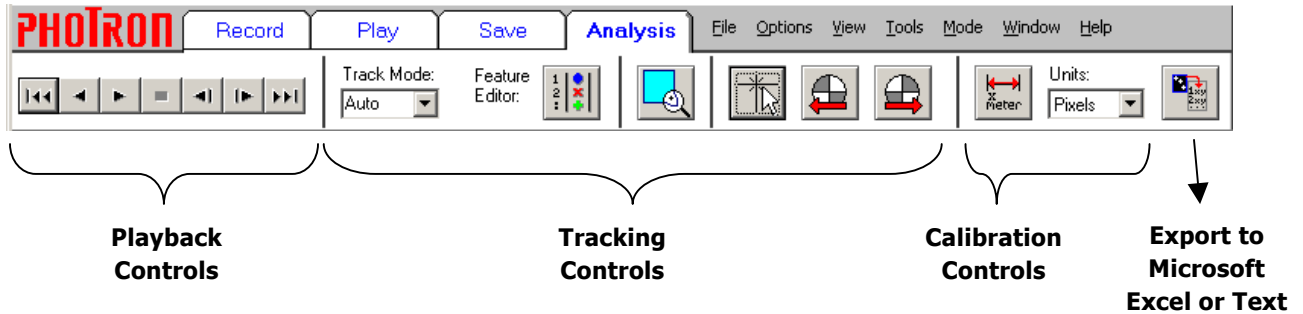
Playback Controls – Identical to those in the Play Tab, these controls are useful for seeking through frames and temporally pinpointing key features for tracking.

Tracking Controls – This is the heart of the Analysis Tab. Here you will find everything you need for both Manual and Auto Tracking, including:

- Choosing among up to 32 independent feature markers

- Locating and marking features on individual frames

- Selecting regions for Auto Tracking

- Executing the Photron Motion Tools Auto-Tracking algorithm, either forwards or backwards

- Saving and Loading raw tracking data

Calibration Controls – Calibration gives meaning to the measurements generated by the tracking process. Use these controls to define scales, units of measurement, and coordinate system parameters. You can also Save and Load calibration settings to and from files.

Export to Microsoft Excel or Text – Photron Motion Tools provides the option of exporting your tracking data to Microsoft Excel format or to a tab delimited text file, for easy analysis and presentation. The choice of Excel or Text is selected from the Options menu.

Start Analysis -- To start analysis, click on the Start Analysis icon . This icon appears whenever a new file or recording is opened.

The functions available through the Analysis Tab interface may also be called via other shortcuts, such as right-click contextual menus and keyboard accelerators. These other interfaces can be used at any time, even when the Analysis Tab is not shown (e.g. you can Select and Track a feature during Play mode, using the context menus).

Feature Options Dialog

The Enhanced Analysis module includes the **Feature Options dialog**, which maintains all of the currently defined features and their properties. Each row corresponds to a unique feature.

Click on the Feature Editor icon [icon] to open the dialog.

Feature Number

Select/deselect up to 32 features through this column. Hold down Ctrl or Shift to select multiple features.

Feature Marker

This symbol marks the tracked locations of this feature on the recording frames.

Feature Lock Setting

This setting toggles whether this feature is locked. When a feature is locked, any of the tracked points for this feature cannot be modified. The feature will also be skipped in any auto-advance cycle.

Visible Setting

Toggles between showing and hiding the feature markers for this feature on the recording.

Auto Tracking Setting

If on, then Auto Tracking is allowed for this feature; otherwise the user must use Manual Tracking.

Add Feature

Adds a new feature to the Feature Editor.

Delete Feature

Deletes the selected feature(s) from the Feature Editor.

Dismiss

Closes the Feature Editor dialog.

Clear Feature

Clears all marked tracking points in all frames for the selected features.

Manual Tracking

The Enhanced Analysis Module allows the user to track up to 32 independent features using the markers in the Features Editor dialog. Manual tracking is performed on a per-frame basis; the user cycles through each relevant frame and manually marks the feature locations by clicking the mouse.

1. Open the Feature Editor by clicking on the Feature Editor icon.

1. Add or delete features using the Add and/or Delete buttons on the Feature Editor until you have the desired number of feature trackers.

2. For those features that you would like to include in the Auto Advance-Feature sequence, unlock the feature in the feature editor. If you are satisfied with the tracking results for a given feature number, or would simply like to exclude it from the auto-advance sequence, lock the feature in the feature editor by clicking on the lock icon.
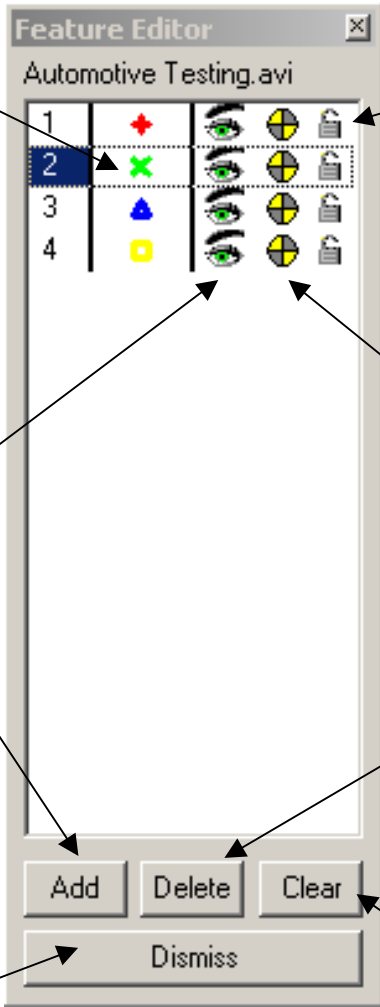
3. Select **MANUAL** from the Track Mode drag-down box.

4. Navigate through the recording video to the desired frame, using either the playback controls or the keyboard shortcuts.

5. Select the active feature marker by clicking on the feature number in the Feature Editor dialog. The active feature is denoted by a dotted line outlining the feature row.

6. Locate the feature's position within the current frame. Use the zoom view or zoom window, along with the reticle, to position the crosshairs on the desired feature with single-pixel precision.

7. Click on the **SELECT POINT** icon . This places the active feature marker on the selected location for this frame. The blue circle denotes the marker(s) associated with the current frame. (Alternatively, you can accomplish steps 5 and 6 simultaneously by holding down the Control key and left-clicking the feature tracking location with the mouse.)

8. Repeat steps 4-6 for the current frame until all relevant features have been marked, changing the active feature manually by clicking on the Feature Editor, or by letting Auto Advance-Feature select the next unlocked feature for you.

9. Once you are done marking the current frame, advance to the next frame and repeat steps 4-7. If Auto Advance-Frame is ON, then Photron Motion Tools will advance the frame for you after you have finished marking the current frame; otherwise you can advance the frame manually using the playback controls.

The following is a summary of interface shortcuts for some of the tasks described above:

Ctrl-click Feature Marking	Mark a feature track point by holding down the control key and left clicking with the mouse. (steps 5-6)
Contextual Menu (right click)	Mark a track point by left clicking on the point, then right clicking and selecting **Analysis**, then **Select Point**. (steps 5-6)
Auto-Advance to Next Feature	Advance automatically to the next feature when you have marked the current feature. To enable, right click within the image, select **Analysis**, then **Options**, then **Auto-Advance**, then **Feature**. (step 4)
Auto-Advance to Next Frame	This option will automatically advance the recording to the next frame when all relevant features have been selected in the current frame. To enable, right click within the image, select **Analysis**, then **Options**, followed by **Auto-Advance**, and finally **Frame**. (step 8)

Automatic Tracking

Photron Motion Tools Auto-Tracking works on the principle of template matching. The user selects a tracking template – a group of pixels within the image. Tracking templates are also referred to as "features" or "regions" of an image. Once the user has selected a "region", Photron Motion Tools advances the video image to subsequent frames and executes a sophisticated correlation algorithm to find a match for the region. If a tracking template match is found in subsequent frames, Photron Motion Tools continues to advance. If no adequate match is found, Photron Motion Tools discontinues automatic tracking. In such a situation, the user can set a new tracking template in the frame in which the previous template was lost and resume tracking.

To automatically track up to 32 features:

1. Open the Feature Editor by clicking on the Feature Editor icon.

2. Add or delete features using the Add and/or Delete buttons on the Feature Editor until you have the desired number of feature trackers.

3. For those features that you wish to Auto Track, toggle the Auto Tracking column to display ⊕.

4. For those features that you would like to include in the Auto Advance-Feature sequence, unlock the feature in the feature editor. If you are satisfied with the tracking results for a given feature number, or would simply like to exclude it from the auto-advance sequence, lock the feature in the feature editor by clicking on the lock icon.

5. Select **AUTOMATIC** from the Track Mode drag-down box.

6.   Navigate through the recording video to the desired frame, using either the playback controls or the keyboard shortcuts.

7. Select the active feature by clicking on the feature number in the Feature Editor.

8. Click on the Set New Region icon.

9. Draw a box around the feature you wish to track, and then click the **SELECT POINT** icon. This selects the boxed area as the tracking region, and sets the tracking location for the feature at the point of the reticle.

10. Repeat steps 5-7 for each desired Auto-Track feature in the frame. If Auto Advance-Feature is ON, then Photron Motion Tools will do step 5 for you, by automatically selecting the next unlocked feature.

11. Make sure that all the desired initial feature locations are currently selected with blue circles ⊕ ; Auto-Tracking will only commence for selected features. (If after setting all the features, the frame automatically advanced due to Auto Advance-Frame, then step back one frame.)

12. Click on the Track icon. Photron Motion Tools will automatically track this region through subsequent frames, using the geometric center of the region as the marker location.

13. When tracking, the Track icon turns into a Stop Tracking icon, which you can click to abort tracking at any time. Otherwise, Photron Motion Tools will continue to track this feature until it can no longer find a good template match or it reaches the end of the video sequence.

14. You may also Reverse Auto-Track by clicking the reverse track icon in step 10.

If Auto Track stops due to a natural template loss, you may continue to track this point manually (please see the section on "Manual Tracking"). To resume Auto Tracking the same feature again:

1. Click on the Set New Region icon .

2. Draw a new box around the feature you wish to track.

3. Click on the Track icon . Photron Motion Tools will ask if you wish to use the original template or to use the new template for tracking from this point forward.

Saving and Loading Tracking Data

After tracking, you may save the tracking data in a raw Photron Motion Tools file format by clicking on **SAVE** on the Analysis Tab. Once the data is saved, you can close the recording, reopen it, and then restore the tracking information for further analysis by clicking on **LOAD** on the Analysis Tab.

The following interface shortcuts are available to simplify and expedite the process of manual tracking:

Select Region	You can directly select an auto track region by right clicking and selecting **Analysis**, then **Select Region**, then drawing a box around the region.
Select and Track	You can directly select an auto track region by drawing a box around the feature, then right clicking and selecting **Analysis**, then **Select and Track**.
Track Feature	This option will track a feature. Draw a box around the feature, then right clicking and selecting **Analysis**, then **Track Feature**.

Calibrating an Image

Calibrating an image serves the following functions:

1) **converts and scales pixel distances to real-world dimensions** (e.g. inches, meters, etc.)

2) **translates and rotates the coordinate system** to remove any tilt introduced by the camera head

Image calibration requires measurement information about some feature in the image. We suggest that you include a horizontal ruler in the picture or some equivalent frame of reference that has both a well-defined scale and known rotational orientation. After an image is calibrated, you can change the units of measure at any time by selecting from the combination list.
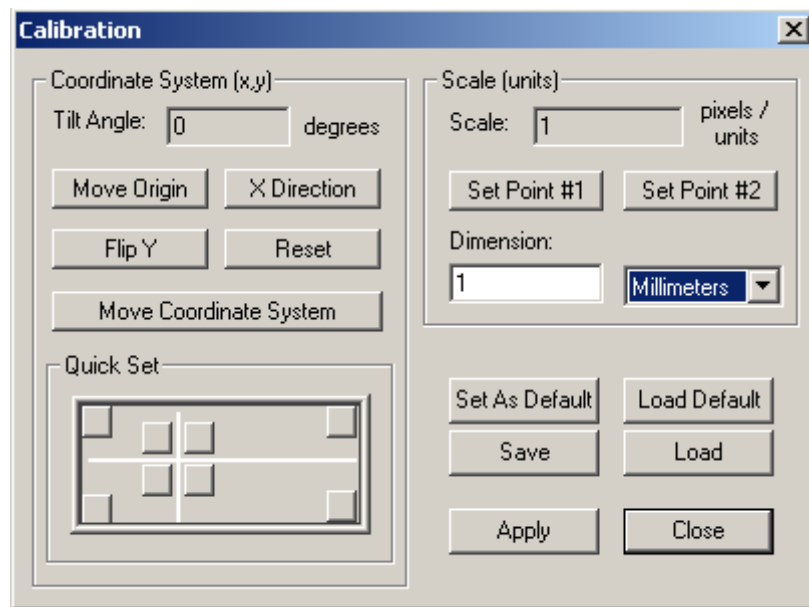
Setting the Calibration Scale

To set the calibration scale:

6. Click on the **CALIBRATE** button ⬚. The Calibration dialog appears (see right).

7. Within the video image, find a known frame-of-reference object. Left-click on one end of the object, using the reticle as a guide.

8. Click on **SET POINT #1** in the "Scale" section of the Calibration dialog.

9. Within the video image, left-click on the other end of the known object. In the Calibration dialog, click on **SET POINT #2**. Type the known unit size of this object into the **DIMENSION** text field, and choose the unit of measure from the drag-down list (e.g. inches, meters, etc.).

10. Click on **CALIBRATE SCALE** button to set the scale factor. The current values will now apply to the currently open recording, until either the recording is closed, or the calibration settings are saved or loaded (see below).

Calibrating the coordinate system

In addition to scaling calibration, the user may also customize the translation and rotation of a recording's coordinate system.

To calibrate the origin and axes of the coordinate system:

7. Choose a point in the image that will serve as the origin of your coordinate system. Left-click on the point and then click on **SET POINT #1**.

8. Determine the appropriate positive X-axis direction, and left-click anywhere in that direction. Click on **X-DIRECTION**. Photron Motion Tools will draw a line from Point #1 to the X-Direction point; this line represents the X-axis.

9. A default Y-axis will also be drawn at a right angle to the X-axis. To flip the Y axis (e.g. reverse the positive Y direction), click on the **FLIP Y** button.

10. To translate the entire coordinate system and set the origin (0,0) to another location, click on and move the crosshairs within the video to the new desired origin location. Left-click on the new location within the image. Click on **SET ORIGIN**. The coordinate system lines will rearrange themselves for the new 0.0 point.

11. Click on **CALIBRATE COORDINATE SYSTEM** to set the calibration.

12. Click **DISMISS** to finish the calibration sequence.

The Enhanced Analysis Module includes **Quick Settings**, which are shortcuts for certain common coordinate system configurations.

To use Quick Settings:

4. Click on any of the buttons in the corners of the Quick Set portion of the Calibration Dialog. The coordinate system will align itself to the corresponding corner of the image.

5. Alternatively, you can center the coordinate system at the reticle location in one of four default "quadrant" orientations by clicking on the appropriate quadrant's button in the center of the Quick Set dialog.

6. Click on **CALIBRATE COORDINATE SYSTEM** to set the calibration.

Saving and Loading Calibration Settings

The calibration values that are set using the **CALIBRATE SCALE** or **CALIBRATE COORDINATE SYSTEM** buttons only apply to the current recording, and even then, only until the recording is closed. To keep the values as defaults for the application, click on **SET AS DEFAULT**. From that point on, any newly opened recording can have its calibrations set to the current default values by clicking on **LOAD DEFAULT**.

However, even if the values are set as the application defaults, closing and reopening a recording will still load the coordinate system in the upper left corner. In particular, you may wish to have different calibration settings for different recordings, rather than one default set.

You may save the current calibration values to disk at any time by clicking on **SAVE** in the Calibration dialog, and providing an appropriate name for the Photron Motion Tools Calibration (.pmtcal) file. The next time you open the recording, you may reload the corresponding calibration values by bringing up the Calibration dialog and clicking on **LOAD**.

Exporting to Excel or Text and other Programs

Photron Motion Tools can export the test and calibration information and the coordinates of each tracked point or feature to Microsoft Excel or to a tab delimited text file. From Excel, you can export to a variety of software packages and text word packages. Each row of the Excel spreadsheet corresponds to a frame. The Excel spreadsheet is print-ready.

In the Enhanced module only, users can select the Excel template. Excel Templates are pre-made XLS worksheets. Such worksheets have formulas and graphs and other features saved in ready positions. Use Excel Templates to simplify repetitive measurements. To enable exporting to an Excel Template:

1. Right click within a window

2. Select **ANALYSIS OPTIONS**

3. Select **EXPORT**

4. Select **EXPORT TO EXCEL TEMPLATE**

To export your analysis data, click on the Export icon .

If you have enabled using an Excel Template, Photron Motion Tools will prompt you for the template filename.

When designing templates, be sure not to add formulas in columns A through BZ. These columns are overwritten by Photron Motion Tools during recording.

Enabling a Tracking Zoom Windows

Photron Motion Tools allows users to actively view features as they are being automatically tracked. This feature is called a "Tracking Zoom Window."
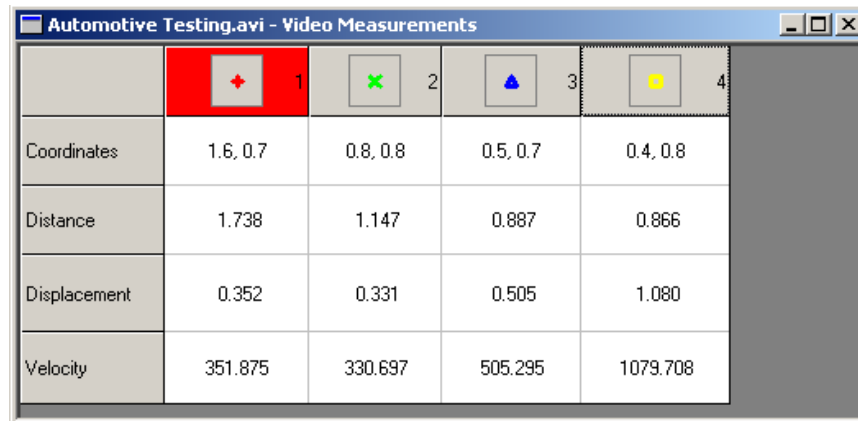
To enable a Tracking Zoom Window:

1. Right click within a window

2. Select **ANALYSIS OPTIONS**

3. Select **SHOW FEATURES**

4. Select **FEATURE ZOOM WINDOW** X, where X is the number of the feature being tracked.

Tracking zoom windows cannot be edited.

Calculating Distance and Velocity

Quick calculation of distance and velocity between points is available using the Video Measurements tool, accessible under the **TOOLS** menu or through the right-click contextual menu.

The information that is displayed (in user units):

Coordinates	X,Y position of the feature relative to the user-defined origin
Distance	Distance of the feature from the user-defined origin
Displacement	Location change (e.g. distance) from the previous frame or tracked point
Velocity	Displacement divided by time, in units/second.

Additional Analysis Options

The following additional features are available through the contextual menus. Right click within an image, then click on **ANALYSIS** and choose from the following features:

Clear All Features in All Frames	Clears all feature markers in the entire recording.
Clear All Features in Current Frame	Clears all feature markers in current frame.
Clear Current Feature from Current Frame Forward	Clears currently active feature marker (e.g. 1-32) from the current frame and from all other subsequent frames.
Clear Current Feature in Current Frame	Clears currently active feature marker (e.g. 1-32) from the current frame only
Show Current Frame	Displays the feature indicators only on the current frame
Show All Frame	Displays the feature indicators for all frames at all times.
Show Calibration Information	Displays the right-angle ruler that identifies the currently set origin, X-direction and Y-direction.
Show Feature Indicator	Displays a legend with the current feature indicators.
Lines Between Features	Enable drawing of lines between features in the current frame or in all frames.

Image Annotation

NOTE: *This chapter is for users who have purchased and installed the **Image Annotation Module** for Photron Motion Tools.*

You may annotate your video sequences with personalized notes and comments for later review or collaboration. To record a note or to review a note, you must open the Annotations window. To access the Annotations window:

1. Open a video sequence.

2. Open a Annotations window using one of the three following techniques:

   a) Under **TOOLS**, select **ANNOTATIONS**

   b) Right click anywhere within the video window, then select **TEXT INFO**, then **ANNOTATIONS**

   c) If your video sequence already has notes recorded, a color button will appear in the lower right portion of the video window. Right click on this button and Annotations will appear.

   The Annotations window appears.
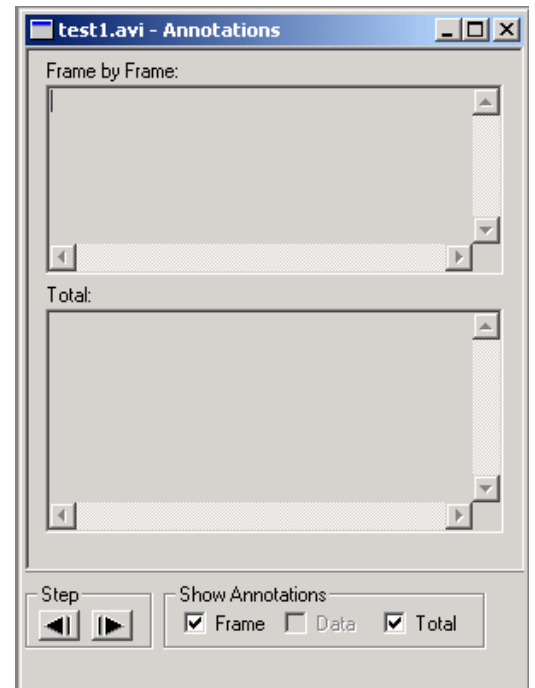
3. Type your notes in the boxes. Frame-by-frame comments are displayed with each frame. Total comments are always displayed. A little green box is displayed in the lower right corner of any video frame that has an associated user annotation.

4. To step through previously recorded comments, use the Step buttons located in the lower left corner.

5. Advance to any particular video frame using the Play features of Photron Motion Tools (Chapter 7).

6. Type a note into either the top box (video) or the bottom box (common to all frames within the sequence).

All Annotations are stored in the Photron Motion Tools binary file. Therefore, the notes can be viewed with any free Photron Motion Tools Player.

NOTE: You must save changes to your annotations using the **FILE -> SAVE ANNOTATIONS** menu option before closing the video or application in order for your changes to be stored.

Automated Download

NOTE: *This chapter is for users who have purchased and installed the **Automated Download Module** for Photron Motion Tools.*

The Photron Motion Tools Automated Download module allows you to set your system to record data and video automatically. This module is very useful for applications that require capture of information at a remote site (e.g. a test range or hazardous environment) or intermittent events (e.g. a production line failure or explosion).

Using Automated Download

To set up Photron Motion Tools to automatically download upon receipt of a trigger, follow these instructions:

1. Click on the Record tab.   Set the frame rate, resolution, exposure time, data record rate and trigger

✓	Trigger Using Hand-Switch
	Trigger Using External Logic
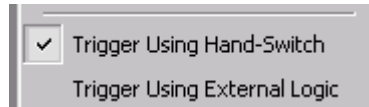
    conditions as described in earlier chapters. Do not press **START RECORDING**.

Tools   Mode   Window   Help
    Synchronized Data...
    GPS/IRIG Timing...
    Automated Download...
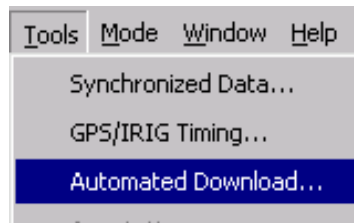
2. Select **MODE** and select either **TRIGGER USING HAND SWITCH (TS)** or **TRIGGER USING LOGIC (TT)**, depending
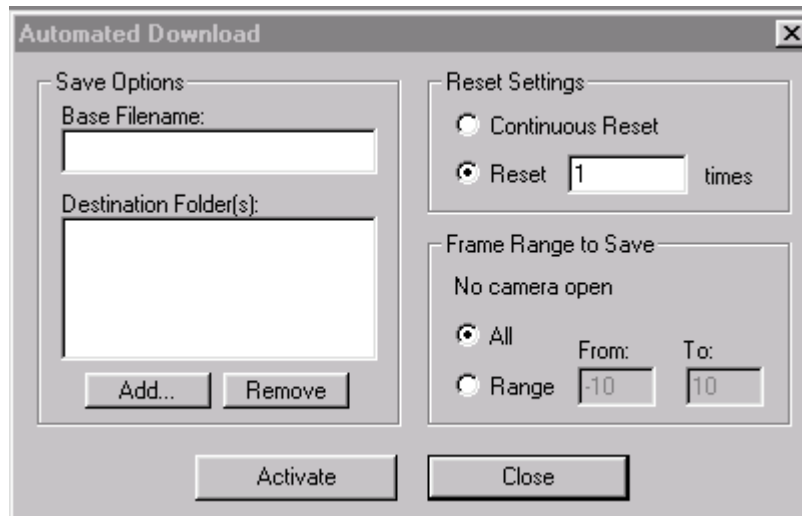
    on where you have connected the external trigger cable to the cameras.

3. Under the Tools menu item, select "Automated Download…"

The following window appears:

4.   Set the following parameters within the window:

Base File Name	The filename that the downloaded video and data use. Photron Motion Tools adds the camera number '_cam#_' and the number '1' to the first download and increments this last digit every time a new file is downloaded. For example, if the filename is "Test", then the first file saved from the master camera is "Test_cam0_1.AVI", the second is "Test_cam0_2.AVI" and so on.
Destination Folder	The folders to where the files are saved. The folders can be on the local computer (e.g. "C:\Tests\") or on any computer that is networked to the computer (e.g. "\\Computer2\Tests\Tuesday\").
	Photron Motion Tools will walk through these directories every time that it tries to save. It will save in the first location that has enough room for the sequence that it is about to save.
	If for example you have filled the drives associated with the first and second destinations but that there is room in the third destination. Photron Motion Tools will save to the third. Each time Photron Motion Tools tries to save it will recheck the destinations from top to bottom to see if there is room. It will save in the first directory where there is space.
Continuous Reset	Will continuously save and re-arm Photron Motion Tools until the operator disables automatic download mode.
Reset n times	Will download only a finite number of recordings, then disable automated download and return to local recording mode. This feature helps prevent unintentional filling of hard drives.
Frame Range	The range of frames to be saved.

5.   Click on **ACTIVATE**. The following window appears:

6.   Click on **ENGAGE.**
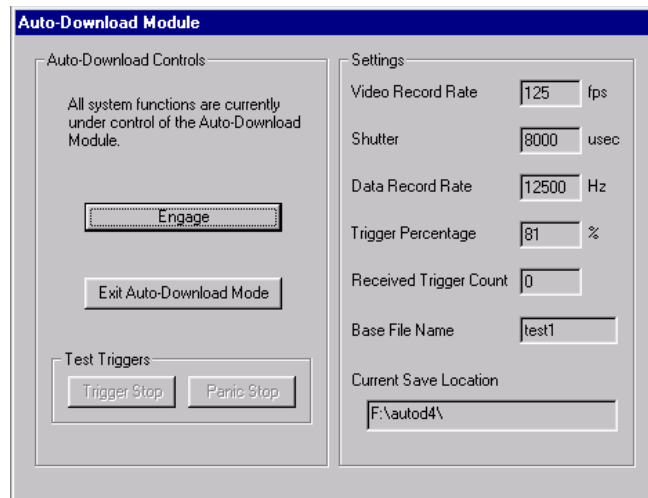
Photron Motion Tools is now waiting for an external trigger input on either the TS or TT line, as specified (or an input from one of the two "Test Trigger" buttons). When automated download is engaged, any external trigger will cause Photron Motion Tools to (1) record video, data and associated timing information, (2) download the information to the destination folder, and (3) re-arm itself into Record Ready mode awaiting the next external trigger.

7. When complete, return to the Photron Motion Tools control panel by clicking **EXIT AUTOMATED DOWNLOAD MODE**.

Notes on Photron Motion Tools Automated Download

1. Users can review recordings with the Photron Motion Tools Player while Automated Download stays operating in the background. Photron Motion Tools continues to record, waiting for a trigger pulse, in the background while you review the previously record file with the Photron Motion Tools Player.

2. Automated Download recording runs on a different thread, freeing up the computer for other applications.

Synchronized Data Acquisition

NOTE: *This chapter is for users who have purchased and installed the **Data Acquisition Module** for Photron Motion Tools.*

Installation

The Photron Data Acquisition module contains five pieces of hardware – a breakout box, a data acquisition card for PCI bus, a 68-68 pin shielded cable, a 1-meter long BNC-BNC coaxial cable, and a BNC feedthrough panel terminating in a sync connector for the type of camera you are using (FastCam PCI or FastCam-X 1280 PCI). It also includes a disk with a set of drivers.

Installing the Data Acquisition Module requires 4 steps.

- Install the cameras and Photron Motion Tools.

  It is assumed that users already have successfully installed their Photron high-speed video cameras and Photron Motion Tools software prior to installing this Synchronized Data Acquisition module. If not, consult the Installation Procedures in your Photron Motion Tools User Guide.

- Install the Data Acquisition Drivers (software)

- Install the Data Acquisition Hardware into the computer

- Interconnect the Data Acquisition Hardware with the Video Cameras

- Reinstall your software and enter a new license key code.

Install the Data Acquisition Drivers (Software)

Note: You should install the software drivers before installing the data acquisition hardware into the computer.

1. Turn on your computer. log in as the computer Administrator.

2. Insert the "NIDAQ" driver CD from National Instruments (Disk 1). The driver installation program should start automatically. If it does not, from the **RUN** prompt, type **F:/SETUP**, where "**F**" is the letter of your CD-ROM drive.

3. The NI-DAQ Installation screen appears.

4. Click on **INSTALL NIDAQ** at the first screen.

5. NIDAQ will prompt you which files you wish to install. Select only the NIDAQ files. .
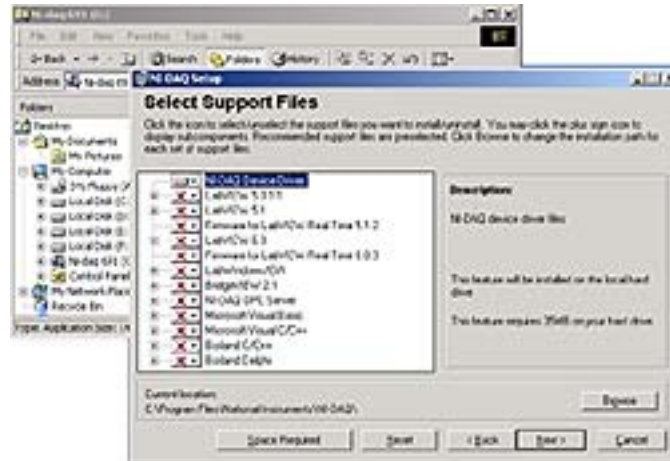
6. Click on the **NEXT** button.

7. Follow the instructions on the screens to load the NIDAQ drivers for the DAQ board. Use the standard defaults for folders and locations and program groups.

8. Restart the computer when instructed.

9. After the re-boot, the NIDAQ Setup Routine will continue. The Documentation Setup screen will appear:
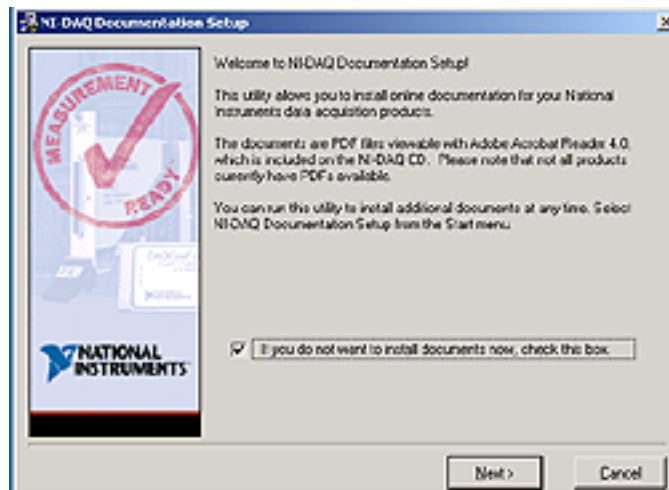
10. It is not necessary to choose any additional documentation. You may always return to this installation to find documentation.

11. Check the checkbox on the screen to decline installing further documents.

12. Click on the **NEXT** button.

13. Follow the instructions on the screens to complete loading and starting the NIDAQ drivers for the DAQ board.

14. When finished, the NIDAQ installation will ask if you wish to "Configure Measurement and Automation System" or "Quit Setup". Select "Configure Measurement and Automation System".

Note: The National Instruments Test Panel is located in the Measurement and Automation software. You can test the operation of your data acquisition hardware using the Test Panel at any time by clicking on the desktop Measurement icon.
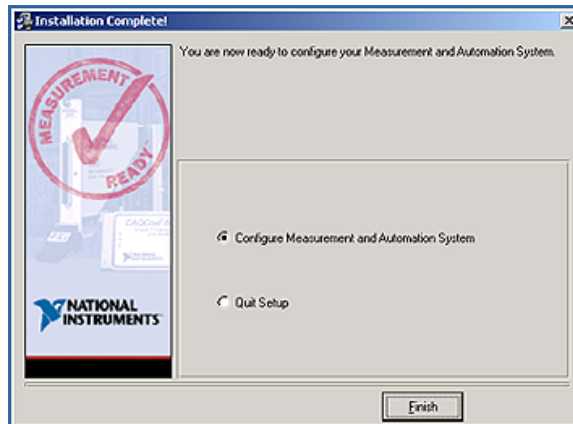
Click on the **FINISH** button.

15. Remove the disk at this time.

Confirm that your Cameras are Set to SLAVE Mode

16. Shut down your computer.

17. Confirm that all the cameras are set to SLAVE mode. Depending on which cameras you are using, SLAVE mode is set differently.

If your camera is a model *FastCam PCI*:

18. Make sure that the SLAVE jumper pins have the "jumper" connector installed as shown in the following picture:
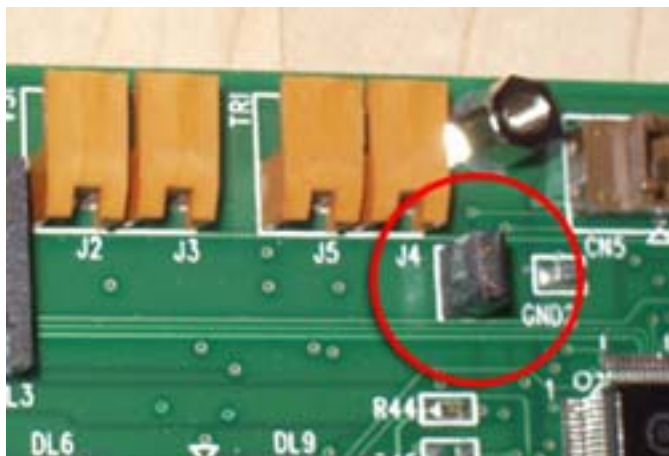
If your camera is a model *FastCam PCI R2:*

18. Make sure that dip switch #4 in the dip switch block is set to ON and that dip switches 1,2 and 3 are set to OFF, as shown in the following picture:

If your camera is a model *FastCam-X 1280 PCI*

18. Make sure that dip switch #3 in the dip switch block is set to ON, as shown in the following picture (jumpers 1,2 and 4 are shown below in the OFF position for clarity only – set these according to the hardware instructions that came with your camera):
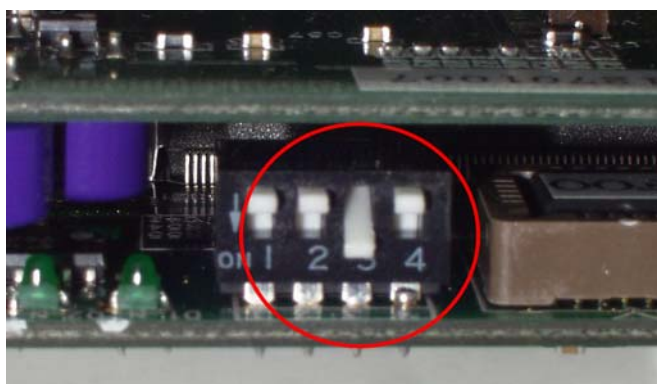
If your camera is a model *FastCam 512 PCI*,

18. Make sure that dip switch #4 in the dip switch block is set to ON, as shown in the following picture (jumpers 1,2 and 3 are shown here in the OFF position for clarity only – set these according to the hardware instructions that came with your camera):

Install the Data Acquisition Hardware into the Computer

19. In an open PCI slot, install the data acquisition card.

20. Connect one end of the 68-pin shielded cable to the back panel connector of your data acquisition card. Then connect the other end of the cable to your BNC Breakout Box as shown in the following figure:
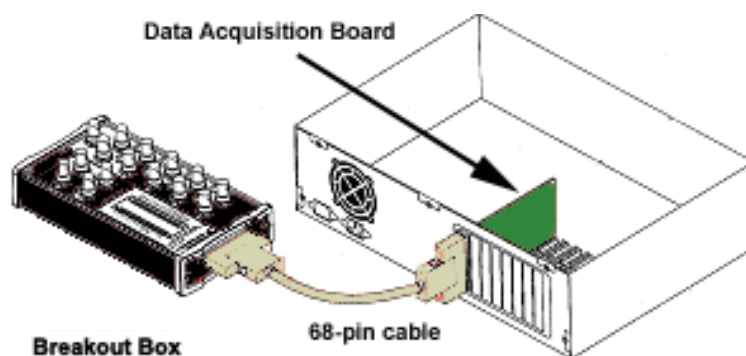
21. Your BNC Breakout Box comes pre-configured with two jumpers in place. Confirm that the first jumper is securely affixed to both **PFI4** and **User2** terminals. Confirm that the second jumper is securely affixed to both **PFI1** and **CTR1Out** terminals.

Interconnect the Data Acquisition Hardware and the Cameras

If your camera is a model *FastCam PCI*:

22. If you are using more than one camera in the computer, determine which camera (and associated camera board) will be "Camera #1" (the first camera in the chain) inside the computer.

23. In an open computer back panel location that is adjacent to the Camera #1 board, install the BNC Feedthrough Panel Adapter that is supplied with your system.

24. Connect the cable from the Feedthrough Panel Adapter to the VSI connector on the Camera #1 board.
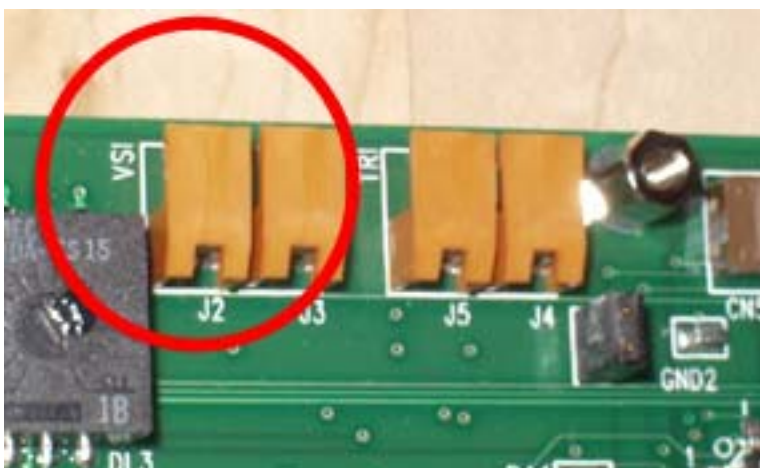
i.

25. If you are using multiple cameras, interconnect the other cameras using the internal VSI to VSO cables supplied by Photron. Record the order in which the cameras are interconnected (for example: SN 1 to SN 2 to SN3). It is also recommended that you interconnect the TRI to TRO ports as well, to allow proper use of the cameras without Data Acquisition mode enabled.

26. Connect one end of the supplied 1-meter BNC-BNC coaxial cable to the "CTR0 Out" BNC connector on the BNC Input Breakout Box (note: in some cases, this connection may be labeled "Sync Out").

27. Connect the other end of the BNC-BNC coaxial cable to the BNC Feedthrough Panel.

28. Connect the external event trigger input to the "USER 2" BNC connector on the breakout box and connect the external event trigger to each camera in the computer. Use the TS connection if the event trigger is a hand switch. Use the TT connection if the event trigger is a TTL source.

Note: the trigger must be connected to the BNC Breakout Box AND each camera in the computer.

The following schematic shows the interconnections for the model **FastCam PCI camera**:

If your camera is a model *FastCam PCI R2:*

6.   If you are using more than one camera in the computer, determine which camera (and associated camera board) will be "Camera #1" (the first camera in the chain) inside the computer.

7.   Connect one end of the supplied 1-meter BNC-BNC coaxial cable to the "CTR0 Out" BNC connector on the BNC Input Breakout Box (note: in some cases, this connection may be labeled "Sync Out").

8.   Connect the other end of the BNC-BNC coaxial cable to the SYNC IN connection on the camera you have selected to be Camera #1.

9.   If you are using multiple cameras, interconnect the synchronization lines for the other cameras using the external SYNC IN and SYNC OUT cables supplied by Photron. Record the order in which the cameras are interconnected (for example: SN 1 to SN 2 to SN3).

10. Connect the external event trigger input to the "USER 2" BNC connector on the breakout box and connect the external event trigger to each camera in the computer. Use the TS connection if the event trigger is a hand switch. Use the TT connection if the event trigger is a TTL source.

Note: the trigger must be connected to the BNC Breakout Box AND each camera in the computer.

The following schematic shows the interconnections for the model **FastCam PCI R2 camera**:

If your camera is a model *FastCam-X 1280 PCI*:

6. If you are using more than one camera in the computer, determine which camera (and associated camera board) will be "Camera #1" (the first camera in the chain) inside the computer.

7. In an open computer back panel location that is adjacent to the Camera #1 board, install the BNC Feedthrough Panel Adapter that is supplied with your system.

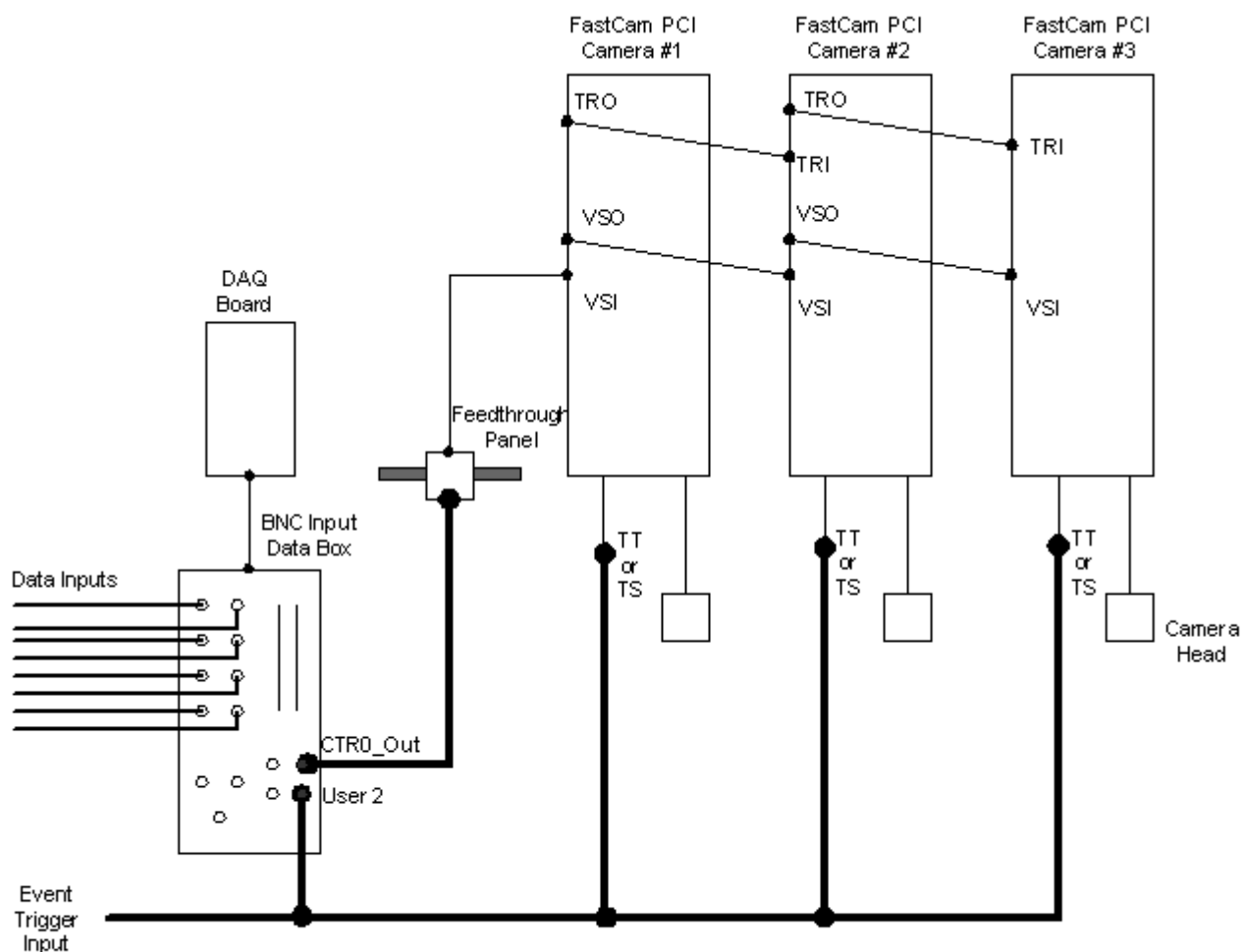8. Connect the cable from the Feedthrough Panel to the BD_IN connector on the Camera #1 board.

9. If you are using multiple cameras, interconnect the other cameras using the internal BD_OUT to BD_IN cables supplied by Photron. Record the order in which the cameras are interconnected.

10. Connect one end of the supplied 1-meter BNC-BNC coaxial cable to the "CTR0 Out" BNC connector on the breakout box (note: in some cases, this may be labeled "Sync Out").

11. Connect the other end of the BNC-BNC coaxial cable to the BNC Feedthrough Panel.

12. Connect the external event trigger input to the "USER 2" BNC connector on the breakout box and connect the external event trigger to each camera in the computer. Use the TS connection if the event trigger is a hand switch. Use the TT connection if the event trigger is a TTL source.

   Note: the trigger must be connected to the BNC Breakout Box AND to the first camera in the chain (e.g. "Camera #1). It is highly recommended to also connect the trigger to each camera in the computer.

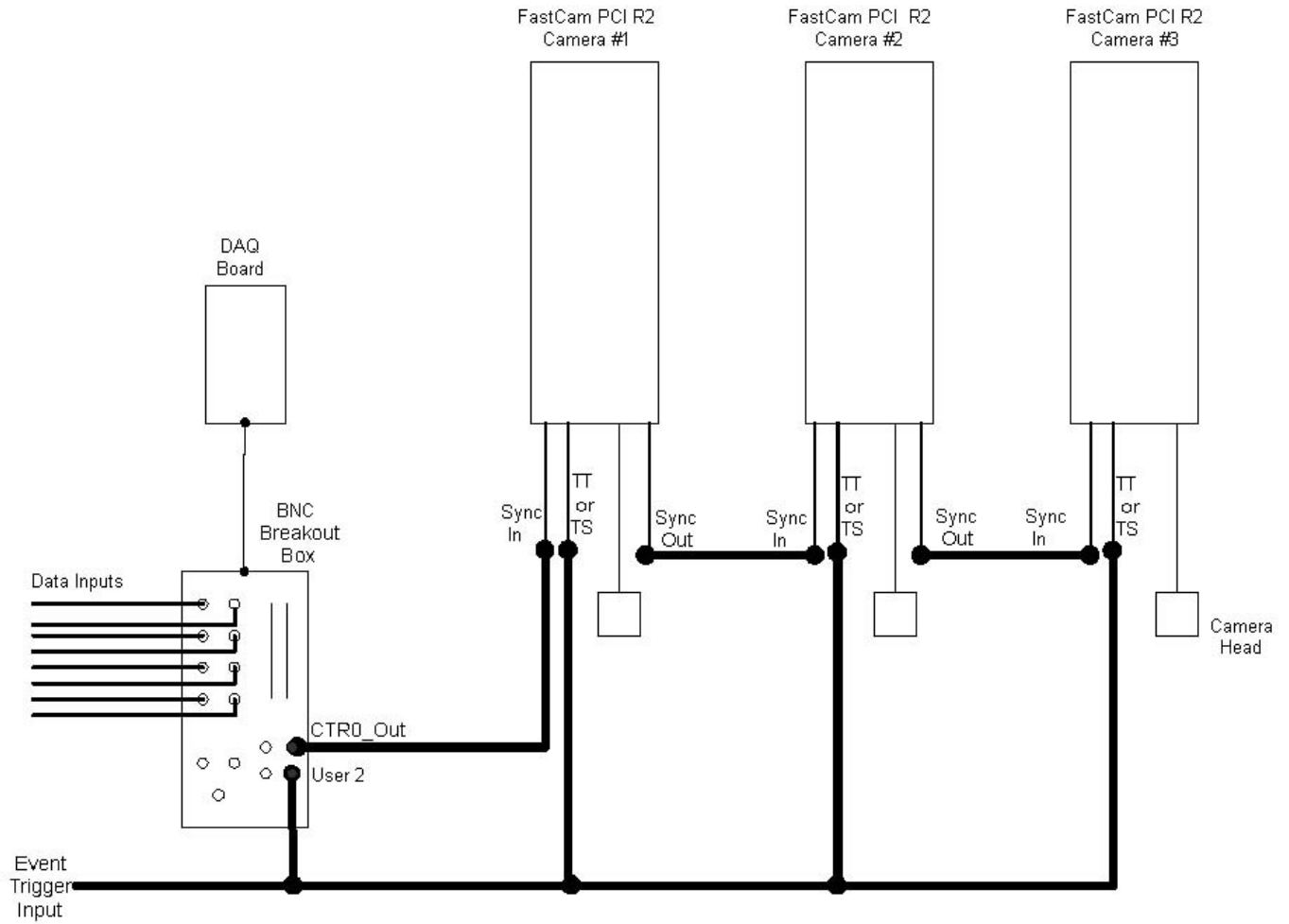The following schematic shows the interconnections for the **FastCam-X 1280 PCI camera**:
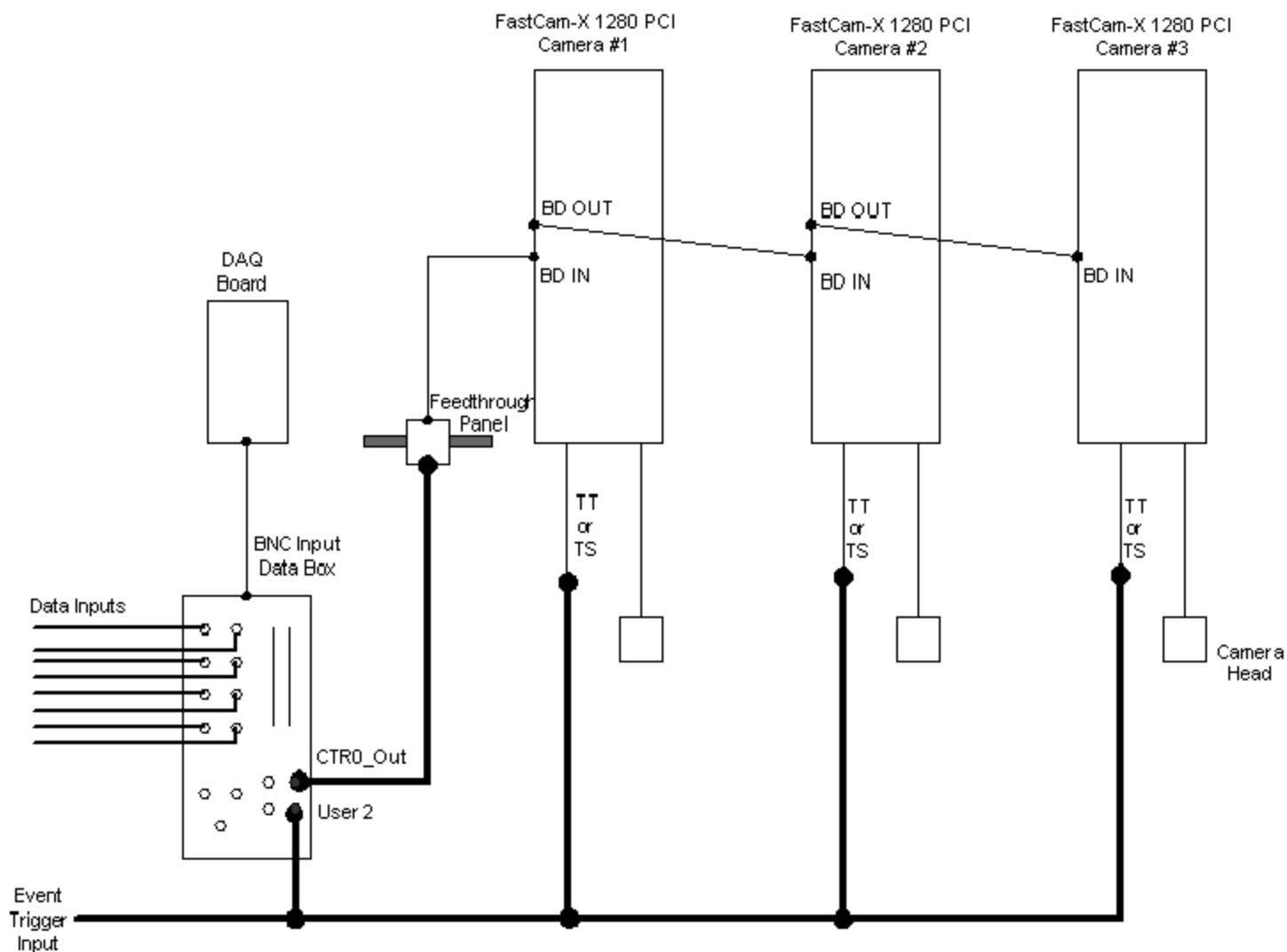
If your camera is a model *FastCam 512PCI*

6. If you are using more than one camera in the computer, determine which camera (and associated camera board) will be "Camera #1" (the first camera in the chain) inside the computer.

7. Connect one end of the supplied 1-meter BNC-BNC coaxial cable to the "CTR0 Out" BNC connector on the BNC Input Breakout Box (note: in some cases, this connection may be labeled "Sync Out").

8. Connect the other end of the BNC-BNC coaxial cable to the SYNC IN connection on the camera you have selected to be Camera #1.

9. If you are using multiple cameras, interconnect the synchronization lines for the other cameras using the external SYNC IN and SYNC OUT cables supplied by Photron. Record the order in which the cameras are interconnected (for example: SN 1 to SN 2 to SN3).

10. Connect the external event trigger input to the "USER 2" BNC connector on the breakout box and connect the external event trigger to each camera in the computer. Use the TS connection if the event trigger is a hand switch. Use the TT connection if the event trigger is a TTL source.

The following schematic shows the interconnections for the model **FastCam 512PCI camera**:
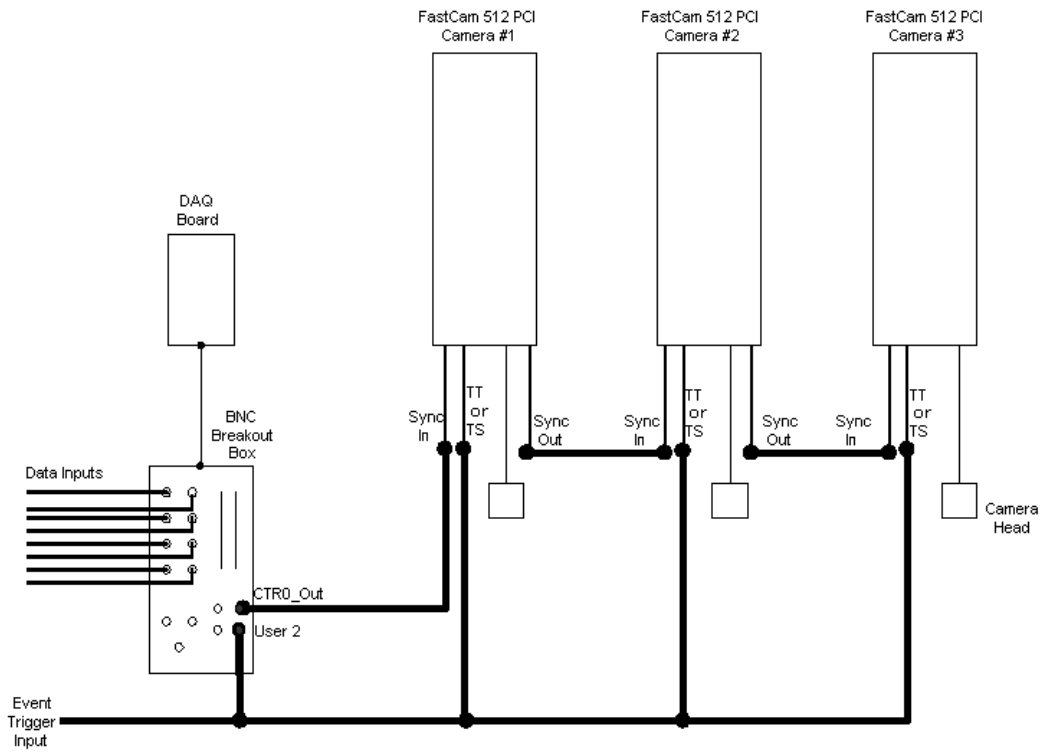
Note: the event trigger must be connected to the BNC Breakout Box AND each camera in the computer, as shown in the diagram above.

Reinstall Photron Motion Tools and Enter a new License Code.

Note: it is not necessary to reinstall Photron Motion Tools to use the Data Acquisition Module. However, if your system included a new application disk, it may contain new drivers or updates. To re-install a new version of Photron Motion Tools, use the following instructions.

26. During the installation procedure, the installer will automatically detect that you are upgrading a previous version of Photron Motion Tools software. You will see the following screen.
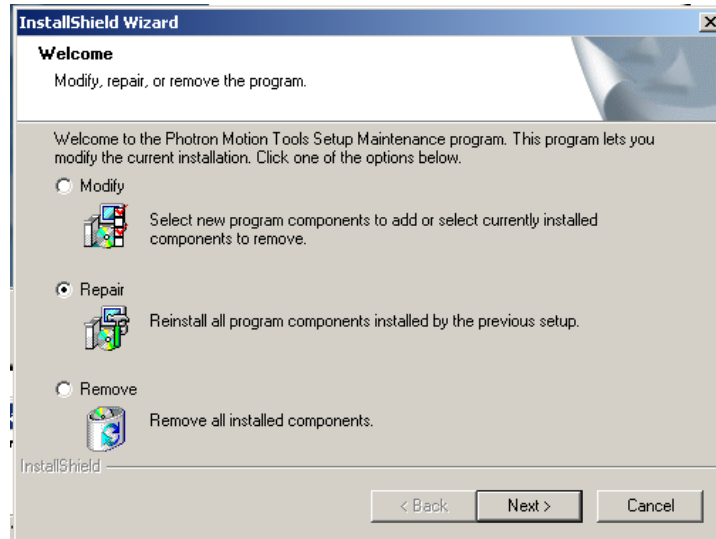
27. Select the Repair option.

28. Click **NEXT**.

29. The installer will then install the new application and all the appropriately modified files. During the installation process, which could take many minutes, a status box will appear.
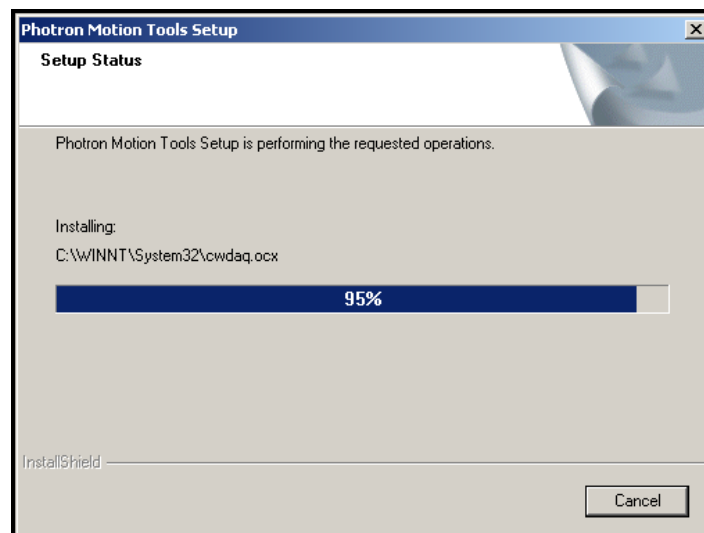
56. The installer may prompt you that it has detected a READ ONLY file, and ask you if you wish to overwrite this file.

57. Click **YES**.

58. If a Hardlock driver is required, the installer will start the Hardlock driver installer. Click **NEXT**. The drivers will be installed.

59. When complete, the maintenance complete window will appear.
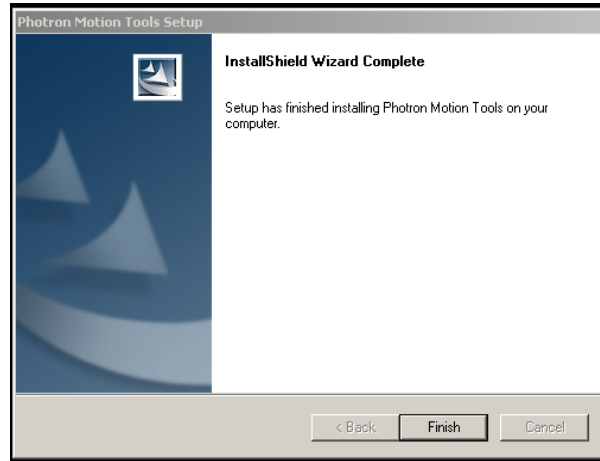
60. Click **FINISH**.

61. Remove the CD-ROM from your CD drive.

62. Restart your computer.

63. Your Synchronized Data Acquisition System includes a new License Key Code. To renter your new License Key Code, click on the Windows **START** button, then **PROGRAMS**, then **PHOTRON MOTION TOOLS**, and then **LICENSE MANAGER**.

56. Enter the 16-digit license code in the New License section. You can find the license code on your Registration Card.

57. After you have entered your license code, click on **CHECK LICENSE**. If you have entered the license correctly, information about the key tag, and a list of the features of Photron Motion Tools that you have purchased will be listed and the **ENABLE LICENSE** button will also become highlighted.

58. Press the **ENABLE LICENSE** button.

Congratulations. You are now ready to use the Photron Motion Tools Synchronized Data Acquisition Module.

Connecting Sensors to the Data Acquisition Hardware

Overview of sensors and data acquisition

Up to 8 channels of data may be captured with the optional Photron Data Acquisition Module. The data is displayed in a separate graph on the screen with the video.

Based on the information you give Photron Motion Tools when setting up your test, Photron Motion Tools measures the difference between two voltage inputs (e.g. a plus input and a minus input), or the difference between an amplifier output and a ground. A wide variety of sensors – also called transducers – can be connected to the Photron Motion Tools breakout box provided with all Photron Motion Tools data acquisition systems.

Sensors have different characteristics that must be considered when connecting to Photron Motion Tools or any data acquisition system. Some sensors have two output wires and produce a signal that is the difference between the positive (+, or signal) lead and the negative (-) lead. These are named "Differential" sensors, as depicted below:
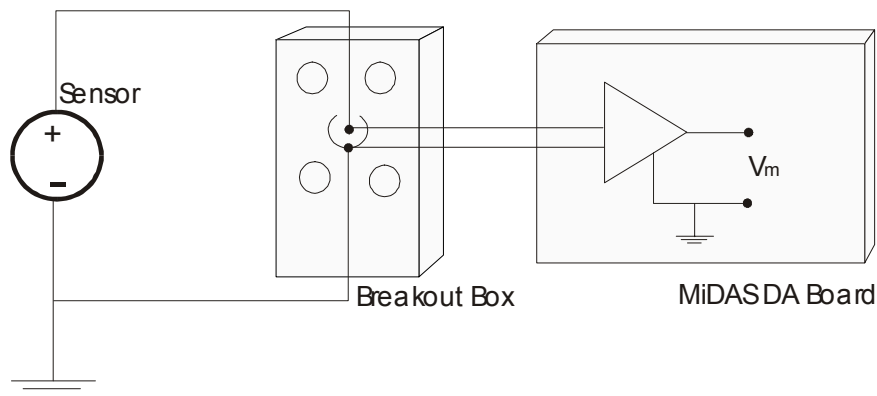
Some sensors have one signal wire and one common wire. These sensors are generally named "Single Ended" sensors. Typically, the common wires for an entire group of Single Ended sensors are all tied together. These are very common in larger test facilities that use many sensors (crash testing, structural testing, etc.)
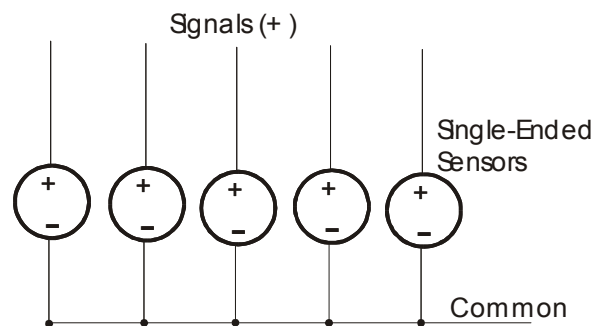
If the common wire from a sensor is physically connected to the data acquisition hardware, the system is considered to be "Referenced" – that is, the sensor common is considered referenced or tied to the data acquisition board common. Contrarily, if the common wire from a sensor is connected to a common building or earth ground (and perhaps not physically connected to the data acquisition hardware), the system is considered to be "Non-Referenced". Combining these, sensor types can be Referenced Single Ended, Non-Referenced Single Ended, or Differential.

Photron Motion Tools is designed to work with all these sensor types. The operator must simply instruct Photron Motion Tools as to which sensor type is being connected and Photron Motion Tools automatically makes all the proper adjustments and switch settings. For example, if you are using a Referenced Single Ended sensor,

Photron Motion Tools knows to reference the signal to the common ground of the system (e.g. computer or building) and makes the appropriate internal switch changes. Likewise, if you are using Differential sensors Photron Motion Tools knows which terminals to assign to the sensor and makes the appropriate switch changes to measure the difference between + and – leads.

If you are unfamiliar with sensor connections or the terms used in this manual, you are advised to consult with Photron engineers or your sensor manufacturer.

Setting up the Data Acquisition Parameters

1. Before you open a camera, select **Mode** , then select "Record Video and Data".

This will enable the "DAQ Control" window.
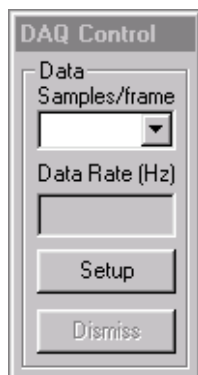
Before acquiring data with your video, you must configure Photron Motion Tools according to the test conditions of your data acquisition much like you configure the software according to the test conditions of your video acquisition. Photron Motion Tools follows conventional data acquisition protocols when setting up a data acquisition measurement.

2. Click on the **Setup** button on the DAQ Control window. Alternatively, you can select **Tools**, then **Synchronized Data** ... to open the "Data Acquisition Settings" box.
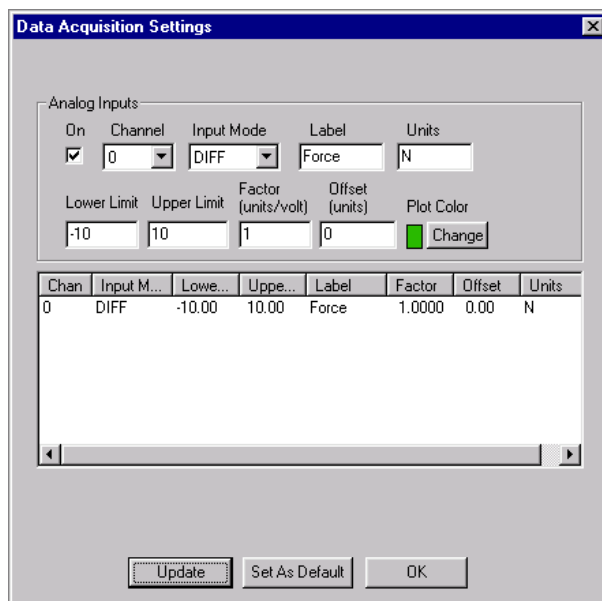
3. Select the appropriate channel (e.g. "Channel 0") from the drag-down box. Photron Motion Tools automatically detects which channels are available. If that channel is available, click the **ON** checkbox. If that channel is unavailable, go to the next highest channel until you find an available channel. Start with Channel 0 always.

4. Determine the type of sensor that you are using (see the instruction manual that came with your sensor for more details). Determine the parameters of the sensor (gain, offset, voltage range, calibration). Make sure you factor in the signal conditioning amplification, if appropriate.

5. Set the information about the sensor, as follows. Enter all the information requested.

Input Mode	The three options here are DIFF, RSE and NRSE. Consult with your sensor manufacturer to determine in which mode your sensor works.
Label	Provide a short (4 character) label for the analog input channel. This label is printed on the melded AVI file. We recommend using lower case letters only.
Units	A short (3 character) field for placing units in the graphs. We recommend using lower case letters only.
Lower Limit	The lower limit, in volts, that you expect to see from your sensor. Voltages that exceed the lower limit in this field will appear as clipped or saturated. A small amount of over scan has been automatically provided. Typical "bi-polar" sensors have an input range of −10volts to +10volts. Typical "uni-polar" sources have an input range of 0V to +10V.
Upper Limit	The lower limit, in volts, that you expect to see from your sensor. Voltages that exceed the lower limit in this field will appear as clipped or saturated. A small amount of over scan has been automatically provided. Typical "bi-polar" sensors have an input range of −10volts to +10volts. Typical "uni-polar" sources have an input range of 0V to +10V.
Factor	The scale factor to be applied to convert the input volts to a meaningful number, in units/volt. This number is applied immediately after the input voltage is registered.
Offset	The offset to be applied to account for drifts or offsets in the input, in units. This offset is applied after the scale factor multiplication.
PLOT COLOR button	The color of the line to be used in multiple-line graphs. Select this button to bring up the color palette.

6. Click on the **UPDATE** button

7. Physically connect the positive signal channel (+) from your sensor to the center post of the BNC.

    •   If you are using a Differential sensor, connect the negative to the outside of the BNC. Note that most Differential sensors will already have BNC terminations.

    •   If your sensor is "Single-Ended Grounded (Non-Reference Single Ended)", connect the common wire from the sensor system to the screw terminal labeled AISENSE on the breakout box.

- If your sensor is "Single-Ended Floating (Reference Single Ended)", connect the common wire from the sensor system to the screw terminal labeled AIGND on the breakout box with a bias resistor, as described by your sensor manufacturer.

Connect your sensors as shown in the following chart:

Channel (as selected in Settings Window)	Connect Sensor to BNC labeled...
0	ACH 0
1	ACH 1
2	ACH 2
3	ACH 3
4	ACH 4
5	ACH 5
6	ACH 6
7	ACH 7

If you are using more than 8 single ended channels, you must split each BNC into a positive (center post) and negative (outer ring). The center posts are channels 0-7 and the outer rings are channels 8-15.

8. Flip the little rocker switch on the bottom of the BNC input as follows:

If your sensor is "Differential, Grounded" to "GS"

If your sensor is "Differential, Floating" to "FS"

If your sensor is "Single-Ended", to "FS"

9. Repeat steps 3-8 for each sensor that you wish to hook up to the breakout box, each time entering the proper settings into the software screen.

10. When the sensors are connected and the settings are entered, click on the **SET AS DEFAULT** button to save the current data configuration as the default for all future measurements. Click on the **OK** button.

Recording Synchronized Data with Video

After you have configured the software settings properly, you can simply record data along with your video. Photron Motion Tools allows you to set the number of data points per channel to be acquired to be different than the video acquisition rate. To record data with video:

2. Before you open a camera, go to **MODE** and select **RECORD VIDEO AND DATA**.
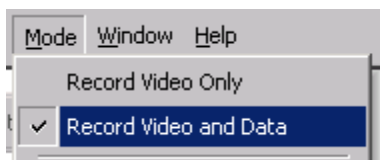
3. Open a camera or multiple cameras as described in Chapter 2 of this manual.

4. Select **MODE** and select either **TRIGGER USING HAND SWITCH (TS)** or **TRIGGER USING LOGIC (TT)**, depending on where you have connected the external trigger cable to the cameras.
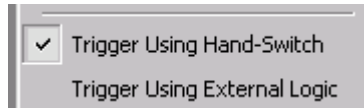
Note: The Photron cameras do not support a Software trigger when connected to the data acquisition card. The only way to trigger the system is from an external trigger.

Note: The FastCam 1280 and the FastCam PCI are triggered according to different specifications.

The FastCam PCI and FastCam PCI R2, when slaved to the data acquisition card, can be triggered by a Hand-Switch on the TS trigger line, or a TTL-logic **rising edge** on the TT line.

The FastCam 1280, when slaved to the data acquisition card, can be triggered by a Hand-Switch or a TTL-logic **falling edge** on the trigger portion of the BD_IN connector.

5. Set up live data graphing, if desirable for your application. Note that it is always advised not to use this feature unless you need to visualize the data. Live data graphing consumes a significant percentage of the processor power during a recording.

6. Click on the Record Tab.

6. Set the video frame rate, the resolution, the shutter speed and the trigger percentage between 0% and 100%.

7. On the DAQ Control Window, set the number of data samples to be acquired per video frame per video channel. If you do not see any options for number of data samples in the DAQ Settings box, click anywhere on a window containing video -- a video window must be active to see these.

Note: For the highest accuracy, select at least 10 samples per video frame.

8. Click the **START RECORDING** button. The button turns yellow and says "Abort (pre-trigger)". Hitting this button will abort your recording, not trigger it.

9. Externally trigger the recording. Both video and data are stopped simultaneously in accordance with your trigger percentage settings. Both the Reference Frame 0 and the Reference Datum 0 are placed at the trigger point of the sequence. Note that the Photron Motion Tools data module requires an external trigger connected to both the BNC Breakout Box and the appropriate trigger lines of each camera for proper execution.

10. Note: For the FastCam PCI only. If you selected "Trigger Using Hand-Switch" from the Mode menu, then the completed recording will not have exactly the pre and post trigger frames that you had selected. Delays that are present in the TS trigger line are accounted for after the recording is complete.

Playing Video/Data Sequences

When the acquisition is completed, the Play tab is automatically brought forth and both Video Playback and Data Playback windows are opened. The Data Playback window is as shown:
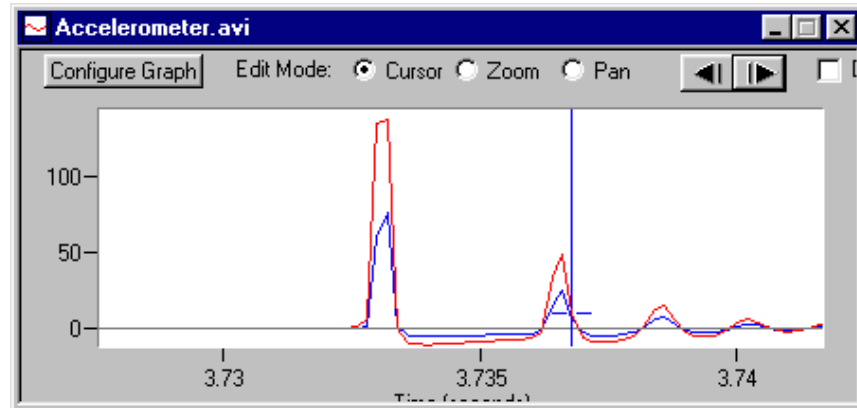
You can "play" the video/data using any of the following techniques:

1. The controls on the Play tab

2. The contextual controls for the Video Playback window

3. The single step controls on the Data Playback window

4. Dragging the cursor in the Data Playback window

Note that if multiple windows are visible on the screen, then the window with the active blue stripe across the top is currently active

The Data Playback window has a waveform display with some button features along the top and right side. A single blue cursor shows the location of the video/data counter, in data points. Along the bottom, the time position is displayed. The user settable features of the Data Playback window are as follows:

< button	This button causes the data cursor to jump one single step backwards. Note that since there might be multiple data points per frame of video, the video frame might not advance every time this button is pressed.
> button	This button causes the data cursor to jump one single step forwards.
Edit Mode: Cursor	When the Cursor mode button is selected, the user has control of the cursor with the mouse. By clicking and dragging the cursor, both the video frames and data are advanced synchronously.
	A "jump advance" feature is also provided – just click anywhere within the waveform window and the cursor jumps to that position and the video is updated
Edit Mode: Zoom	When the Zoom mode button is selected, the user can change the zoom magnification of the waveform window. Simply click and drag within the waveform window to create a box around the feature that you

desire to amplify. When the mouse is released, the waveform is zoomed.

Double-click anywhere within the waveform window to de-zoom the window to the full range.

Edit Mode: Pan
When the Pan mode button is selected, the user can drag the graph up, down left or right.

Display Values
When enabled, the right side of the Data Playback window will display the cursor values for all the active channels.

Data Index
The current data point number of the current acquisition.

Time
The current time position of the cursor and the video.

Modifying the Data Window Appearance

To modify the appearance of the Data Window, follow these steps.

1. Open a Data Graph Window, as shown above.

2. Click on the **CONFIGURE GRAPH** button

The top half of the window is displayed to selecting the active channels to display or to block from display. The bottom half of the window contains the following selection information:

Use Units
When this option is selected, the Y-axis (vertical axis) is displayed in units rather than volts.

Y Label from Channel x
When selected, this option calculates the maximum of the Y-axis label with the data from the selected channel (must be an active channel). If only one channel is active, or if this checkbox is unselected, the Y-axis maximum value will be calculated as the maximum of the first active channel (e.g. channel 0).

To activate or deactivate any channels, use the **ADD** and **REMOVE** buttons. The "Displayed" channels are shown on the right side of the ledger. The "Not Displayed" channels are shown on the left side. To move, simply highlight the channel of interest and press the **ADD** or **REMOVE** buttons.

Clicking on WINDOW then CREATE NEW GRAPH can create new graphs. A single screen appears asking for the name of the new graph. Once the new graph appears on the Photron Motion Tools desktop, use the **CONFIGURE GRAPH** button to customize its appearance.

Important Notes on Photron Motion Tools Data Acquisition

1. All cameras in the computer must have their jumpers set to SLAVE mode.

2. The Photron cameras do not support a Software trigger when slaved to an external piece of hardware like the data acquisition card.   The only way to trigger the system is from an external trigger.

3. Data acquisition is enabled when the DAQ Control box is visible. If you dismiss this box, Photron Motion Tools is set to video only mode and you must select "Record Synchronized Data" again.

4. Consult with your sensor manufacturer for specific details regarding your sensor(s). The Photron Motion Tools breakout Box accepts –10V to 10V signals (the standard in the data acquisition Industry). If your sensors put out more than this amount, you might damage the inputs.

5. Whenever possible, use the TT trigger inputs with data and/or multiple synchronized cameras. Inherent in the design architecture of the Photron FastCam PCI cameras is a –30 to +30 ms trigger frame offset when using the TS inputs. The corresponding frame offset for the TT trigger lines is approximately +/- 1 frame.

6. The FastCam PCI, FastCam PCI R2 and FastCam-X 1280 PCI, when slaved to the data acquisition card, can be triggered by a Hand-Switch on the TS trigger line, or a TTL-logic rising edge on the TT line.

7. If the cameras are opened in the incorrect order per their internal wiring (e.g. camera 2 is opened first), the cameras will not trigger properly. You may realize an error message "PCC Error: OnCommand Camera Mode". You may also realize a message telling that you cannot stop a camera while another camera in the chain is recording. If you find this situation, you must abort the recording per the following steps:

    a. Right click within the recording window.

    b. Select Record.

    c. Select Abort Recording
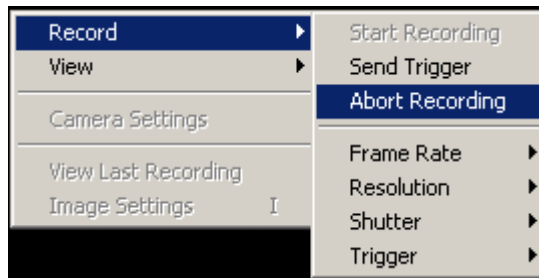
After aborting a recording, open the cameras in the correct order according to the hardware connection.

Synchronizing to GPS or IRIG Time Generators

NOTE: *This chapter is for users who have purchased and installed the* **GPS/IRIG Module** *for Photron Motion Tools.*

Overview

The PhoMoTo GPS/IRIG module provides the ability for Photron cameras to accurately read time and location information. This information is provided from either a time generator that is centrally located to all the instruments participating in the measurement (e.g. an IRIG time generator) or from the network of Global Positioning Satellites (GPS), which broadcast master time as well as signals that enable PhoMoTo to calculate its exact position on earth.

The PhoMoTo GPS/IRIG module phase locks all the internal clocks within the PhoMoTo system to the external source. It displays the local frame time and the universal time.

The primary function of the GPS/IRIG module board is to provide precise time and frequency to the cameras. The GPS/IRIG board can derive time from any of the sources listed following.   In all but the Free Running mode of operation, the board synchronizes its on board 10 MHz oscillator to the timing source.

The GPS/IRIG board achieves synchronization by extracting a signal from the timing source and using this signal to discipline the oscillator such that the locally generated signal is matched in phase and frequency to the reference.   Once synchronization is achieved, the GPS/IRIG board is able to maintain time even if the timing source is lost (though some timing drift will occur); this is referred to as flywheeling. The GPS/IRIG board will also obtain time (as much as possible) from the timing source if it is available.

You can also use your GPS/IRIG board as a timing generator for other devices nearby.

Installation

The Photron GPS/IRIG module contains five pieces of hardware -- a GPS/IRIG card for PCI bus, a 15-pin pigtail terminated in 5 BNC connections, and a BNC-BNC coaxial cable, a GPS Antenna Kit, and a BNC feedthrough panel terminating in a sync connector for the type of camera you are using (FastCam PCI or FastCam-X 1280 PCI).

Installing the GPS/IRIG Module requires 4 steps.

- Install the cameras and Photron Motion Tools.

  It is assumed that users already have successfully installed their Photron high-speed video cameras and Photron Motion Tools software prior to installing this Synchronized Data Acquisition module. If not, consult the Installation Procedures in your Photron Motion Tools User Guide.

- Install the GPS/IRIG Hardware into the computer

- Interconnect the GPS/IRIG Hardware with the Video Cameras

- Install the GPS/IRIG software Drivers

- Reinstall your software and enter a new license key code.

Confirm that your Cameras are Set to SLAVE Mode

1. Shut down your computer.

2. Confirm that all the cameras are set to SLAVE mode. Depending on which cameras you are using, SLAVE mode is set differently.

If your camera is a model *FastCam PCI*:

3. Make sure that the SLAVE jumper pins have the "jumper" connector installed as shown in the following picture
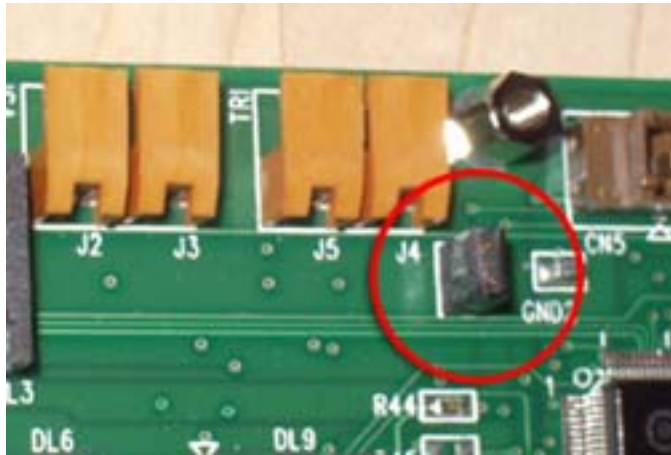
If your camera is a model *FastCam PCI R2:*

3. Make sure that dip switch #4 in the dip switch block is set to ON, as shown in the following picture (jumpers 1,2 and 3 are shown below in the OFF position for clarity only – set these according to the hardware instructions that came with your camera):
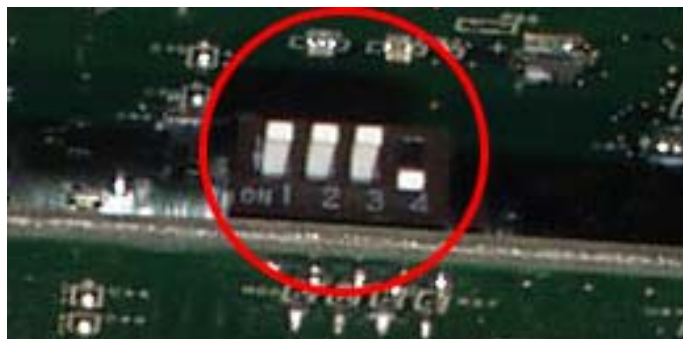
If your camera is a model *FastCam-X 1280 PCI*

3. Make sure that dip switch #3 in the dip switch block is set to ON, as shown in the following picture (jumpers 1,2 and 4 are shown below in the OFF position for clarity only – set these according to the hardware instructions that came with your camera):
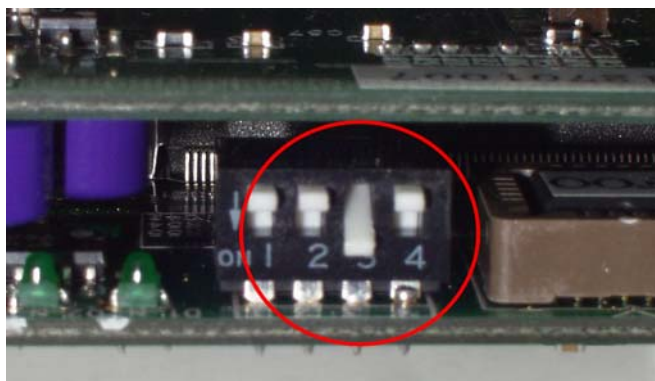
If your camera is a model *FastCam 512 PCI*,

3. Make sure that dip switch #4 in the dip switch block is set to ON, as shown in the following picture (jumpers 1,2 and 3 are shown here in the OFF position for clarity only – set these according to the hardware instructions that came with your camera):

Install the GPS/IRIG Board into the Computer

4. In an open PCI slot, install the GPS/IRIG card.

5. Attach the 5-BNC pigtail to the GPS/IRIG card back panel.

Interconnect the GPS/IRIG Board and the Cameras

If your camera is a model *FastCam PCI*:

6. If you are using more than one camera in the computer, determine which camera (and associated camera board) will be "Camera #1" (the first camera in the chain) inside the computer.

7. In an open computer back panel location that is adjacent to the Camera #1 board, install the BNC Feedthrough Panel Adapter that is supplied with your system.

8. Connect the cable from the Feedthrough Panel Adapter to the VSI connector on the Camera #1 board.
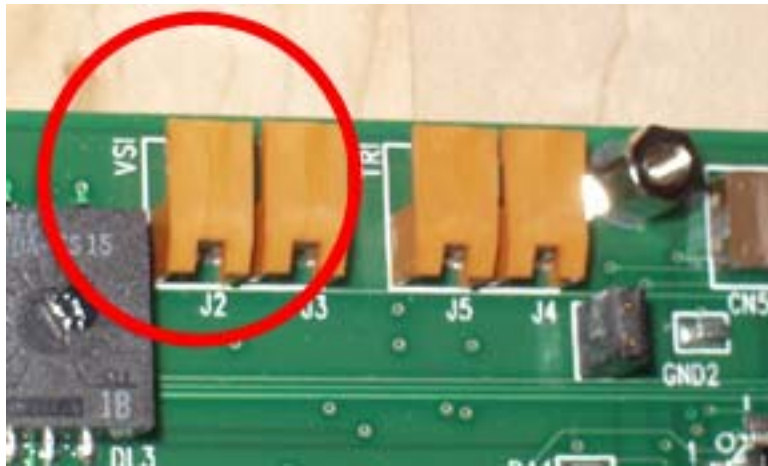
i.

9. If you are using multiple cameras, interconnect the other cameras using the internal VSI to VSO cables supplied by Photron. Record the order in which the cameras are interconnected (for example: SN 1 to SN 2 to SN3). It is also recommended that you interconnect the TRI to TRO ports as well, to allow proper use of the cameras without Data Acquisition mode enabled.

10. Connect one end of the supplied BNC-BNC coaxial cable to the "Heartbeat Out" BNC connector on the pigtail.

11. Connect the other end of the BNC-BNC coaxial cable to the BNC Feedthrough Panel.

12. Connect the external event trigger input to the "Event Trigger In" BNC connector on the pigtail and connect the external event trigger to each camera in the computer. Use the TS connection if the event trigger is a hand switch. Use the TT connection if the event trigger is a TTL source.

13. Connect to your time source. If you are connecting to a land-based time code generator (IRIG or NASA, for example), connect your source to the BNC on the pigtail labeled "Time Code Input". If you are using GPS for time and location information, your antenna is connected to the small connector on the GPS/IRIG board back panel.

Note: the trigger must be connected to the GPS/IRIG card AND each camera in the computer.

The following schematic shows the interconnections for the model **FastCam PCI camera**:

If your camera is a model *FastCam PCI R2*:

6. If you are using more than one camera in the computer, determine which camera (and associated camera board) will be "Camera #1" (the first camera in the chain) inside the computer.

7. Connect one end of the supplied BNC-BNC coaxial cable to the "Heartbeat Out" BNC connector on the pigtail.

8. Connect the other end of the BNC-BNC coaxial cable to the SYNC IN connection on the camera you have selected to be Camera #1.

9. Interconnect the synchronization lines for the other cameras using the external SYNC IN and SYNC OUT cables supplied by Photron. Record the order in which the cameras are interconnected (for example: SN 1 to SN 2 to SN3).

10. Connect the external event trigger input to the "Event Trigger In" BNC connector on the pigtail and connect the external event trigger to each camera in the computer. Use the TS connection if the event trigger is a hand switch. Use the TT connection if the event trigger is a TTL source.

11. Connect to your time source. If you are connecting to a land-based time code generator (e.g. IRIG), connect your source to the BNC on the pigtail labeled "Time Code Input". If you are using GPS for time and location information, connect your antenna to the small connector on the GPS/IRIG board back panel.

    Note: the trigger must be connected to the GPS/IRIG board AND each camera in the computer.

If your camera is a model *FastCam-X 1280 PCI*:

6.   If you are using more than one camera in the computer, determine which camera (and associated camera board) will be "Camera #1" (the first camera in the chain) inside the computer.

7. In an open computer back panel location that is adjacent to the Camera #1 board, install the BNC Feedthrough Panel Adapter that is supplied with your system.

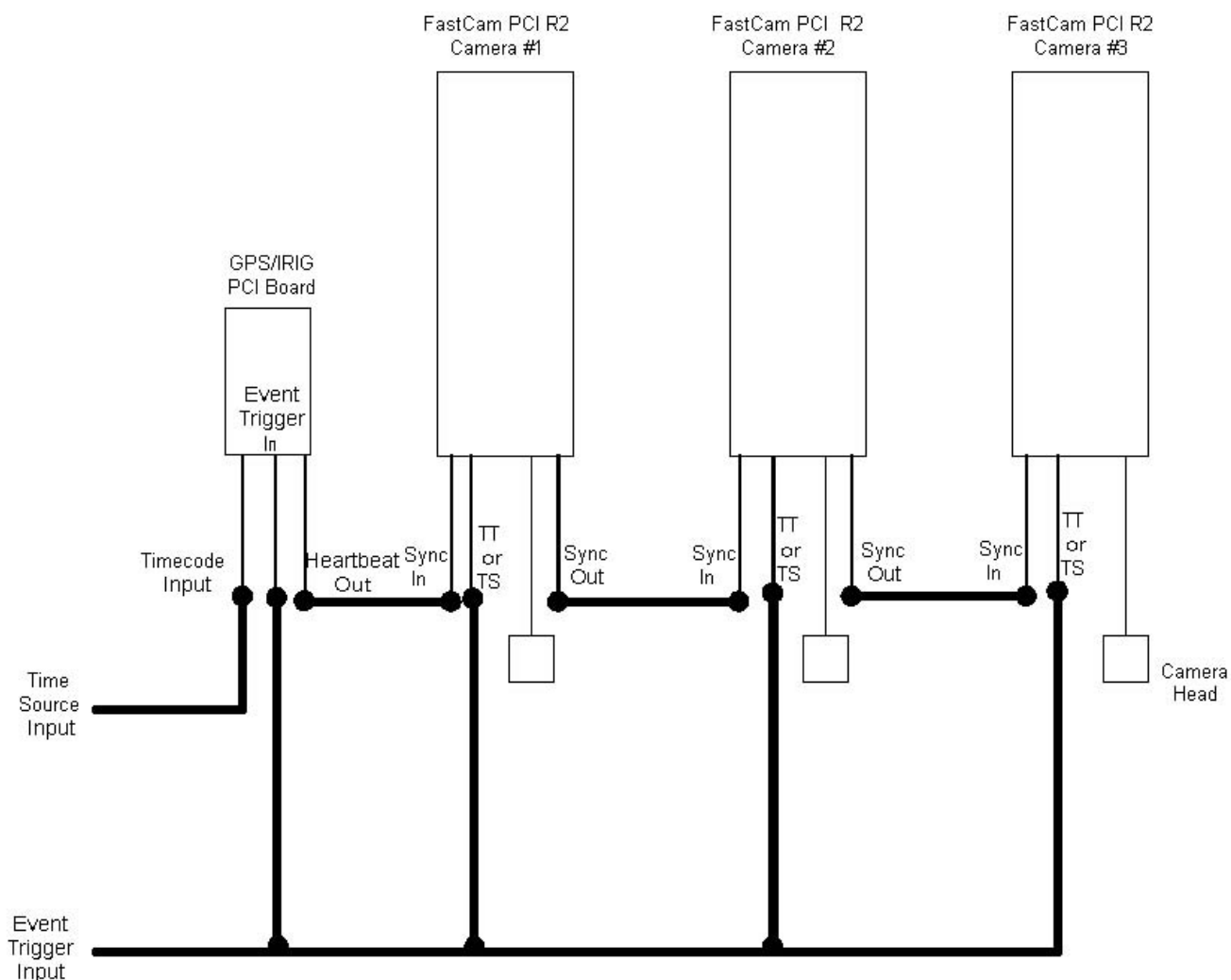8. Connect the cable from the Feedthrough Panel to the BD_IN connector on the Camera #1 board.

9. If you are using multiple cameras, interconnect the other cameras using the internal BD_OUT to BD_IN cables supplied by Photron. Record the order in which the cameras are interconnected.

10. Connect one end of the supplied BNC-BNC coaxial cable to the "Heartbeat Out" pigtail connector.

11. Connect the other end of the BNC-BNC coaxial cable to the BNC Feedthrough Panel.

12. Connect the external event trigger input to the "Event Trigger In" BNC connector on the pigtail .

13. Connect the external event trigger to each camera in the computer. Use the TS connection if the event trigger is a hand switch. Use the TT connection if the event trigger is a TTL source.

Note: the trigger must be connected to the GPS/IRIG card AND each camera in the computer.

Note: on some FastCam-X 1280 PCI cameras, the external TT and TS lines are disabled. Check with Photron to determine the status of your FastCam-X 1280 PCI. If your camera board has these ports disabled, connect the external trigger input for that camera directly to the other half of the BD_IN connector.   The trigger portion of the BD_IN connector supports either Hand-Switch or TTL-logic falling edge.

14. Connect to your time source. If you are connecting to a land-based time code generator (IRIG or NASA, for example), connect your source to the BNC on the pigtail labeled "Time Code Input". If you are using GPS for time and location information, your antenna is connected to the small connector on the GPS/IRIG board back panel.

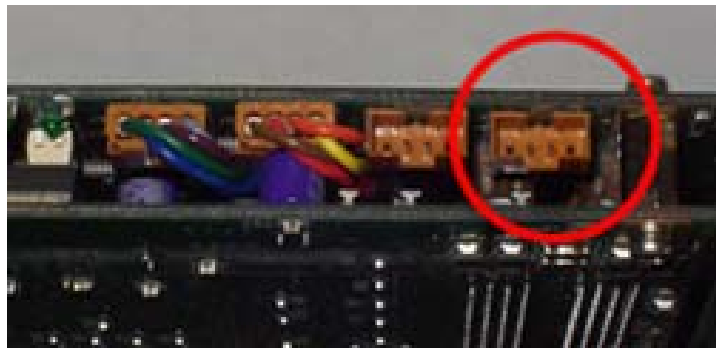The following schematic shows the interconnections for the FastCam-X 1280 PCI camera:

If your camera is a model *FastCam PCI R2*:

6. If you are using more than one camera in the computer, determine which camera (and associated camera board) will be "Camera #1" (the first camera in the chain) inside the computer.

7. Connect one end of the supplied BNC-BNC coaxial cable to the "Heartbeat Out" BNC connector on the pigtail.

8. Connect the other end of the BNC-BNC coaxial cable to the SYNC IN connection on the camera you have selected to be Camera #1.

9. Interconnect the synchronization lines for the other cameras using the external SYNC IN and SYNC OUT cables supplied by Photron. Record the order in which the cameras are interconnected (for example: SN 1 to SN 2 to SN3).

10. Connect the external event trigger input to the "Event Trigger In" BNC connector on the pigtail and connect the external event trigger to each camera in the computer. Use the TS connection if the event trigger is a hand switch. Use the TT connection if the event trigger is a TTL source.

11. Connect to your time source. If you are connecting to a land-based time code generator (e.g. IRIG), connect your source to the BNC on the pigtail labeled "Time Code Input". If you are using GPS for time and location information, connect your antenna to the small connector on the GPS/IRIG board back panel.

> Note: the trigger must be connected to the GPS/IRIG board AND each camera in the computer.

Install the GPS/IRIG drivers (Windows 2000 and Windows XP):

15. Turn on your computer. Log in as Administrator.

16. The Found New Hardware notice will appear.

17. Insert the Photron Motion Tools disk supplied with your system. If the disk starts automatically (e.g. auto-runs), cancel and close the disk.

18. Windows will inform you that it found the drivers in **"F:\ Drivers\TimeSynch\Win2000_XP\",** where **F**: is the letter of your CD Drive. If not, then navigate the browser to this folder and file.

19. Click **OK**.

20. Remove the Photron Motion Tools disk.

21. Restart your computer.

Install the GPS/IRIG drivers (Windows NT 4.0):

14. Turn on your computer. Log in as Administrator.

15. Insert the Photron Motion Tools disk supplied with your system. If the disk starts automatically (e.g. auto-runs), cancel and close the disk.

16. Navigate to the **F:\Drivers\TimeSynch\NT** folder, where **F:** is the letter of your CD drive.

17. Find and double-click on the file named "Install.bat". This will run a program that will automatically install the correct NT drivers. Alternatively, from the **RUN** prompt, type "F:\camera drivers\NT\INSTALL.BAT", where F is the letter of your CD drive.

18. If prompted to finish the installation, click on **OK**.

19. Restart your computer.

Reinstall Photron Motion Tools and Enter a new License Code.

Note: it is not necessary to re-install Photron Motion Tools to use the GPS/IRIG Module. However, if your system included a new application disk, it may contain new drivers or updates. To re-install a new version of Photron Motion Tools, use the following instructions.

30. During the installation procedure, the installer will automatically detect that you are upgrading a previous version of Photron Motion Tools software. You will see the following screen.
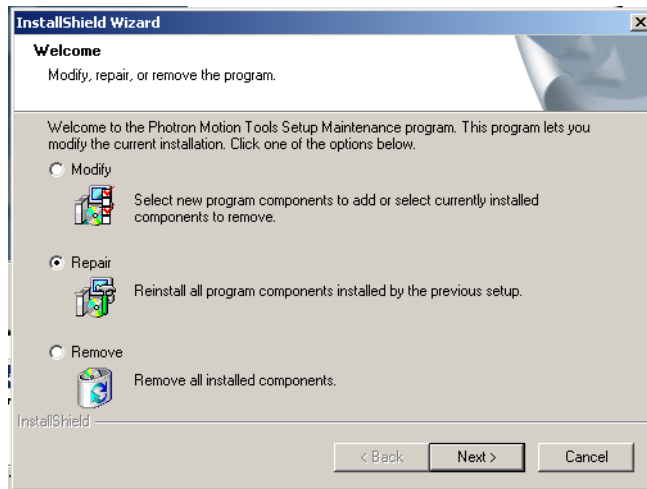
31. Select the Repair option.

32. Click **NEXT**.

33. The installer will then install the new application and all the appropriately modified files. During the installation process, which could take many minutes, a status box will appear.
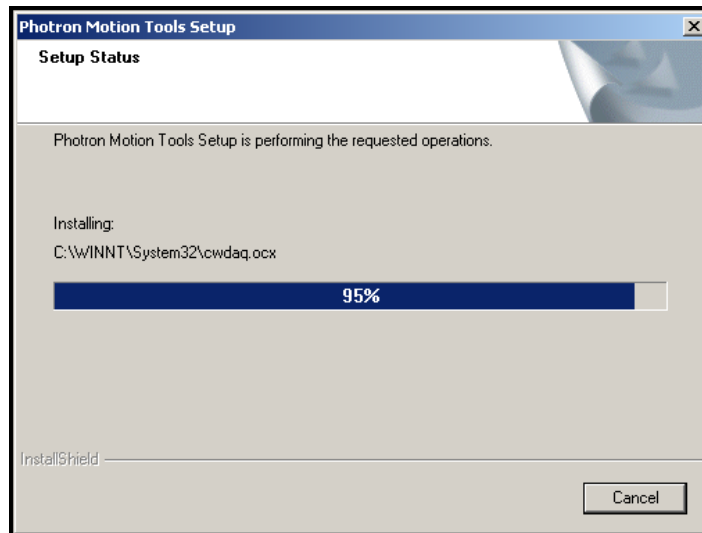
64. The installer may prompt you that it has detected a READ ONLY file, and ask you if you wish to overwrite this file.

65. Click **YES**.

66. If a Hardlock driver is required, the installer will start the Hardlock driver installer. Click **NEXT**. The drivers will be installed.

67. When complete, the maintenance complete window will appear.
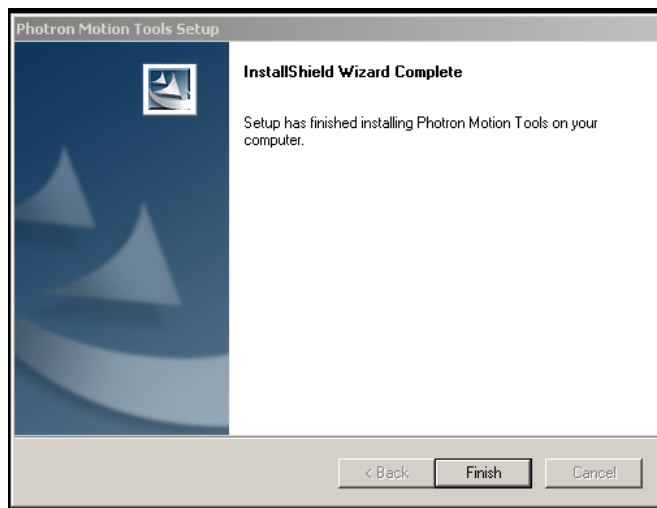
68. Click **FINISH**.

69. Remove the CD-ROM from your CD drive.

70. Restart your computer.

71. Your Synchronized Data Acquisition System includes a new License Key Code. To renter your new License Key Code, click on the Windows **START** button, then **PROGRAMS**, then **PHOTRON MOTION TOOLS**, and then **LICENSE MANAGER**.

56. Enter the 16-digit license code in the New License section. You can find the license code on your Registration Card.

57. After you have entered your license code, click on **CHECK LICENSE**. If you have entered the license correctly, information about the key tag, and a list of the features of Photron Motion Tools that you have purchased will be listed and the **ENABLE LICENSE** button will also become highlighted.

58. Press the **ENABLE LICENSE** button.

Congratulations. You are now ready to use the Photron Motion Tools GPS/IRIG Module.

Configuring to Record with GPS/IRIG:

To record with the GPS/IRIG receiver, you must first configure PhoMoTo to synchronize its internal clock with the external time code generator (e.g. IRIG or GPS).

1. Under Mode, select GPS/IRIG Time Sync.

2. Open a camera and set the frame rate, shutter and other test conditions as described in Chapter 2 of this User Guide.

PHOTRON MOTION TOOLS
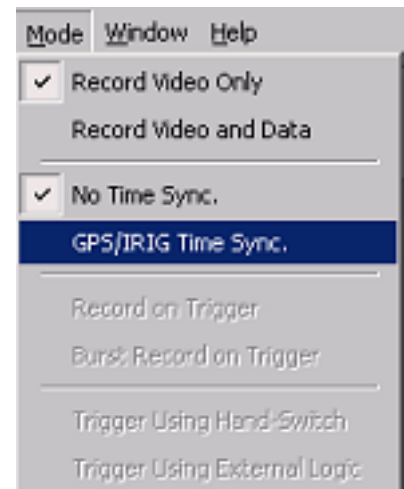
3. Select your trigger mode, as described in Chapter 2 of this User Guide. Note that the FastCam-X 1280 PCI triggers on the falling edge of a trigger pulse.

4. To configure the settings of GPS/IRIG, select GPS/IRIG Timing from under the Tools menu item.
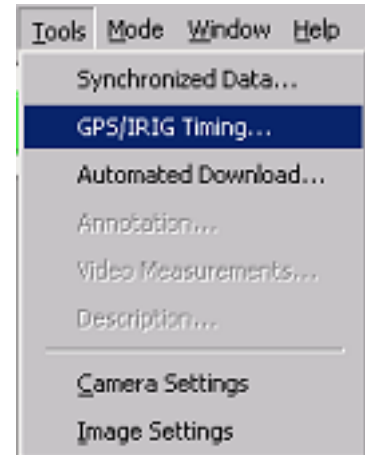
5. The GPS/IRIG Settings window appears (this window will appear slightly differently if a non-GPS mode is selected)

6. Set the mode and other settings per the instructions below. You can close this window or leave it open to monitor signal strength, if desired.

7. Record an image as described in the previous chapters of this user guide. Trigger the recording using an external trigger.

8. Display the information below each recorded image per the instructions below.

GPS/IRIG Modes

These various modes are selected from the modes dropdown menu on the GPS/IRIG timing window. The selection of one of these modes configures PhoMoTo to receive its external synchronization from the indicated source.

IRIG-B DC	The external source that you are connecting to the GPS/IRIG pigtail connection labeled "Time Code Input" is an Inter Range Instrumentation Group Format-B DC Level Shift device. The user must set the correct year.
IRIG-B AM	The external source that you are connecting to the GPS/IRIG pigtail connection labeled "Time Code Input" is an Inter Range Instrumentation Group Format-B Amplitude Modulation device. The user must set the correct year.
IRIG-A DC	The external source that you are connecting to the GPS/IRIG pigtail connection labeled "Time Code Input" is an Inter Range Instrumentation Group Format-A DC Level Shift device. The user must set the correct year.
IRIG-A AM	The external source that you are connecting to the GPS/IRIG pigtail connection labeled "Time Code Input" is an Inter Range Instrumentation Group Format-A Amplitude Modulation device. The user must set the correct year.
GPS	Used when a Global Positioning System (GPS) antenna is connected to the GPS/IRIG card. mounted such that it has an unobstructed view of the sky.
	An unobstructed view of the sky is important because the GPS sensor must initially track four satellites to obtain accurate time.
1 Pulse/Sec	The external source that you are connecting to the GPS/IRIG pigtail connection labeled "Time Code Input" is a 1 pulse per second square wave. Note that it is important that you have verified the integrity (level and stability) of this signal. There is no way for PhoMoTo to verify that what you have connected is indeed a 1 pulse per second TTL square wave. The user must set the correct year, month, day, minute, and second.
Free Run	This mode allows the user to perform measurements when an external timing source is unavailable.
	You are explicitly stating that you are not using an external source to synchronize the GPS/IRIG board and therefore not using the connection to the GPS/IRIG pigtail.
	Note: The GPS/IRIG board will behave as if it is in Free Run mode if it loses communication to the external source for which

you have it configured.

IEEE 1344	The external source that you are connecting to the GPS/IRIG pigtail connection labeled "Time Code Input" is an IEEE 1344 device.
NASA 36	The external source that you are connecting to the GPS/IRIG pigtail connection labeled "Time Code Input" is an NASA 36 device.

The GPS/IRIG module's current date and time is displayed in the top text field.   This information is automatically obtained from the external time source when possible. In the various IRIG modes, IEEE 1344, and NASA 36 modes the user must set the year.

In 1 Pulse/sec and free run modes, the user must set the year, month, day, hour, minute, and second. PhoMoTo assists you in setting this information by obtaining the operating system clock when you press the "Set Time…" button.

The "Last Trigger" text field is populated with the date and time of the last trigger event that the GPS/IRIG board received. This field is not displayed until you have performed at least one recording.

In GPS mode only, the "Latitude", "Longitude", and "Altitude" text fields display their information as labeled. The button "Get Position" will read this information from the GPS/IRIG board.

Status Indicators

There are 3 status indicators in the "Status" group box to indicate the state of the GPS/IRIG board.

The "Valid Input" indicator is green when the GPS/IRIG board is tracking the indicated reference time source.   If the light is red, it indicates that the GPS/IRIG board is not tracking the time source, usually because the time source has been lost of has become unstable. When this is the case, the board is flywheeling, and will keep time at the last known rate. When a timing Mode changes this light will go read until the GPS/IRIG board locks to the new timing source.

The "Phase Lock" indicator is green if the GPS/IRIG board oscillator is synchronized to better than 5 microseconds in IRIG, NASA, and IEEE modes; or to better than 2 microseconds in all other modes.

The "Frequency Stable" indicator is green if the on-board oscillator frequency offset relative to the timing source is better than 5×10^{-8}.
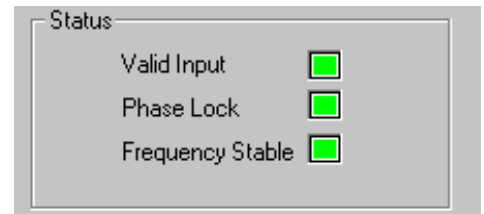
Satellite Strength Indicators (GPS mode only)

On the GPS tab, you will find a box on the lower right, labeled "Satellites". This satellite group box contains information regarding the satellites that the GPS antenna can see. The text fields to the left of the edit boxes indicate the unique satellite identifier number. The number in the edit box indicates the received signal strength for the labeled satellite.

The **GET POSITION** button will read this information from the GPS/IRIG board. If PhoMoTo is unable to read the satellite signals, it will display an NA (Not Available).

Setting Local Time and Generator Mode

Clicking on the **SETTINGS** button on the GPS or IRIG/NASA tab opens the settings dialog box shown at right.

In general you will not need to adjust the parameters that are accessed from this dialog box. They are typically set once (factory) and not touched.

The Settings box allows you to override certain time signals, to reset local time, or to add an offset to time to compensate for time zone changes. It also allows you to set your GPS/IRIG board as a "Generator", where it sends pulses out instead of reading them in. This allows you to daisy chain many instruments off the PhoMoTo GPS/IRIG hardware – a very valuable feature in the field. The following are the setting options you can change:

Receiver (Decoder) Settings
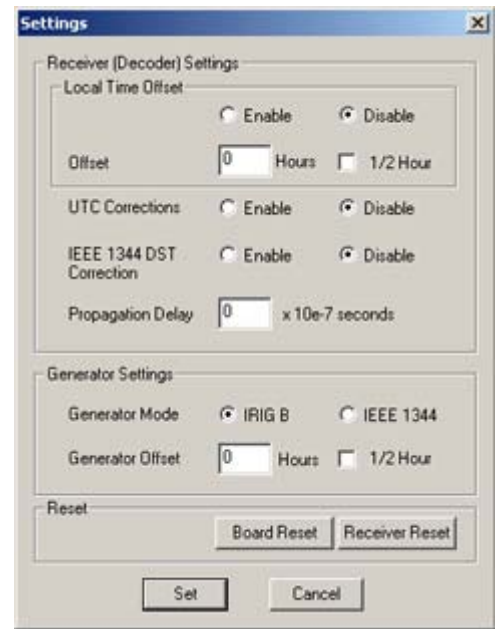
Local Time Offset	Enable / disable the local time offset.
Offset	You can offset local time up to 16 hours from the receiver time in ½ hour increments.
UTC Corrections	The UTC Corrections may be enabled or disabled. Enabling UTC Corrections commands the device to include any leap second corrections provided by the reference source and act on any leap event data that is present.
IEEE 1344 DST Correction	The IEEE 1344 Daylight Savings Time Corrections may be enabled or disabled. Enabling IEEE 1344 DST Corrections commands the device to include the daylight savings time corrections provided by the reference.
Propagation Delay	It is sometimes desirable to program an offset into the basic time keeping functions relative to the reference input. For example, if the reference input is an IRIG-B time code, there may be significant cable delay between the IRIG-B generator and the GPS/IRIG board. The delay setting allows this time difference to be removed by inserting the known amount of offset between the IRIG B reference and the GPS/IRIG board location; in this scenario, a positive offset would be used.

Generator Settings

Generator Mode	An IRIG B or IEEE 1344 time code output signal is available in both modulated and DCLS (DC Level Shift) forms. This signal will be present at the GPS/IRIG pigtail connector labeled "Time Code Output".
Generator Offset	The generator can output signal that is offset by up to

16 hours in ½ hour increments from its current time.

Reset Settings

Board Reset	You should never need to hit this button. This performs a board level reset of the PhoMoTo GPS/IRIG board.
Receiver Reset	You should never need to hit this button. This performs time code (and GPS) receiver reset of the PhoMoTo GPS/IRIG board.

Configuring the GPS Connection (GPS Modes only)

Clicking on the **GPS CONFIG**... button on the GPS enabled tab opens the GPS configuration dialog box shown below.

In general, you will have no need to adjust the parameters in this dialog window. This information is provided for the "GPS Power User". The default parameters are such that they should work for the majority of applications.

Position Fix Mode
The options for this are Automatic, Manual 2D, and Manual 3D.

The preferable fix mode is 3D, where altitude is calculated along with the latitude, longitude and time. However, this requires four satellites with a PDOP below the PDOP mask set in order to obtain position. Normally, this would provide the most accurate solution. Thus, if only 3-D solutions are desired, then you should select 3D manual mode. Depending on how the PDOP mask is set, this may be restrictive when the receiver is subjected to frequent obscuration, or when the geometry is poor due to an incomplete constellation.

Alternatively, if you only want a 2D solution, then 2D manual should be requested. In this case, the sensor uses either the last altitude obtained in a 3D fix, or the altitude supplied by the user. However, any error in the assumed altitude will affect the accuracy of the latitude and longitude solutions. High accuracy users should avoid this mode and should expect fixes with accuracy's that are at best as accurate as the supplied altitude. If a marine user enters sea-level as the altitude, then small errors in the horizontal solution will occur when the sea is rough or there are high tidal variations. However, these errors may be smaller than the altitude errors induced by the supplied altitude, so 2D may be preferable for a marine user who does not want to observe "unusual" altitudes.

The default mode is Auto 2D/3D, where the receiver first attempts to obtain a 3D solution with a PDOP below the PDOP mask and PDOP switch.   If this is not possible, then the receiver attempts to obtain a 2D solution with a PDOP less than the PDOP mask. This mode supplies fairly continuous position fixes even when there is frequent obscuration. This mode is preferable for most land or air applications, where altitude changes are occurring and there is occasional obscuration.

Initial Position
By clicking on the **SET**... button in the Initial Position group box, the user can set the initial "guess" for the position of the receiver. This is also the location where you set the altitude, if in 2D mode.
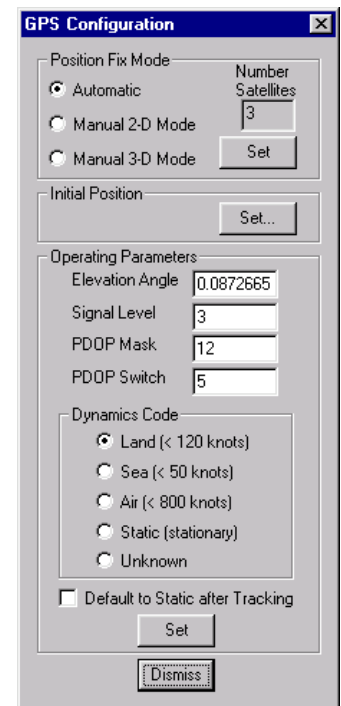
Operating Parameters

To understand the operation of the PhoMoTo GPS/IRIG hardware, one should first understand both "PDOP" and how it affects the quality of GPS data.

Dilution of precision (DOP) is the mathematical representation of the quality of GPS data being received from satellites. The number of visible satellites and their relative positions in the sky control DOP. The most commonly used dilution of precision is position dilution of precision (PDOP), which is the combination of horizontal dilution of precision (HDOP) and vertical dilution of precision (VDOP). A PDOP value of 1 indicates an optimum satellite constellation and high-quality data. The quality of the data decreases as the PDOP value increases.

Elevation Angle	This is the minimum elevation angle for satellites to be used in a solution output by the receiver. Satellites that are near the horizon are typically more difficult to track due to signal attenuation and are also generally less accurate due to higher variability in the ionospheric and tropospheric corruption of the signal. When there are no obstructions, the receiver can generally track a satellite down to near the horizon.
	When this mask is set to low, the receiver may experience frequent constellation switching due to low elevation satellites being obscured. Frequent constellation switching is undesirable because small position jumps may be experienced when selective availability (SA) is present.
	The benefit of a low elevation mask is that more satellites are available for use in a solution and a better PDOP may be yielded. The current mask is set to five degrees and provides a reasonable tradeoff of the benefits and drawbacks. High accuracy users may prefer a mask angle around ten degrees, where the ionosphere and troposphere begin to be more predictable.
Signal Level	This mask defines the minimum signal strength for a satellite to be used in a solution. There is some internal hysteresis on this threshold that allows brief excursions below the threshold if lock is maintained and the signal was previously above the mask. The mask has been set to 4.0 in V1.14 and higher versions due to increased tracking capability now included. The mask should only be lowered cautiously since this mask is also used to minimize the effects of jammers on the receiver. High accuracy users may use a slightly higher mask of 5.0-6.0 since weaker measurements may be slightly noisier. However, good performance is available with the default setting.
PDOP Mask and Switch	The PDOP mask is the maximum PDOP for which any 2-D or 3-D solution will be made. The switch is the level at which the receiver stops attempting a 3-D solution, and tries for a 2-D solution when in automatic 2-D, 3-D mode. The switch level has no affect on either manual mode. Raising the PDOP mask will generally increase the fix density during obscuration, but the fixes with the higher PDOP will be less accurate (especially with SA present). Lowering the mask will

<table>
<tr><td></td><td>improve the average accuracy at the risk of lowering the fix density.</td></tr>
<tr><td>Dynamics Code</td><td>In AIR mode the receiver assumes a high dynamic environment. In this case, the satellite search and reacquisition routines are optimized to tolerate high accelerations. A user, which is subject to only benign accelerations (less than l g) may benefit by selection of LAND or SEA mode where the search and reacquisition routines assume a low acceleration environment. In this case, satellite loss-of-lock is due more often to obscuration rather than extreme dynamics.</td></tr>
<tr><td>Default to Static</td><td>If the checkbox "Default to Static After Tracking" is set. The receiver will switch to Static Mode after satellite acquisition and lock.</td></tr>
</table>

Displaying Synchronized Time and Position

After you have completed a recording using the GPS/IRIG module, in addition to the video or video/data you will have some or all of the following information:

- The time for every frame.

- The time of the trigger. The trigger time will occur at any time not just at a frame edge. The zero frame, is the frame that was in the process of being recorded when the trigger was received.

- The position of the GPS antenna (GPS mode only)
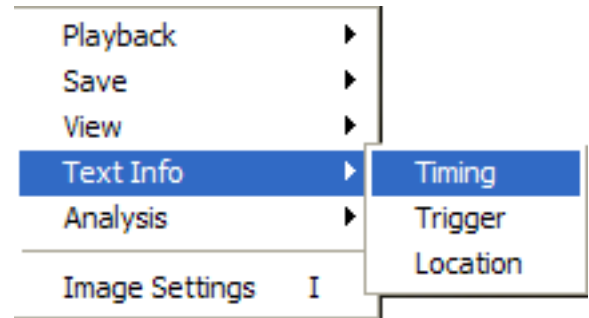
You can access this information by using a contextual command. Right click within the image window. A menu will appear that will allow you to display the GPS/IRIG generated information.

A window will appear below the image window. The selected information will appear within this window. The information is retrieved from the PhoMoTo Binary File. The raw video and the stored information are not modified in any way with PhoMoTo. The information that is displayed is summarized as follows for each of the display options shown in the figure at right. .

<table>
<tr><td>Timing</td><td>text information will appear below the video sequence, in the following format:

"Year-Month-Day-Hour-Minute-Second-Fraction of Second "− Source: "Source Text"</td></tr>
<tr><td>Trigger</td><td>text information will appear below the video sequence, in the following format.:

"Year-Month-Day-Hour-Minute-Second-Fraction of Second" Trigger Time</td></tr>
<tr><td>Location</td><td>text information will appear below the video sequence, in the following format:

"Lat ###.####, Long ###.####, Alt ###.####"</td></tr>
</table>

To maintain compatibility across all recording options, you have the option to display the time and position information even if you don't have the GPS/IRIG module.   PhoMoTo will either display un-initialized numbers as is the case for latitude, longitude, and altitude, or it will display information taken from another source as is the case for Timing.

The source text for Timing will be one of the following text descriptions:

Source: Synch from External Source	This text is displayed next to the Frame Time, when the sequence that you are viewing was recorded with a PhoMoTo GPS/IRIG module enabled. It means that the information was fundamentally obtained, as described above, from the external time source (GPS, IRIG-B, etc.). It also means that this was the first camera in a multi-camera chain.
Source: OS System Clock at Acquisition	This text is displayed next to the Frame Time, when the sequence that you are viewing was recorded with PhoMoTo but did not use the PhoMoTo GPS/IRIG module. This means that the frame time is derived from the system clock time at the end of the recording. It also means that this was the first camera in a multi-camera chain.
Source: Derived from Master	This text is displayed next to the Frame Time, when the sequence that you are viewing was recorded with a PhoMoTo. It means that the information was fundamentally obtained, as described above, from the external time source or the OS system clock. It also means that this camera was "down the chain" (i.e. not the first camera) in a multi-camera chain.
Source: OS File Create Time	This text is displayed next to the Frame Time, when the sequence that you are viewing was recorded with PhoMoTo before the GPS/IRIG module was available, or you used another system to acquire the sequence. It means that time is derived from the time of file creation. The last frame is treated as if it were created at file creation time.

When using multiple cameras, all cameras in the chain are phase locked and synchronized through the hardware chain to the external time source. All cameras in the record sequence will have the correct timing, trigger, and location information if present, as shown in the following figure:

Using your GPS/IRIG Board as a Time "Generator"

The GPS/IRIG board generates IRIG-B or IEEE 1344 time code synchronized to the reference source. Modulated and DC level shift format are produced simultaneously.   The generator is available in any mode of operation. Simply connect the hardware that can read either IRIG-B or IEEE 1344 to the "Time Code Output" connector on the GPS/IRIG pigtail, and select which generator mode you would like to use.

The mode selection is made from the GPS/IRIG module Settings Dialog as shown at right. The options for using your GPS/IRIG board as a generator as follows:

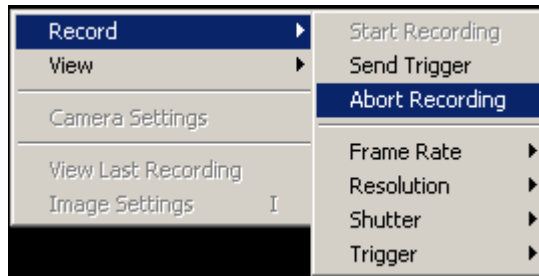|	
Generator Mode	An IRIG B or IEEE 1344 time code output signal is available in both modulated and DCLS (DC Level Shift) forms. This signal will be present at the GPS/IRIG pigtail connector labeled "Time Code Output".
Generator Offset	The generator can output signal that is offset by up to 16 hours in ½ hour increments from its current time.

Important Notes on the GPS/IRIG module

1. PhoMoTo GPS/IRIG module may not work properly with your FastCam PCI camera due to a limitation in the camera TTL input signal circuitry. Contact Photron if your FastCam PCI is not working properly with GPS/IRIG module.

2. All cameras in the computer must have their jumpers set to SLAVE mode.

3. The GPS/IRIG module does not work with the Data Acquisition module.

4. Whenever possible, use the TT trigger inputs with data and/or multiple synchronized cameras. Inherent in the design architecture of the Photron FastCam cameras is a –30 to +30 ms trigger frame offset when using the TS inputs. The corresponding frame offset for the TT trigger lines is approximately +/- 1 frame.

5. If Photron Motion Tools is configured for a TT trigger, which is by camera design a rising edge trigger input, and if you start recording with the external trigger line high, then data will be triggered off the falling edge

6. The Photron cameras do not support a Software trigger when slaved to an external piece of hardware like the GPS/IRIG card.   The only way to trigger the system is from an external trigger.

7. The FastCam PCI and FastCam PCI R2, when slaved to the data acquisition card, can be triggered by a Hand-Switch on the TS trigger line, or a TTL-logic rising edge on the TT line.

8. The FastCam 1280, when slaved to the data acquisition card, can be triggered by a Hand-Switch or a TTL-logic falling edge on the trigger portion of the BD_IN connector.

9. You will notice that your resulting recording does not have the exact number of pre and post frames that you would expect as dictated by the trigger percentage. This is due to small latencies in hardware setup times, and the overhead to make certain that everything is occurring on a synchronized edge.   This does not affect your measurement. The time of the zero frame (the trigger frame) is correct, as is all of the time information for every single frame.

10. The "Automatically update GPS information" option accessed from the menu item "OPTIONS- SYSTEM CONFIGURATION" will enable automatic updating of GPS satellite information. You may notice, a slight 'blip' in video playback about every 10 seconds if you automatically update the GPS information, as there is a little overhead associated with obtaining this information from the GPS/IRIG board.

11. Note that it is not necessary to wait for any of the lights to turn green before you do a recording with a PhoMoTo GPS/IRIG module.   However, if you want the accuracy and stability as stated in the performance specifications you must wait until all lights are green.

12. If the cameras are opened in the incorrect order per their internal wiring (e.g. camera 2 is opened first), the cameras will not trigger properly. You may realize an error message "PCC Error: OnCommand Camera Mode". You may also realize a message telling that you cannot stop a camera while another camera in the chain is recording. If you find this situation, you must abort the recording per the following steps:

d. Right click within the recording window.

e. Select Record.

f. Select Abort Recording

Record ▶	Start Recording
View ▶	Send Trigger
	Abort Recording
Camera Settings	
	Frame Rate ▶
View Last Recording	Resolution ▶
Image Settings I	Shutter ▶
	Trigger ▶

After aborting a recording, open the cameras in the correct order according to the hardware connection.