

i-SPEED



USER GUIDE

Software Suite

Contents

Chapter 1 Getting Started	1
Overview of the i-SPEED Software Suite	2
Registration Numbers and License Numbers	2
Control and Control Pro Versions	2
Optional data capture device	4
Purchase Options	4
Chapter 2 Installing the i-SPEED Software Suite	5
Install the i-SPEED Software Suite Application	6
If you have purchased the Control Pro Software package	12
If you have purchased the optional external data box Control Pro Software package	13
If you are upgrading from previous versions of i-SPEED Software Suite	16
Chapter 3 Quick Tutorial	17
Making a Recording	18
Open Stored Images and Data	20
Download and Navigate in Strip View	21
Playing Back in Working View	22
Image Processing to Enhance the Image	24
Calibrate the Video	24
Analyze the Motion	25
Graph the Results	27
Add User Comments	28
Chapter 4 i-SPEED Software Suite Interface	29
General Description	30
The Title, Menu, Tool and Status Bars	34
Tool Tips	37
Image Size and Zooming	37
Context Menus	38
The Reticle	38
The Lens Calculator	39
Chapter 5 Record Settings	43
Connecting to a camera network	44
The Acquire Tool Bar	45
Setting the record parameters	46
Setting the Record Modes	48
Burst Record on Command (BROC) Mode	48
Record on Command (ROC) Mode	49
IRIG Settings (FS Models Only)	49
Rotated and Flipped Video	49
Economy Mode	50
Transfer Format	52
Acquiring User Data	53
Differential Sensors	55
Single-Ended Grounded Sensors (Non-Referenced or NRSE)	55
Single-Ended Floating Sensors (Referenced or RSE)	55
Automatic Download (Control Pro only)	58
Video Trigger	60
Chapter 6 Triggering your Recording	62
Overview of Triggering	63
Trigger Command	63
STOP Command	63
Defining the Reference Frame and Reference Datum	64
Defining a Frame, Exposure Time, and Buffer	64
Camera Trigger Modes	65
Record on Trigger (ROT) Mode	65
Record on Command (ROC) Mode	66
Burst Record on Command (BROC) Mode	67

Chapter 7 Making a Recording	68
The Record Sequence	69
Making a Recording	69
Zooming, Panning and Viewing Live Images	70
Apply Changes to All Cameras	70
Chapter 8 Downloading Images and Data	71
Thumbnails and Full Frames	72
External Data	73
Downloading in the Working View	74
Saving Prior to Downloading	74
Chapter 9 Strip View	75
Strip View Overview	76
Strip View Layout	76
Strip View Definitions	76
Strip View Settings	77
Adding and Removing Strips	79
Navigating in a Strip	79
Playing Strips	80
Bookmarks	80
Edit Recorded Parameters	80
Data Strip Interaction	81
Chapter 10 Working View	82
Working View Overview	83
Working View Layout	83
Adding and Removing Working View Windows	86
The Graph Panel	87
Synchronizing Multiple Windows	88
Chapter 11 Playing Back in Working View	89
Components of the Play Tab	90
Setting Bookmarks	92
Chapter 12 Adding User Comments	93
The Comments Tab	94
The Annotations Tab	95
Chapter 13 Image Processing	98
The Image Processing Tab	99
Image Filtering	99
Image Enhancement	100
Detailed Input/Output Mappings	101
Saving and Loading Processing Settings	103
Chapter 14 Image Calibration	104
The Image Calibration Tab	105
Overview of Calibration	106
Calibrating the Scale	106
Calibrating the Coordinate System (Control Pro version only)	107
Perspective Calibration (Control Pro version only)	109
Saving and Loading Calibration Settings (Control Pro version only)	110
Displaying Calibration Marker (Control Pro version only)	112
Chapter 15 Analyzing Motion	113
Overview of Motion Analysis	114
Control and Control Pro Versions	116
Manually tracking features	117
Automatically tracking features (Control Pro Version)	120
Manually repairing automatically tracked data	126
Displaying position, distance and velocity	127
Exporting Motion Analysis	127
Saving and Loading Tracked Points (Control Pro only)	130

Chapter 16 Graphing User Data and Analysis (Control Pro only)	132
The Graph Panel	133
The Graphing Tab	134
Zooming and Panning a Graph	136
Changing the Displayed Channels	137
Changing the Y Axis	138
Scaling the Visible Data	139
Changing the Line Colors	139
Single Stepping through a Graph	140
Data Filtering	141
Chapter 17 Saving and Reloading your Work	142
Overview	143
i-SPEED Software File Formats	143
Setting the Frame Rate in Saved AVI Files	146
Saving Analyses, Calibrations, Comments and Bookmarks	146
Saving from the Strip View	148
Saving from the Working View	151
Loading Video and User Data into i-SPEED Software	153
Moving and Deleting i-SPEED Files on your Computer	155
Saving and Loading in Bayer Format	156
Chapter 18 Data acquisition add-on module	160
Introduction	161
Differential Sensors	162
Single-Ended Grounded Sensors (Non-Referenced or NRSE)	162
Single-Ended Floating Sensors (Referenced or RSE)	162
Installing the Data Acquisition module	163
Configuring the Data Acquisition Software	164
Chapter 19 IRIG Settings (FS Models Only)	166
Introduction	167
Setting the Camera to IRIG Mode	167
Configuring IRIG Settings for Recording	167
Performing a Recording with IRIG Synchronization	169
Displaying IRIG Time during Playback	169
Chapter 20 Lens Distortion Correction	171
Introduction	172
Applying Lens Distortion Correction to a Video	174

End-user license agreement

NOTE

This license agreement applies to the software supplied on disk with the *i-SPEED* system and not the *i-SPEED* camera itself.

READ THE FOLLOWING TERMS AND CONDITIONS OF THIS AGREEMENT CAREFULLY BEFORE OPENING PACKAGE CONTAINING THE PROGRAM DISKETTES (THE SOFTWARE). BY OPENING THIS PACKAGE CONTAINING THE SOFTWARE YOU ACCEPT AND AGREE TO THE TERMS AND CONDITIONS HEREOF. IF YOU DO NOT AGREE TO BE BOUND BY THE TERMS AND CONDITION OF THIS AGREEMENT, PROMPTLY RETURN THIS PRODUCT UNOPENED AND YOUR MONEY WILL BE REFUNDED. THIS LICENSE AGREEMENT REPRESENTS THE ENTIRE AGREEMENT CONCERNING THE SOFTWARE BETWEEN YOU AND OLYMPUS OPTICAL CO. LTD CORPORATION. ("OLYMPUS").

1. **LICENSE.** In consideration of payment of the Licensee fee, Olympus grants to you, as the End User, and you accept, a nonexclusive, nontransferable sublicense to use the Software for internal use, and not as a service bureau or for the benefit of a third party, in accordance with the terms hereof on one hardware system at a time. If you want to use the Software on more than one hardware system at a time you must obtain separate licenses for each system.

2. **OWNERSHIP OF THE SOFTWARE.** Olympus or its suppliers own and will retain all title, copyright, trademark and other proprietary rights in and to the Software. This sublicense is NOT a sale of the Software or a sale of any copy of the Software. This Agreement does not convey to you an interest in or to the Software but only a limited right of use the Software, as is provided herein, revocable in accordance with the terms of the Agreement. You agree as follows:

- a. You may NOT make any copies of all or any part of the Software except for archival copies and reasonable backups of the Software as may be permitted by the United States Copyright Act.
- b. You may NOT reverse compile, reverse assemble, reverse engineer, modify, incorporate in whole or in part in any other product or create derivative work based on all or any part of the Software
- c. You may NOT remove any copyright, trademark, proprietary rights, disclaimer or warning notice included on or embedded in any part of the Software
- d. You may NOT sell, license, sublicense or otherwise transfer the Software without the prior written consent of the Olympus to function as an Appointed Distributor with respect to the Software. Any Appointed Distributor shall ensure that the End User is not located in a state or territory for which export restrictions exist under US, UK or other applicable laws and shall assist Olympus as requested in documenting compliance.

3. **COPYRIGHT; RESTRICTED USE.** This Software is the property of Olympus or its suppliers and protected by United States copyright laws and international treaty provisions. Therefore, you must treat the Software like any other copyrighted material.

This product and documentation are provided on a RESTRICTED basis. Use, duplication, or disclosure by the US Government is subject to restrictions set forth in Subparagraphs (c) (1) and (2) of the Commercial Computer Software Restricted Rights at 48 CFR 52.227-19, as applicable.

4. **LIMITED WARRANTY.** Olympus warrants, for your benefit alone, for a period of sixty (60) days after receipt by you, that the Software will conform in all material respects to the user documentation furnished to you by Olympus. The sole responsibility of Olympus under this warranty will be, at its option, (1) to use reasonable efforts to correct documented errors in the Software that are reported to it within the forgoing warranty period or (2) to refund the License fee paid. Olympus and its suppliers do not warrant that the Software will be error free, nor that all program errors will be corrected. This limited warranty does not apply insofar as: (a) the Software is subjected to misuse, neglect, accident or exposure to environmental conditions beyond those specified by Olympus and its suppliers; (b) claims resulting from acts or omissions caused by persons other than Olympus or its suppliers or from products, material or software not provided by Olympus or its suppliers; or (c) you use Software that does not include all updates available from Olympus or its suppliers.

THIS IS THE ONLY WARRANTY GIVEN WITH THE SOFTWARE; OLYMPUS ITS SUPPLIERS MAKE NO OTHER WARRANTIES, EXPRESS, IMPLIED, OR ARISING BY CUSTOM OR TRADE USAGE, AND SPECIFICALLY DISCLAIM THE IMPLIED WARRANTIES OR NON-INFRINGEMENT, MERCHANTABILITY OR OF FITNESS FOR ANY PARTICULAR PURPOSE. THIS EXPRESS WARRANTY SHALL NOT BE ENLARGED OR OTHERWISE AFFECTED BY OLYMPUS'S RENDERING OF TECHNICAL OR OTHER ADVICE OF SERVICE IN CONNECTION WITH THE SOFTWARE. KEYMED AND ITS SUPPLIERS SHALL NOT BE HELD RESPONSIBLE FOR THE PERFORMANCE OF OR OUTPUT OBTAINED FROM THE SOFTWARE NOR ANY LIABILITY TO ANY PARTY ARISING OUT OF USE OF THE SOFTWARE OR USE OF ITEMS DESIGNED WITH THE SOFTWARE

5. **HIGH RISK USE UNAUTHORIZED.** The Software are not designed, manufactured, or intended for use in hazardous, medical, or other environments requiring fail-safe performance where the failure of the Software could lead directly to death, personal injury, or significant physical or environmental damage. Use of the Software in such a manner is not authorized.

6. **LIMITATION OF LIABILITY.** The cumulative liability of Olympus and its suppliers to you or any other party for a loss of damages resulting from any claims, demands, or actions arising out of or in connection with the Software, or arising out of or in connection with or relating to this License Agreement shall not exceed the License fee paid to Olympus by you for the Software. In no event shall Olympus or its suppliers be liable for any indirect, incidental, special, exemplary, or consequential damages (including any damages resulting from loss of use, loss of data, loss of profits or loss of business), or lost profits, even if Olympus has been advised of the possibility of such damages.

7. **MISCELLANEOUS.** This Agreement shall be construed and governed in accordance with the laws of England, and shall be construed as an instrument under seal. Should any term of this Agreement be declared void or unenforceable by any court or competent jurisdiction, such declaration shall have no effect on the remaining terms hereof. The failure of either party to enforce any rights granted hereunder or take action against the other party in the event of any breach hereunder shall not be deemed a waiver by that party as to subsequent enforcement of rights or subsequent actions in the event of future breaches. The provisions of this Agreement may be enforced not only by Olympus, but by its suppliers, each of which is an intended third party beneficiary of this Agreement.

Getting started

Overview of the i-SPEED Software Suite	2
Registration Numbers and License Numbers	2
Control and Control Pro Versions	2
Optional data capture device	4
Purchase Options	4



Getting Started

Overview of the *i-SPEED* Software Suite

Welcome to the *i-SPEED* Software Suite User Manual. *i-SPEED* Software Suite is the accompanying software to the *i-SPEED* video camera from Olympus. The software is supplied on a single CD, which contains all the software necessary to install any of the versions or optional features. The installation procedure unlocks the version of the software that you have purchased.

The *i-SPEED* Software Suite is a unique software system that provides the following core functionalities:

- Camera control
- Triggering of the cameras
- Synchronization of multiple cameras
- Download of images from the cameras to the PC
- Image processing to improve image quality
- Motion Analysis of the images
- Lens Calculator
- Acquisition of synchronized User Data
- Saving of images and data to a hard disk

In addition, the following functionalities can be added in the optional versions or module:

- Automation of acquisition and download process
- Automatic correlation tracking of features within images
- Expansion of data acquisition using external hardware

Registration Numbers and License Numbers

Each version is supplied with a unique registration number. This number must be used to register the software and to request technical support. This number identifies the shipment and submission.

In addition, some versions are also supplied with a 16-digit License Key Code. This code is entered using the software License Manager to unlock certain features.

Control and Control Pro Versions

The *i-SPEED* Software Suite comes in two versions:

- Control Version
- Control Pro Version

The following table shows the delineation of features for the different versions:

Features	Control	Control Pro
Video Acquisition		
Multi-camera synchronization		✓
Remote camera control	✓	✓
Automatic download		✓
i-SPEED 1, 2, and 3 camera control	✓	✓
Pre/post Event triggering	✓	✓
BROC/ROC		✓
Hot Connect Mode	✓	✓
Ability to rotate and flip images during capture	✓	✓
Additional camera, status, and battery information		✓
Video Triggering		✓
User Data Acquisition		
Enhanced 16-channel data capture and waveform display		✓
Analysis and Measurements		
On-screen distance, speed, angle and angular velocity measurement	✓	✓
On-screen video annotation		✓
On-screen graphing		✓
Manual Feature Tracking	✓	✓
Auto-feature tracking		✓
Compute relative motion of two track points		✓
Tracking of rotating objects		✓
Multi-Point manual/auto feature tracking		✓
Enhanced 2-D calibration		✓
Image processing	✓	✓
Basic image filtering		✓
Saving processed video with analysis overlays		✓
Excel export of captured analog data		✓
Data filtering of graphed data		✓
User Commentary		
Bookmarking of images	✓	✓
User defined commentary	✓	✓
Frame-by-Frame commentary		✓
Data commentary		✓
Excel export of all commentary		✓
HTML export of all commentary		✓
Saving		
Microsoft AVI formats	✓	✓
MJPEG encoded AVI	✓	✓
Sequences of still frames	✓	✓
Image compression	✓	✓
Partial image saving (clips)	✓	✓

The Control Version of the *i-SPEED* Software Suite does not require that a software security device (often called a dongle, hardlock or keytag) be placed on the computer. The Control Pro Version requires such a security device be installed prior to launching the software. In the absence of the security device, the software will automatically revert to the Control Version.

Optional data capture device

This module allows users to connect up to 16 channels of synchronised data to the captured video files. It is an optional module that can be added at any time to the Control Pro version of the software, it requires the installation of supplied hardware and additional hardware drivers. The data acquisition features of the Control Pro Version also require that an external data acquisition system be attached to the computer. The details of this hardware will be provided with the hardware and associated installation and user guides.

Purchase Options

Users may purchase upgrades from the Control to the Control Pro version of software, or add the optional data acquisition at any time. All the software is installed at the same time from a single disk. Contact your Olympus sales agent for details on how to upgrade to a higher performance version of software.

Installing the i-SPEED Software Suite

Install the i-SPEED Software Suite Application	6
If you have purchased the Control Pro Software package	12
If you have purchased the optional external data box Control Pro Software package	13
If you are upgrading from previous versions of i-SPEED Software Suite	16



Installing the *i-SPEED* Software Suite

The *i-SPEED* Software Suite is supplied on a single CD. Both versions of the software – Control and Control Pro - are contained within this one disc. Only the features that you have purchased are unlocked for your installation. The Control Pro version of the *i-SPEED* Software Suite is protected by a software security key tag (also known as a keylock, Hardlock or dongle).

The recommended PC specification to run the *i-SPEED* Software Suite is given below.

- Windows XP operating systems
- 3GHz processor
- 2GB RAM
- 500GB hard disk drive
- 1000 Base-T Ethernet

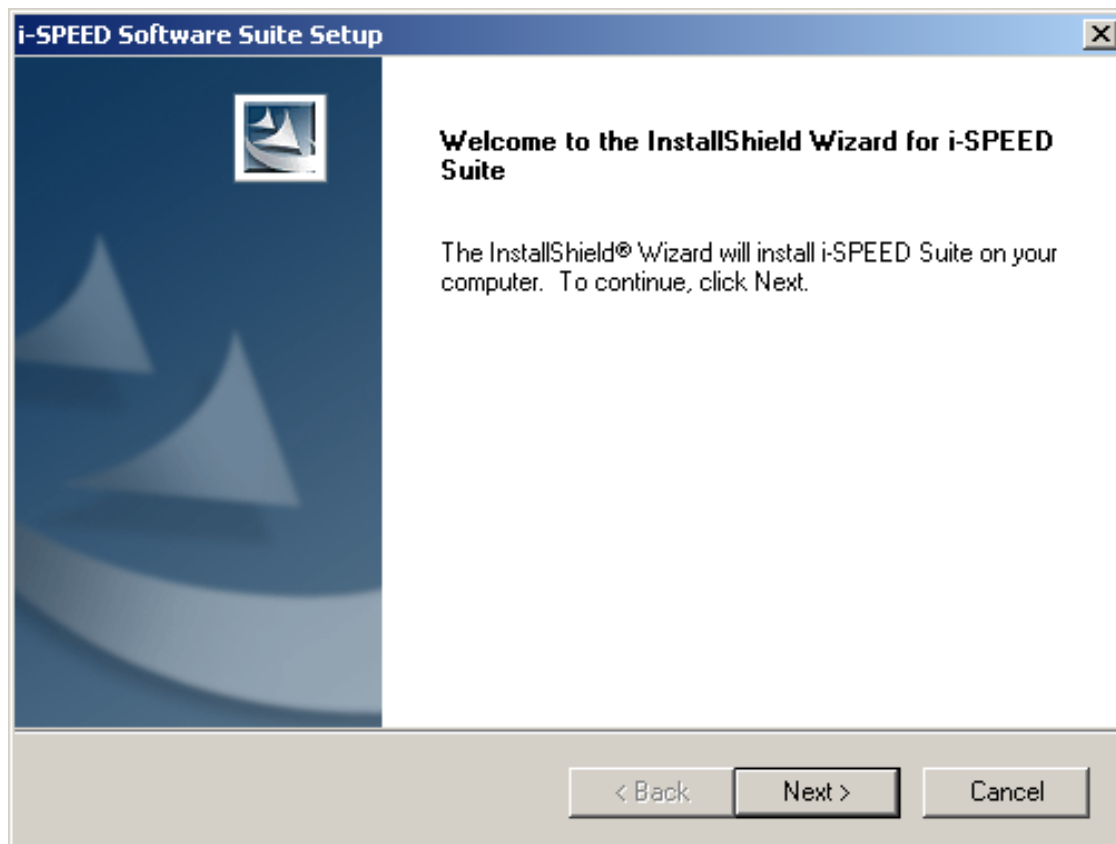
The installation procedure is the same for all operating systems.

Install the i-SPEED Software Suite Application

- 1 Power on your personal computer.

NOTE: You must be logged in as Administrator on the personal computer to properly install *i-SPEED* software.

- 2 Insert the CD that contains the *i-SPEED* Software Suite into your CD-ROM drive. The *i-SPEED* Software Suite installer should automatically start. If it does not, from the **RUN** prompt, type **F:\SETUP**, where "F" is the letter of your CD drive. The following installer Welcome screen will appear:

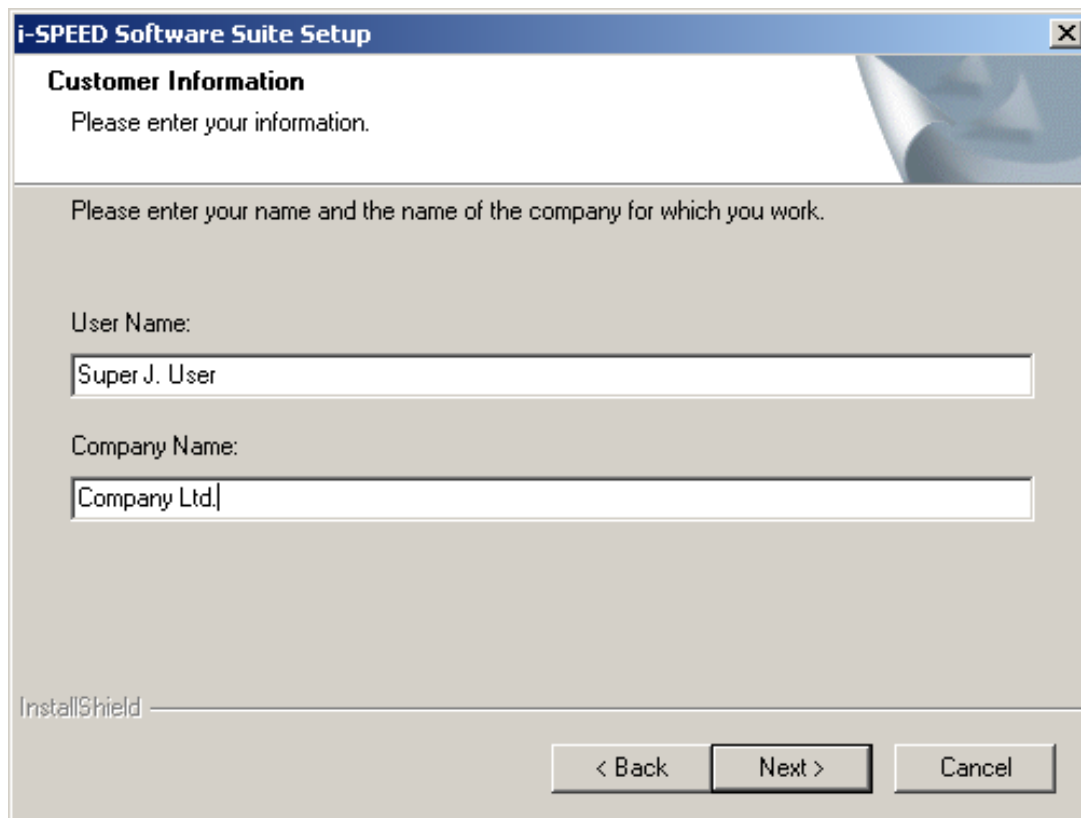


If the *i-SPEED* installer indicates that it has detected a previous version of the software, skip to the next chapter to upgrade your software without re-installing all the components.

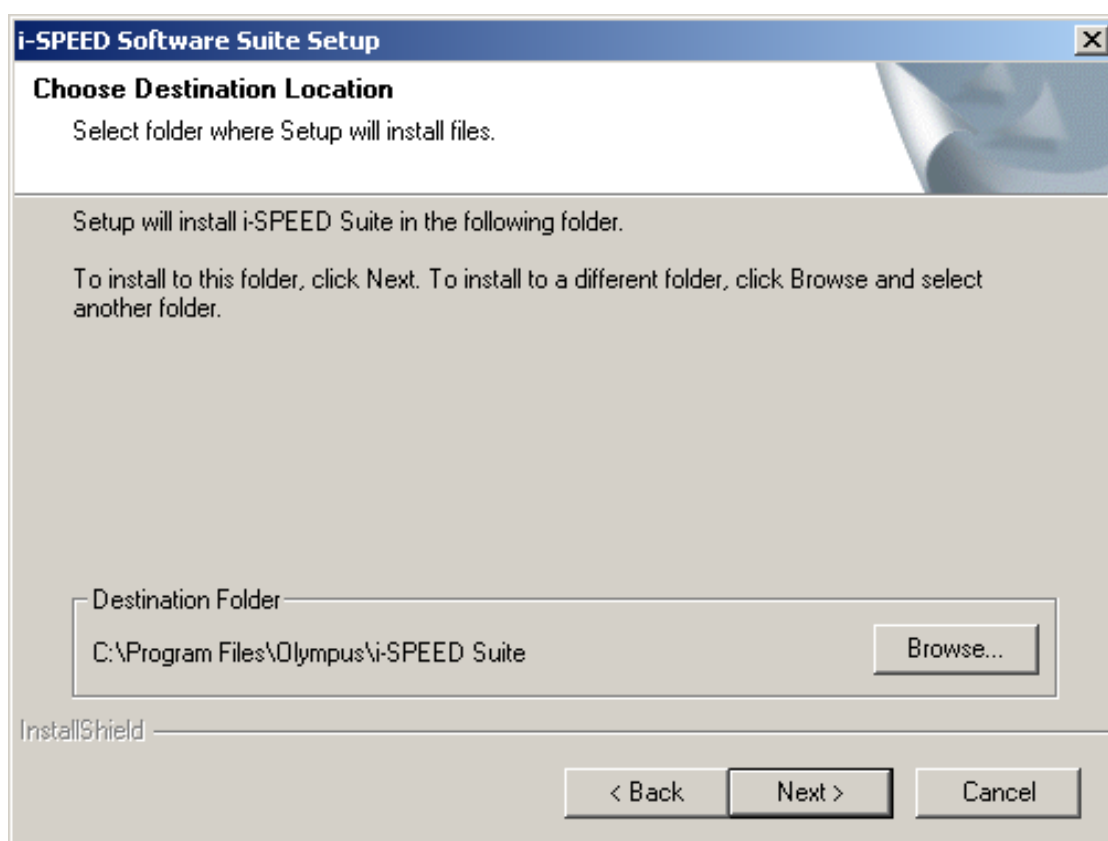
- 3 Click **NEXT**. The *i-SPEED* Software Suite License Agreement will pop up. Read the agreement carefully.



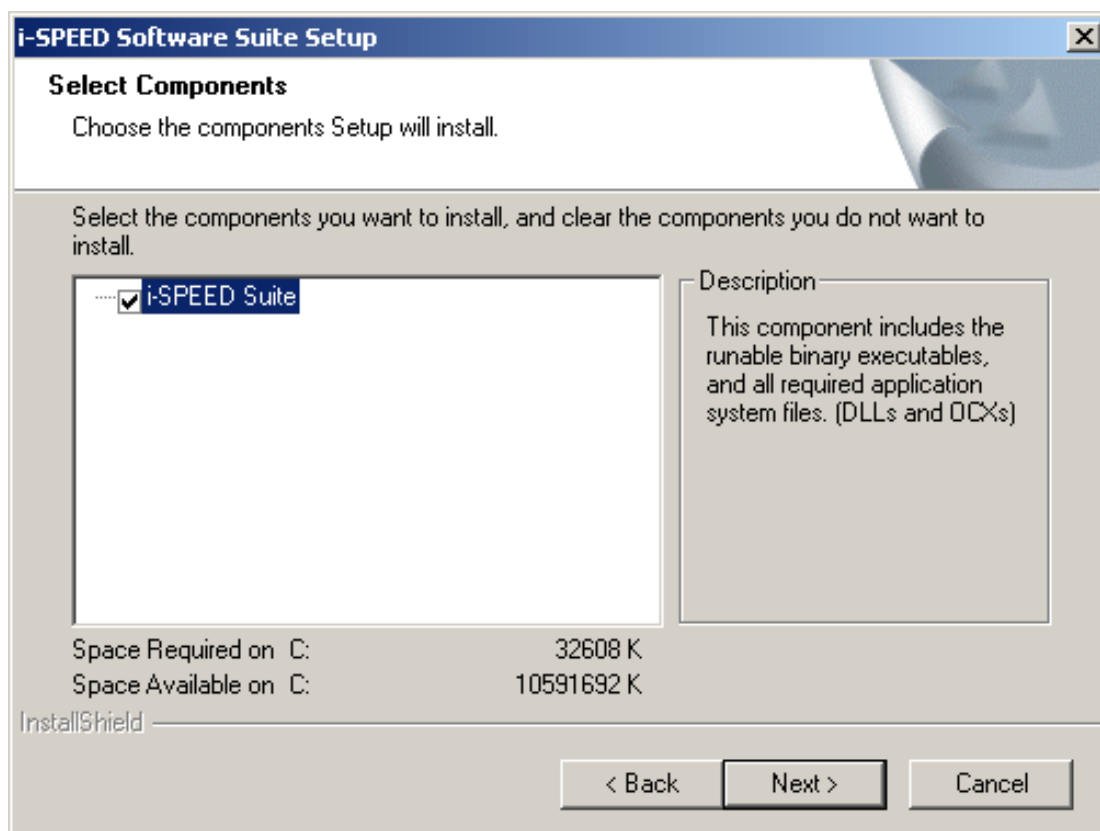
- 4 If you agree to the license terms, click **YES**. The installer will prompt you for your name and affiliation.



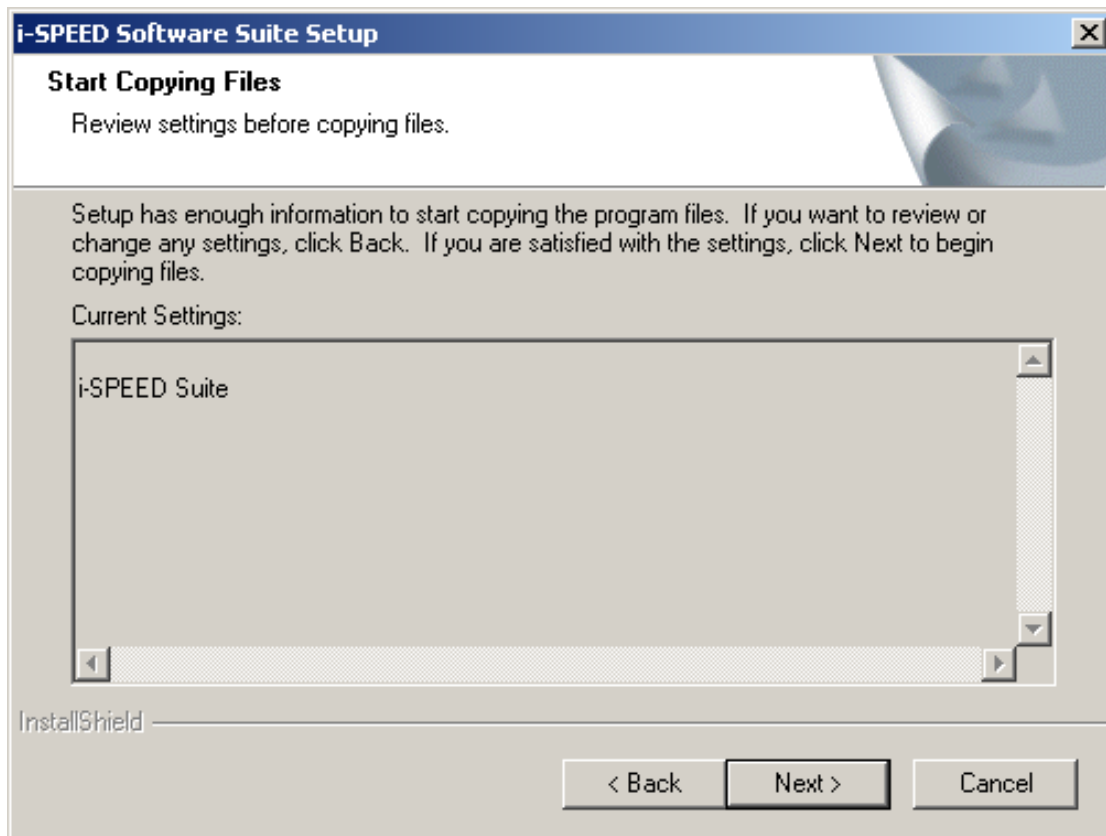
- 5 Click **NEXT**. The installer will prompt you to choose the destination folder. Unless you have a special configuration, select the default **C:\PROGRAM FILES\OLYMPUS\i-SPEED SUITE**.



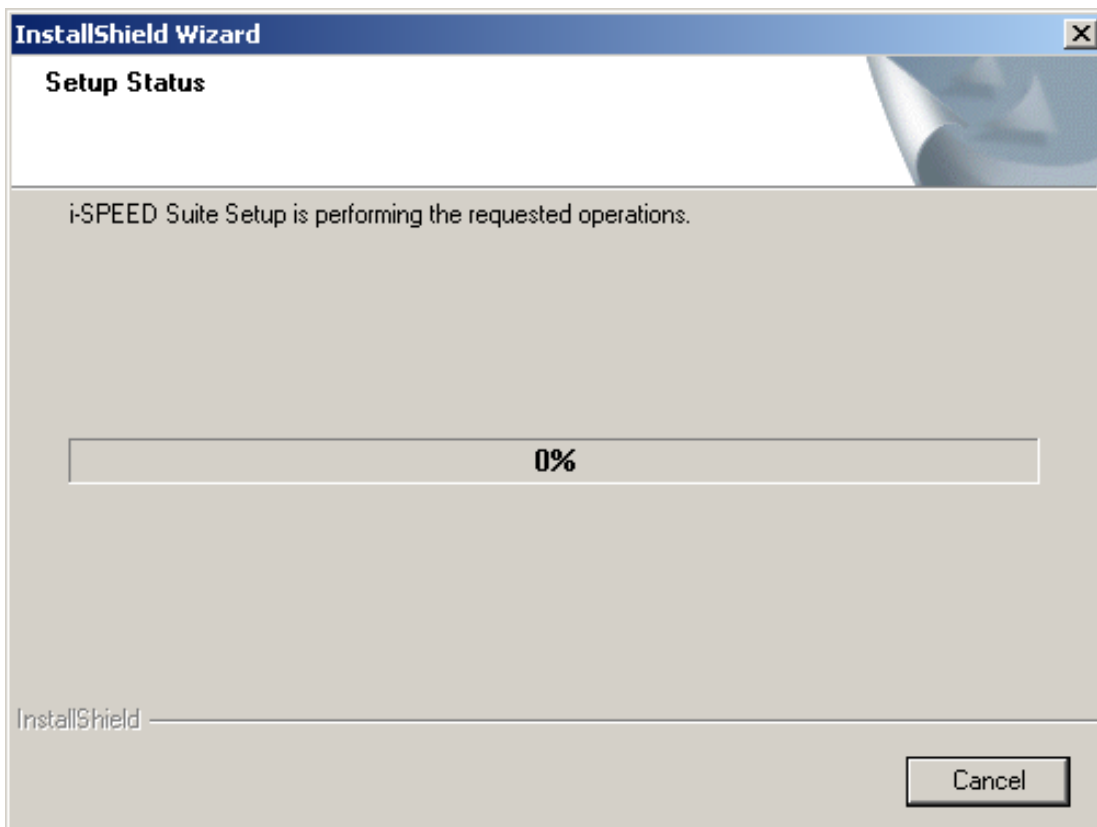
- 6 Click **NEXT**. The installer will prompt you to select the components of *i-SPEED* Software Suite you desire to install. Select all the files available.



- 7 Click **NEXT**. At the Component Installation Summary screen, confirm that *i-SPEED* Software Suite and the License Manager will be installed.



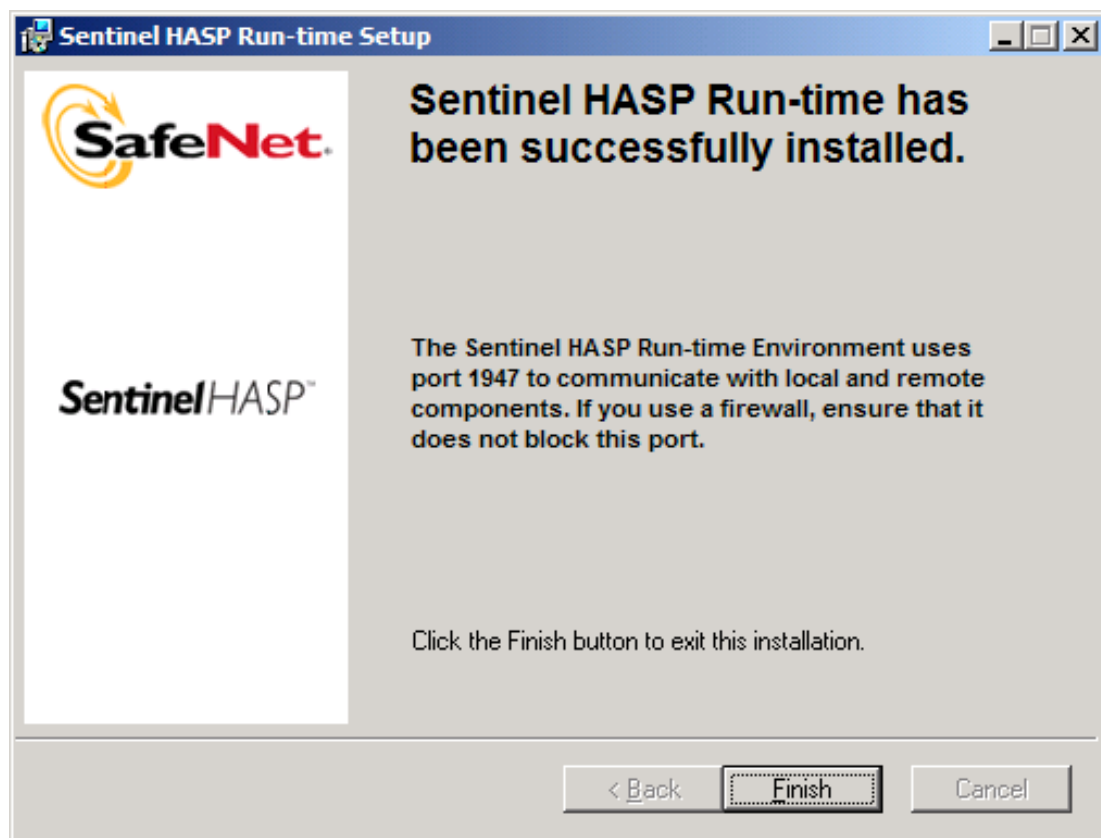
- 8 Click **NEXT**. The installer will then install the application and all the appropriate files. During the installation process, which could take many minutes - a status box will appear.



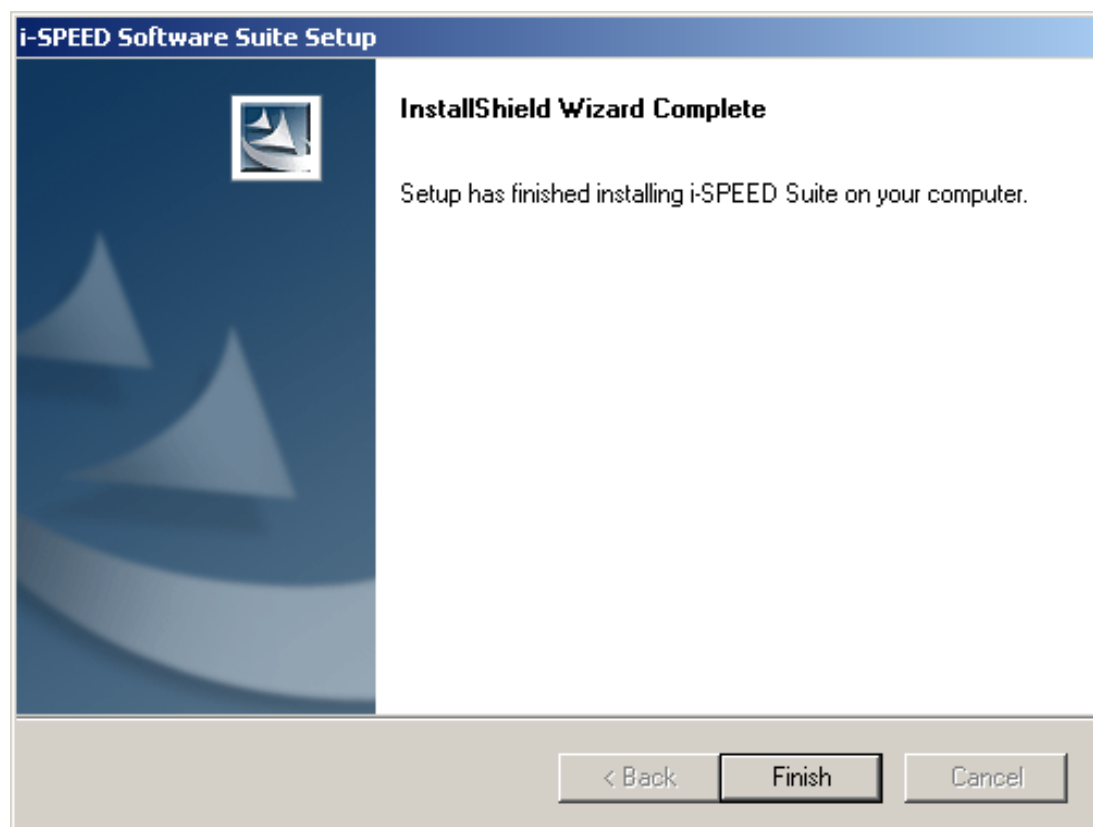
- 9 The installer will then start the security device driver installation subroutine.



- 10 Click NEXT. The software security drivers will be installed.



- 11** Click **FINISH**. The installer will then complete the installation.

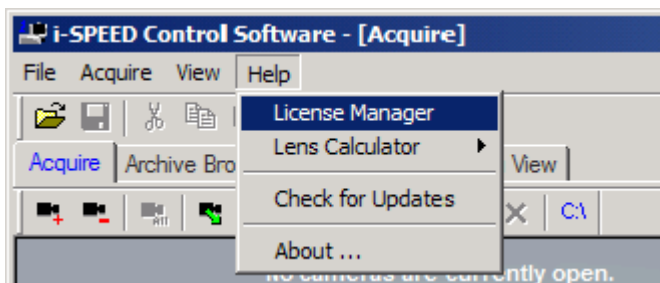


- 12** At the Setup complete screen, click **FINISH** and remove the CD-ROM from your CD drive.

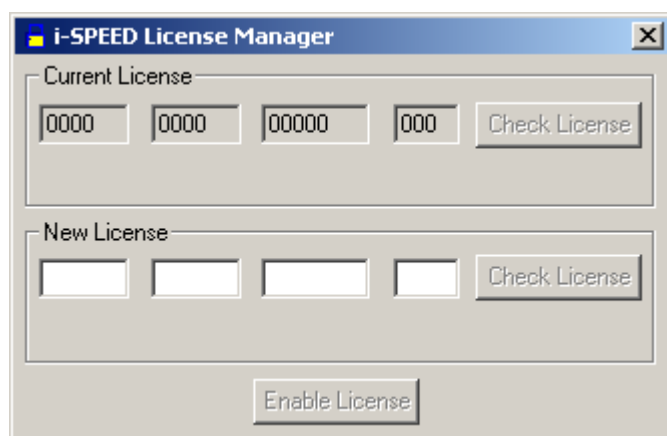
If you have purchased the Control Pro Software package

To unlock the features of the Control Pro Software, you must enter your 16-digit license code through the *i-SPEED* License Manager.

- 1 From the Windows Start Button, start the *i-SPEED* Software Suite. After the *i-SPEED* software has started, click on Help ' License Manager.



The License Manager window appears.



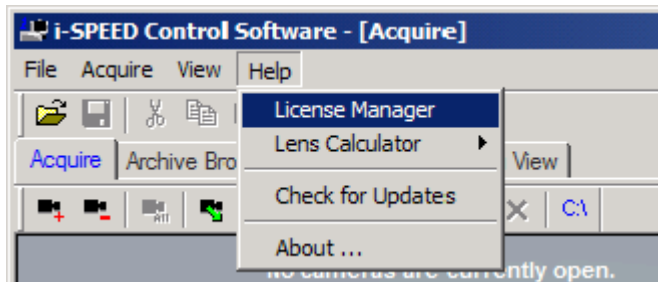
- 2 Type in the 16-digit Security License Code that was supplied with your software, then click on the Check License button. If a valid code has been entered, click on the Enable License button.

If you have purchased the optional external data box Control Pro Software package

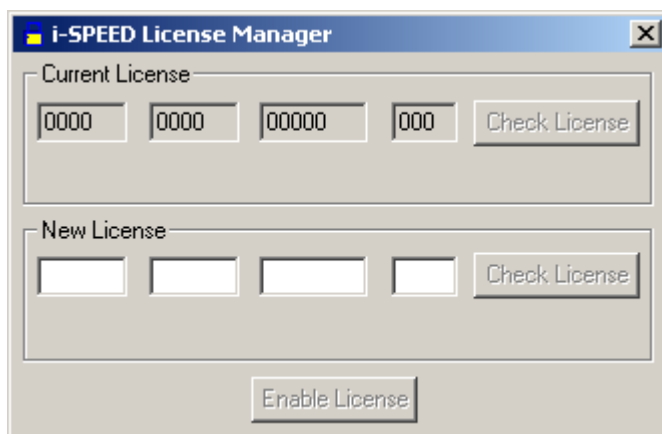
If you have purchased the optional external data box Control Pro Software package, then you must (1) enter your unlock code. This section assumes that you have successfully installed the hardware and device drivers and (2) installed the external data acquisition drivers.

To unlock the optional features of the Control Pro Software, you must enter your new 16-digit license code through the *i-SPEED* License Manager.

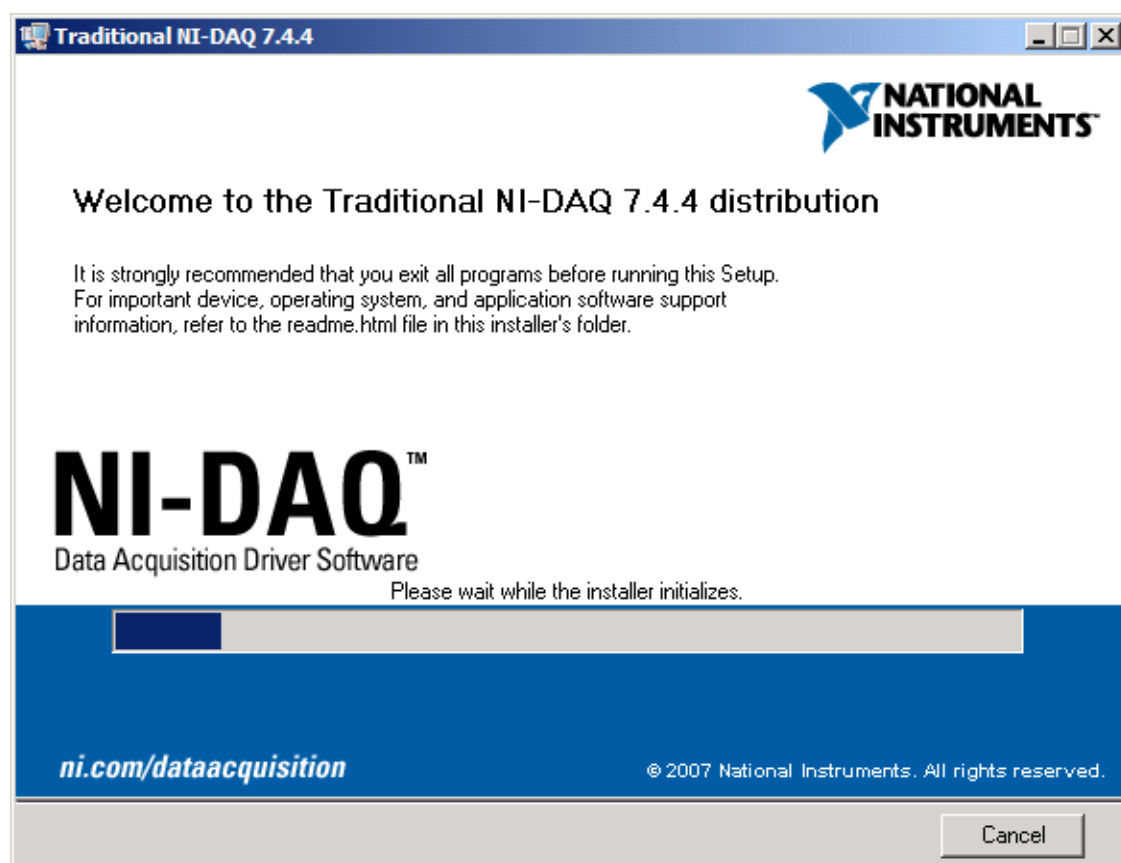
- 1 From the Windows Start Button, start the *i-SPEED* Software Suite. After the *i-SPEED* software has started, click on Help ' License Manager.



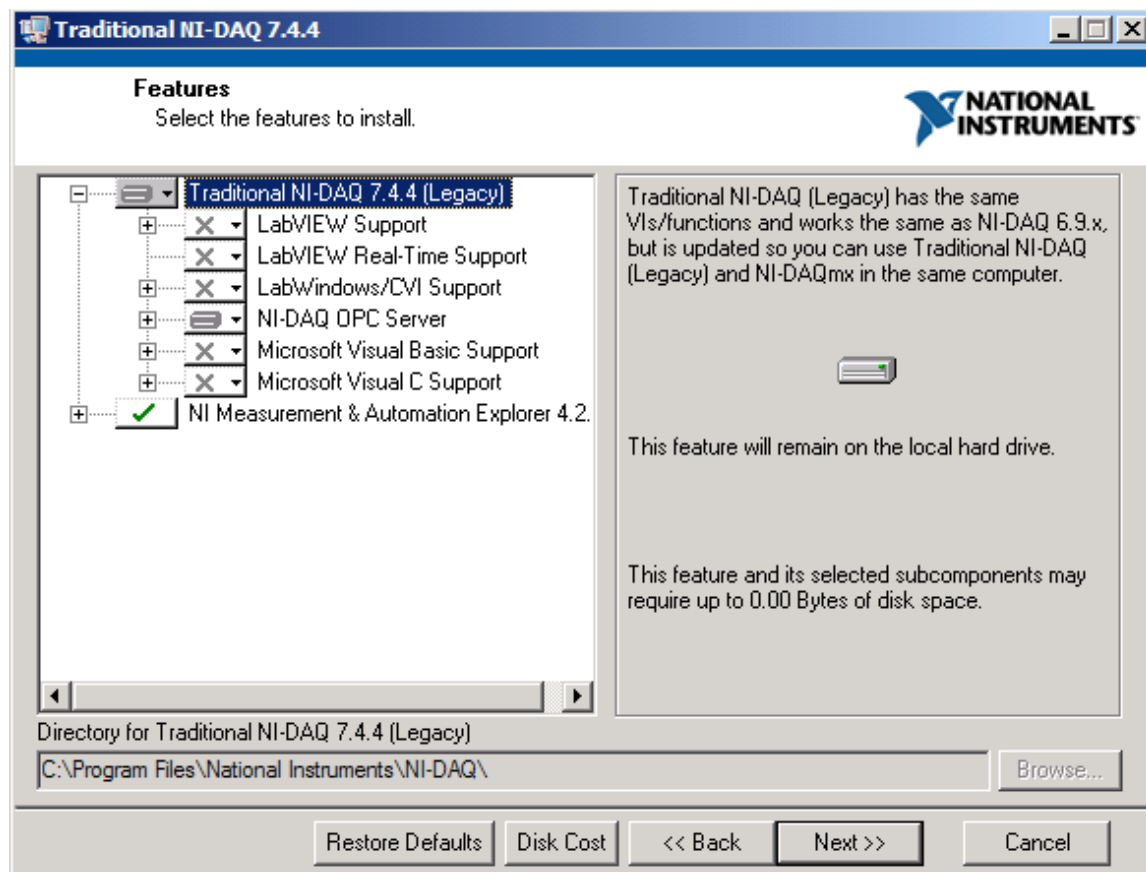
The License Manager window appears.



- 2 Type in the 16-digit Security License Code that was supplied with your software upgrade package, then click on the Check License button. If a valid code has been entered, click on the Enable License button.
- 3 To install the external data acquisition hardware, remove the National Instruments NI-DAQ disk from your packaging.
- 4 Insert the "NI-DAQ Traditional Driver and Installation Disk". 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. The NI-DAQ Installation screen appears, follow the on-screen instructions.

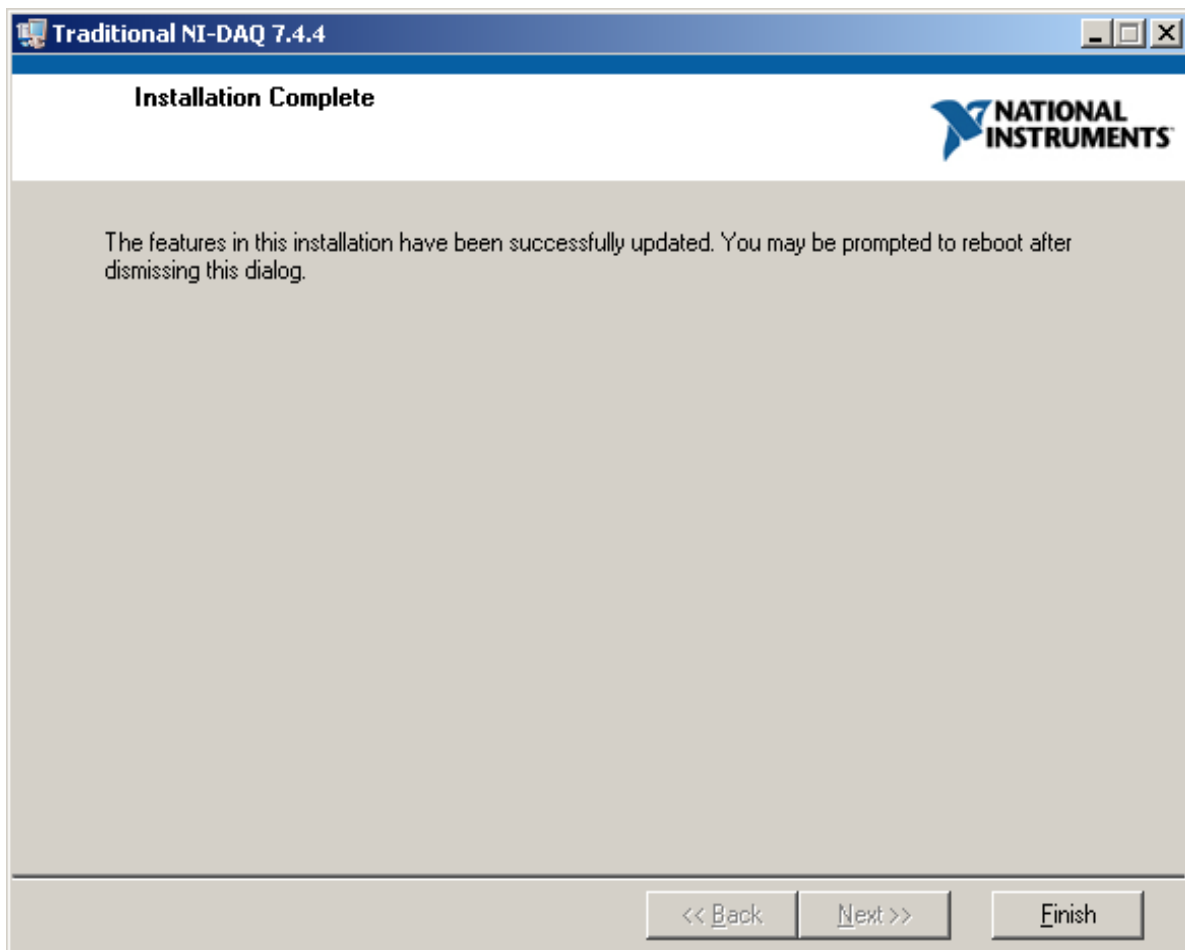


- 5 Click on **NEXT** at the first screen and follow the on-screen instructions. NI-DAQ will prompt you which files you wish to install. Select only the NI-DAQ files.



- 6 Click on the **NEXT** button. Follow the instructions on the screens to load the NI-DAQ drivers for the DAQ board. Use the standard defaults for folders and locations and program groups.

- 7 Once the installation has completed, restart the computer when instructed.

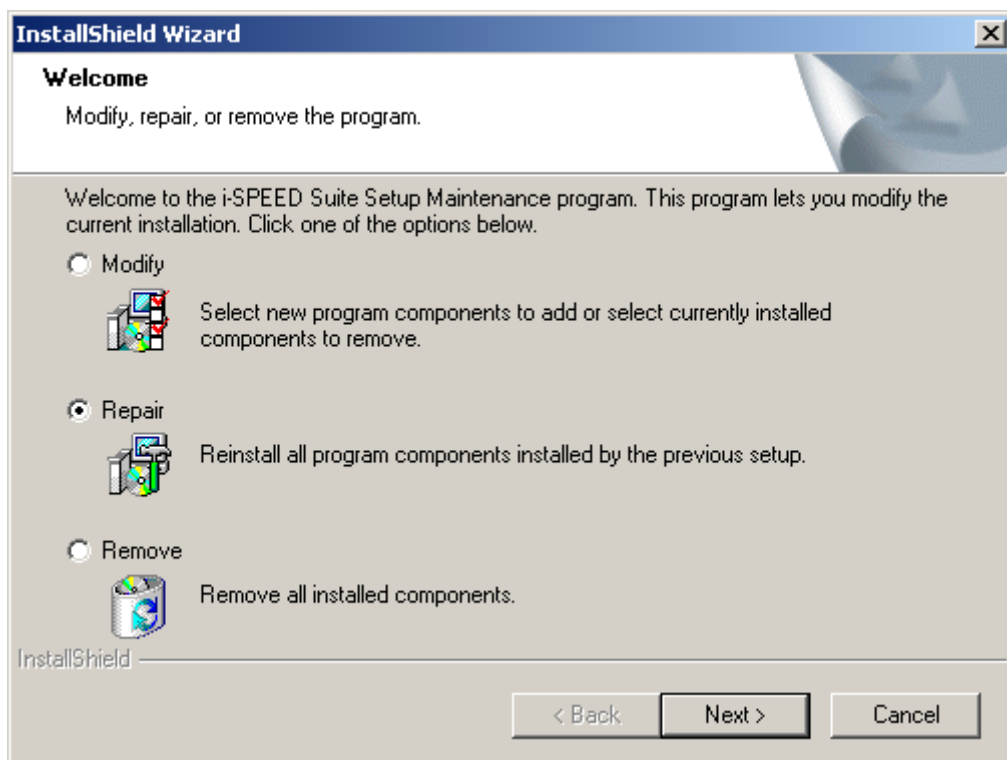


- 8 Connect your data acquisition hardware to your personal computer.

If you are upgrading from previous versions of i-SPEED Software Suite

NOTE: It is not necessary to uninstall previous versions of i-SPEED Software Suite.

During the installation procedure, the installer will automatically detect that you are upgrading a previous version of i-SPEED Software Suite software. You will see the following screen.



- 1 Select the Repair option.
- 2 Click **NEXT**. The installer will then install the new application and all the appropriately modified files.

The installer may prompt you that it has detected a READ ONLY file, and ask you if you wish to overwrite this file. In this event, click **YES**. If the security driver is required, the installer will automatically start the proper driver installer. When complete, click **FINISH** and remove the CD-ROM from your CD drive. Restart your computer.

Quick Tutorial

Making a Recording	18
Open Stored Images and Data	20
Download and Navigate in Strip View	21
Playing Back in Working View	22
Image Processing to Enhance the Image	24
Calibrate the Video	24
Analyze the Motion	25
Graph the Results	27
Add User Comments	28



Quick Tutorial

This brief tutorial is designed to provide a quick summary of the features and benefits of the *i-SPEED* Software Suite. This overview covers provides simple, step-by-step instructions for (1) recording an image, (2) downloading it to the computer, (3) manipulating it within the Strip View, and (4) then playing / processing / analyzing it within the Working View. These fundamental tasks within the *i-SPEED* Software Suite encompass the key features of the software. Users that require a more comprehensive explanation of any feature are referred to the detailed User Manual.

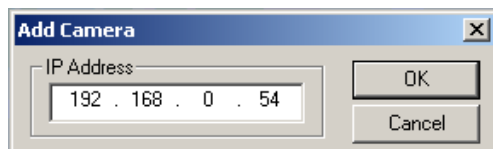
For previously recorded sequences the process starts by (1) exploring your hard-drives with the Archive Browser, (2) viewing temporal relationships within Strip View, and (3) then playing / processing / analyzing it within the Working View.

Making a Recording

- 1 Click on the Acquire tab.

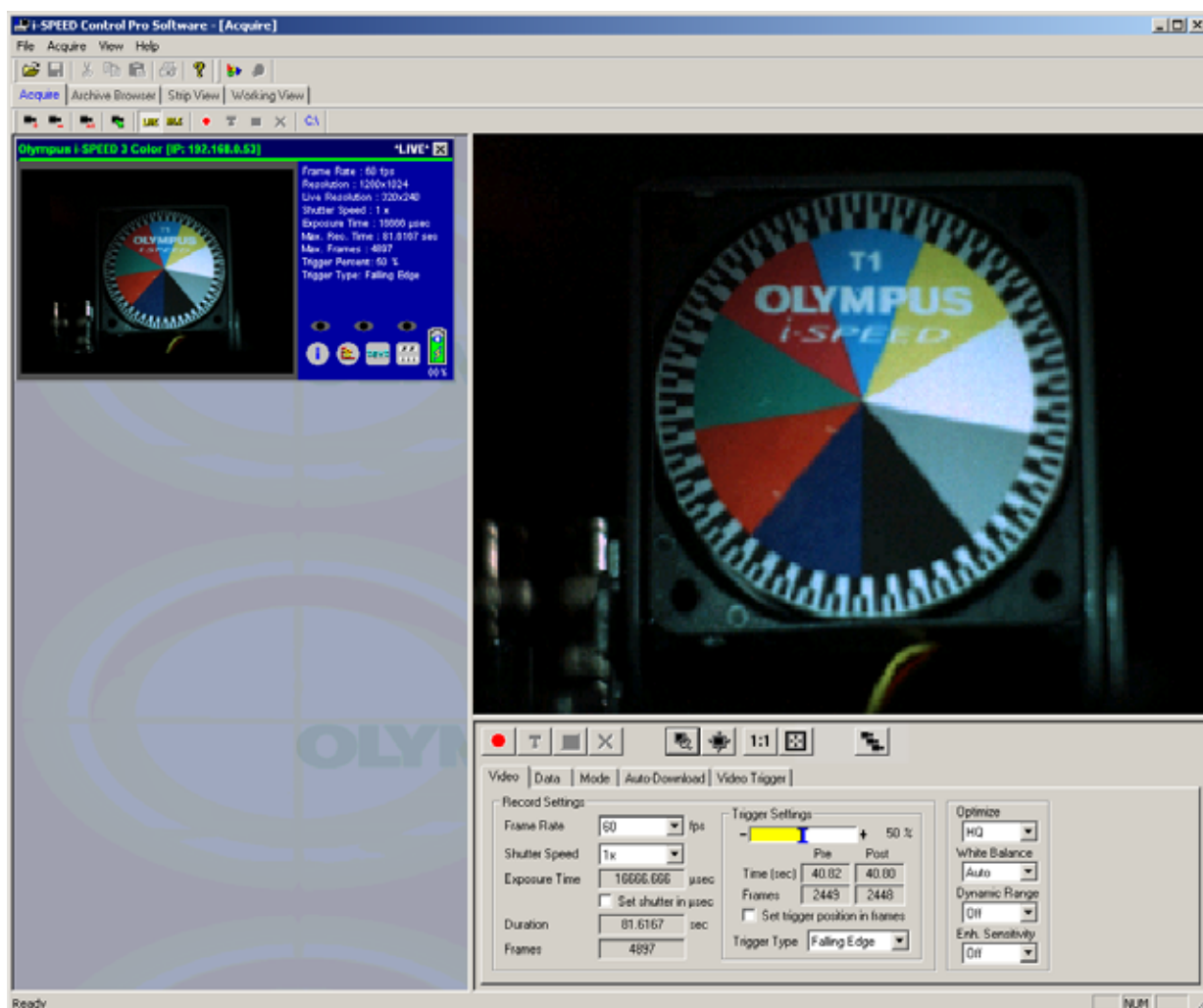


- 2 Either click on the Add a Camera button or Add All Cameras button. If you select the Add a Camera button, the following window will appear:



Type in the IP address of the camera you wish to add to the network. The IP address can be found in the Home/Config/Ethernet menu screen on the CDU.

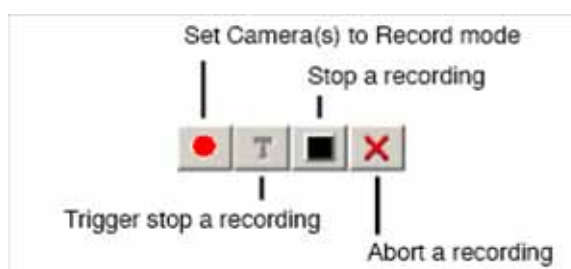
The list of open cameras will be listed in the left column of the Acquire window, as shown below:



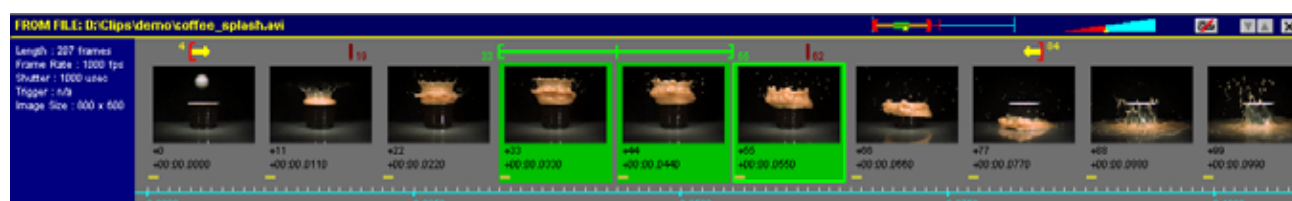
- 3 Highlight each camera along the left side and enter the record parameters in the control panel on the lower right, as described in the User Manual. The parameters include:

Video
Frame rate
Shutter speed
Trigger position
Trigger type
Mode
Burst Record on Command (BROC)
Record on Command (ROC)
Economy mode
Data
Data source (external box for Control Pro only)
Sample rate
Sensor type (Control Pro only)
Gain (Control Pro only)
Offset (Control Pro only)
Labels (Control Pro only)
Auto Download
Destination folders
Frame range
Reset type
Internal clock reset delay
Filename
Video Trigger
Define region
Set region
Re-train
Trigger settings

- 4 Click on the Set Camera(s) to Record mode button (tool tip shortened to "Record").

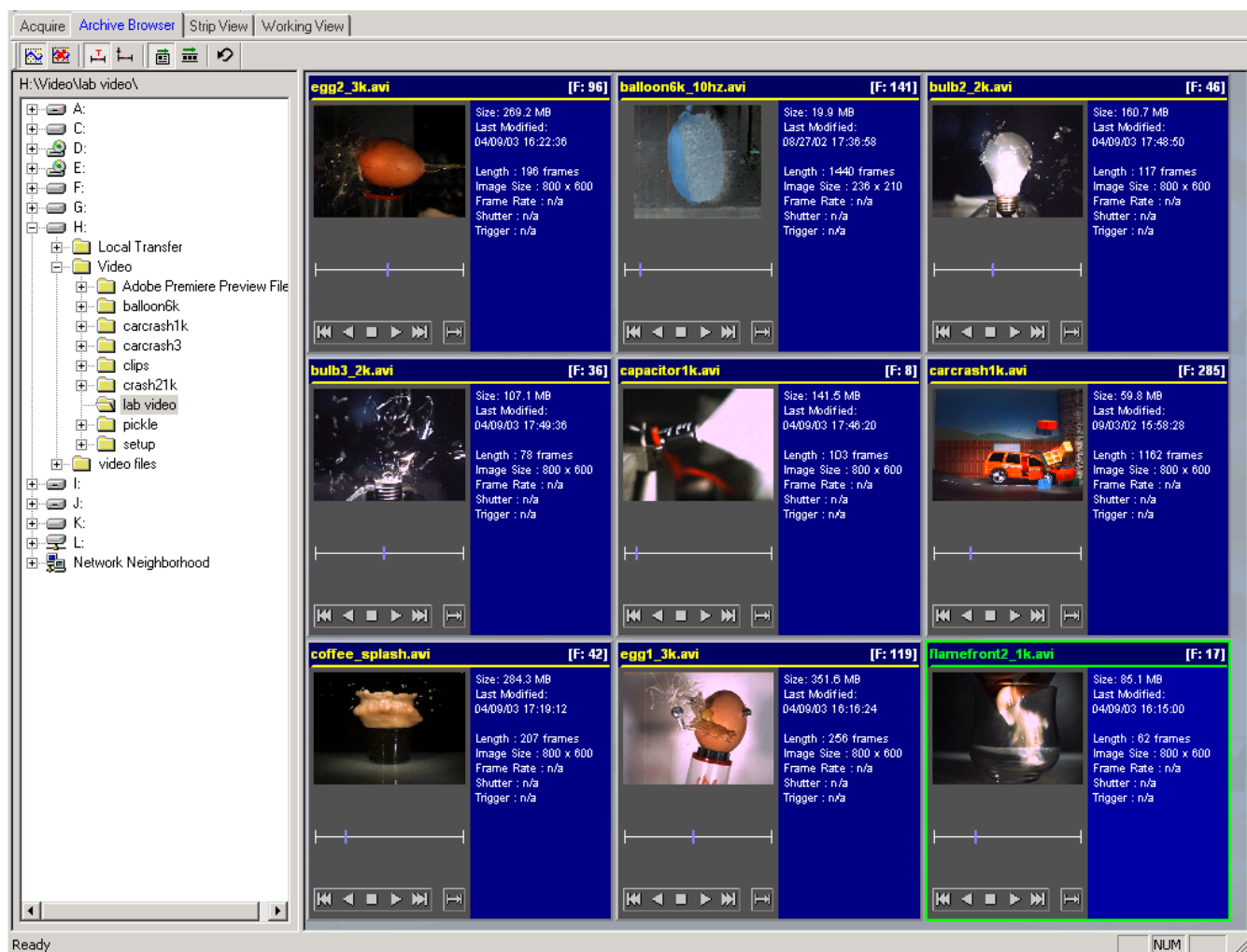


- 5 When ready, click Trigger Stop a Recording button (if available), else use the hardware trigger button. The *i-SPEED* Software Suite will trigger the camera per the trigger instructions in the video tab. When the recording is complete, it will open in the Strip View.



Open Stored Images and Data

- 1 Select the Archive Browser tab.
- 2 Use the Navigator bar along the left side of the Archive Browser



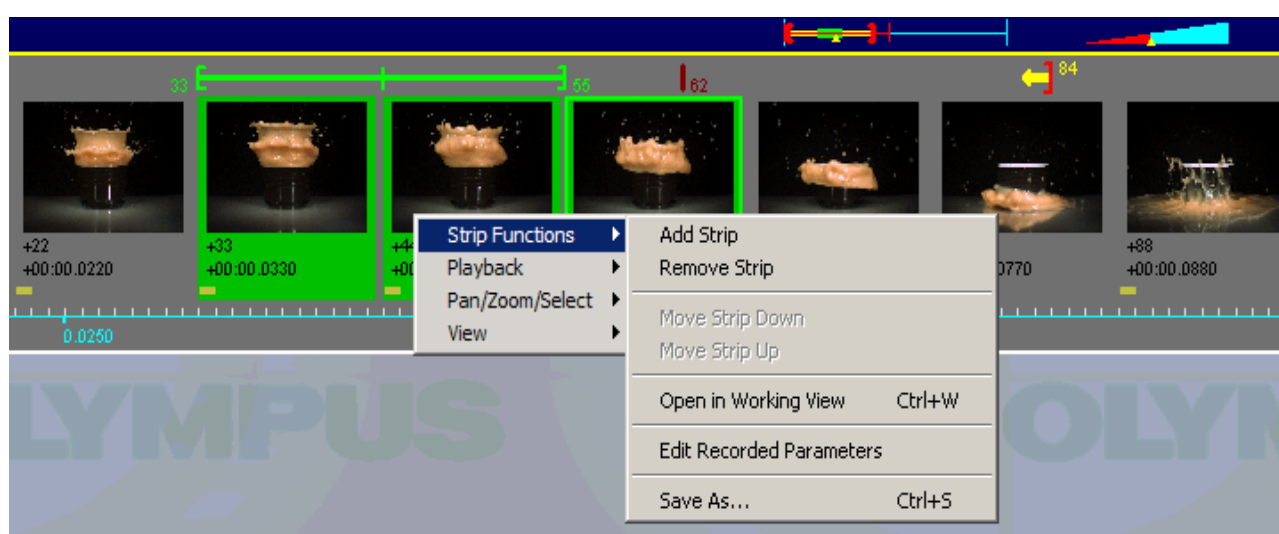
- 3 Highlight the video of choice.
- 4 Right click within the window. Select "Open within Strip View", or simply double click on the image.

Download and Navigate in Strip View

- 1 Select the region in which the event of interest occurred. Click and drag the mouse over the strip, highlighting the time of interest.
- 2 Right click within the highlighted area. Select "Transfer" and then "Transfer Selected Frames", or simply hit the "Enter" key. The strip view will automatically zoom and center the strip on your selected region.
- 3 Use the zoom and pan features of the Strip View to fine-tune your region selection.

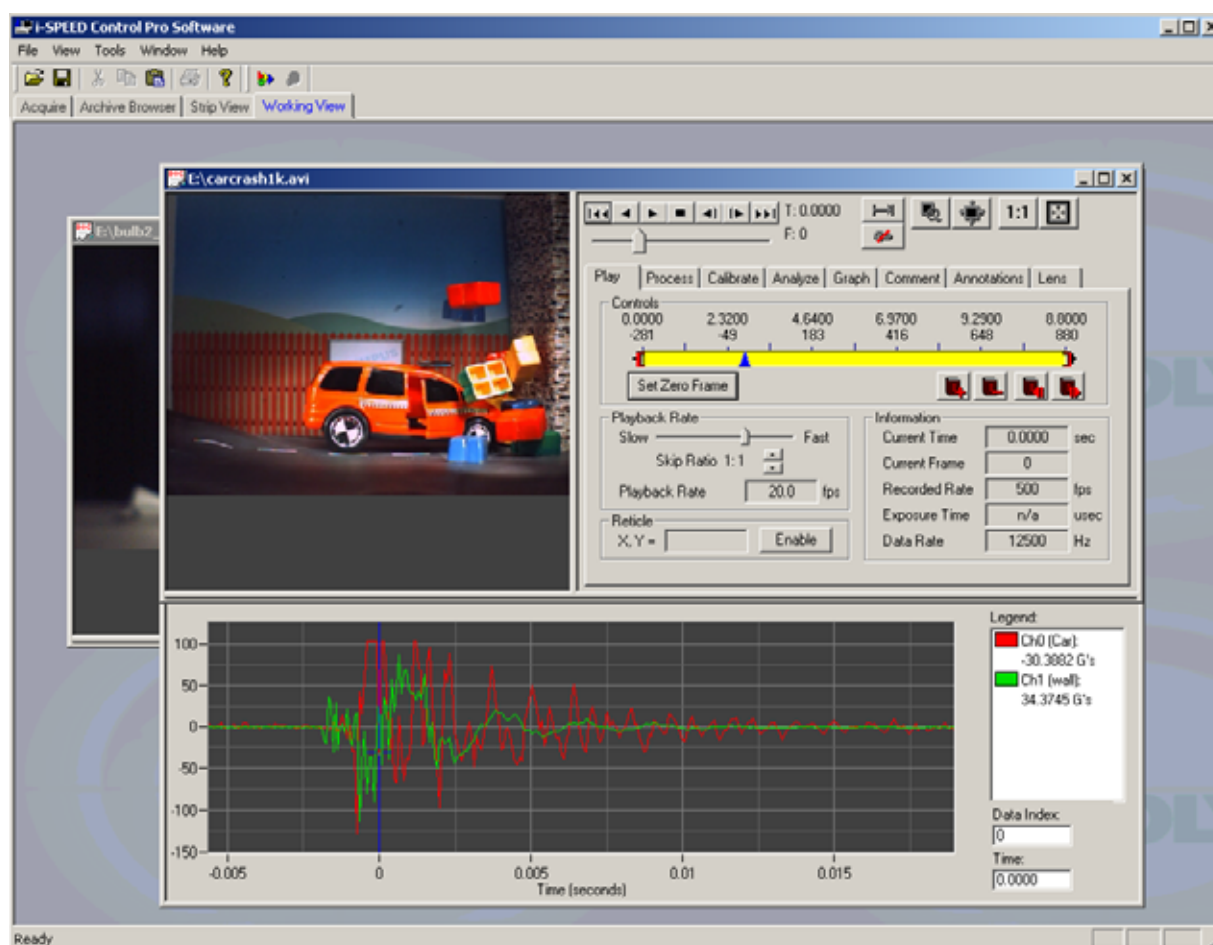


- 4 When you have bracketed the region of interest, set the Range. Right click within the video and select "Pan/Zoom/Select" and then "Set Selection as Range", or simply press the space bar.
- 5 Now that you have isolated the event of interest and bracketed the event in time, move the image to the Working View. Right click within the strip and select "Strip Functions", then "Open in Working View", or simply double-click within the strip.

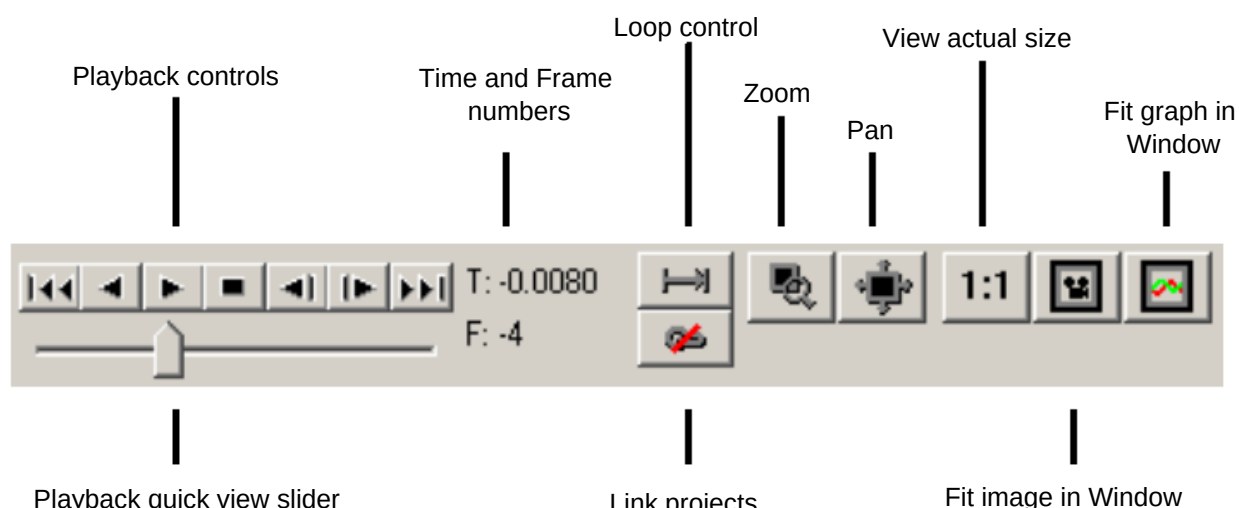


Playing Back in Working View

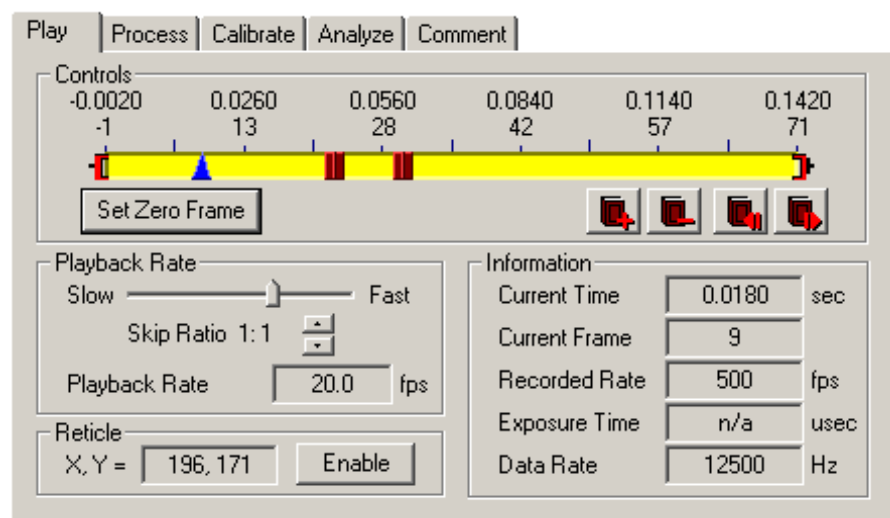
- 1 The images now appear in the Working View window.



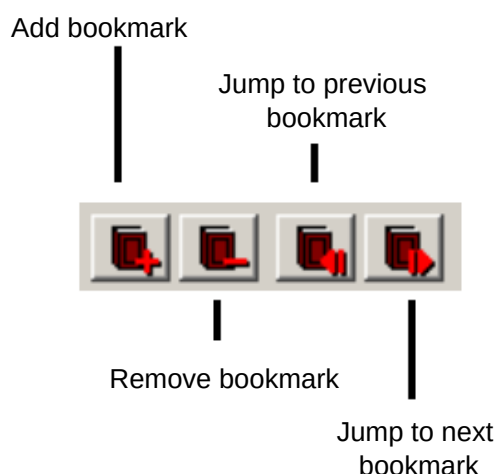
- 2 Review the data using the navigation tools on the top of the control panel located to the right of the video image.



- 3 Zoom in and out to magnify the image.
- 4 Click on the Play tab:



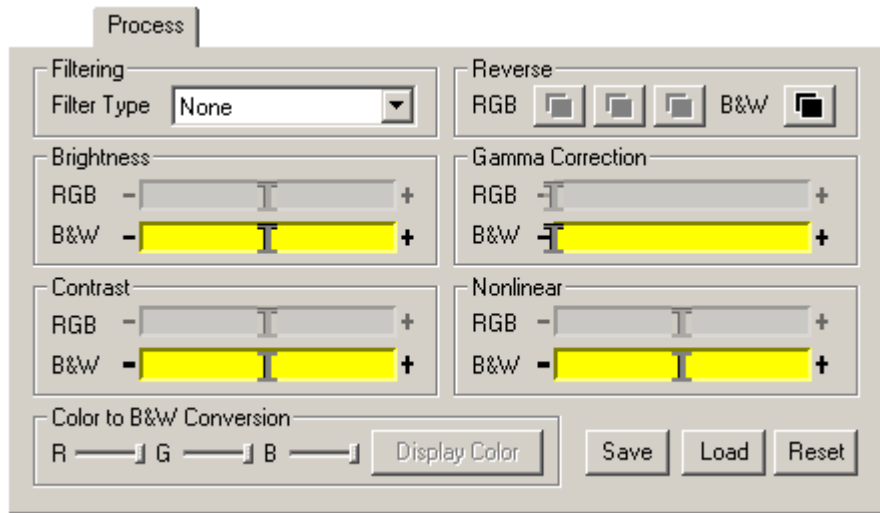
- 5 Set multiple bookmarks by clicking on the Add Bookmark icon.



- 6 Adjust the Range Brackets to modify the region of interest.

Image Processing to Enhance the Image

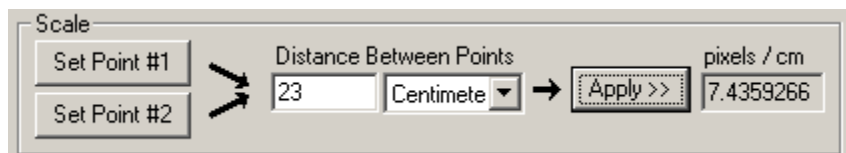
- 1 Click on the Process tab.



- 2 Use the Brightness, Contrast, Gamma and Nonlinear sliders to modify the appearance of the image until the features of interest are most pronounced (e.g. white on black background).
- 3 Try changing the Image Filter setting to improve the image appearance.

Calibrate the Video

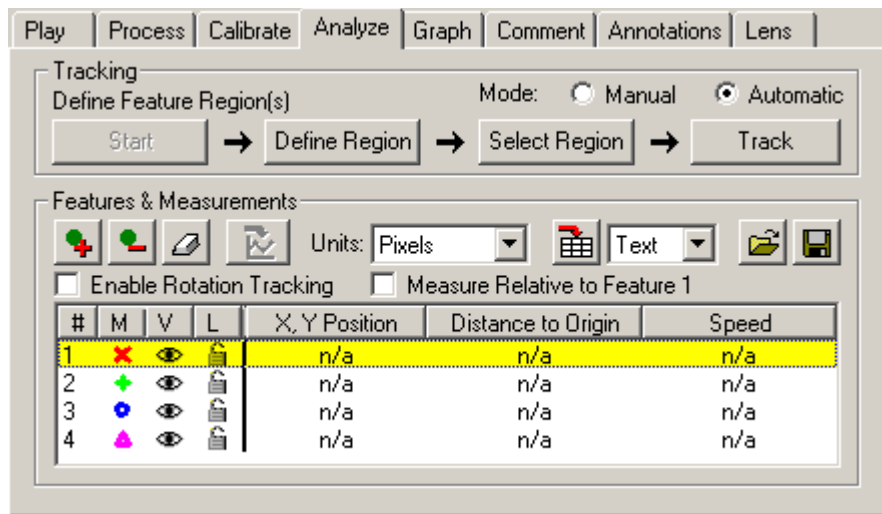
- 1 Click on the Calibrate tab.
- 2 Select the "Normal" mode of calibration.
- 3 Find a feature within the video that has a known size.
- 4 Click the reticle on one side of the known feature.



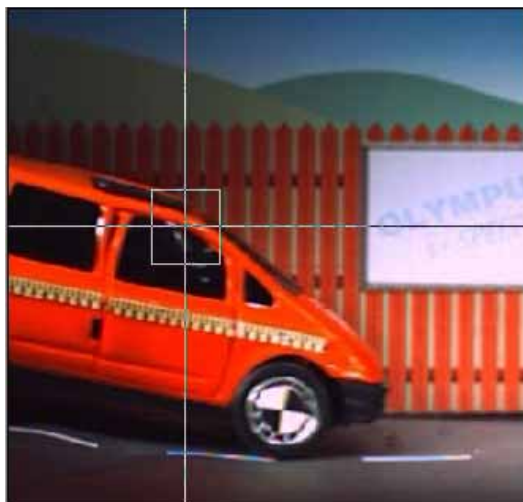
- 5 Click on the Set Point #1 button.
- 6 Click the reticle on the other side of the known feature.
- 7 Click on the Set Point #2 button.
- 8 Enter the distance between the two points and the units of measure.
- 9 Click "Apply>>".

Analyze the Motion

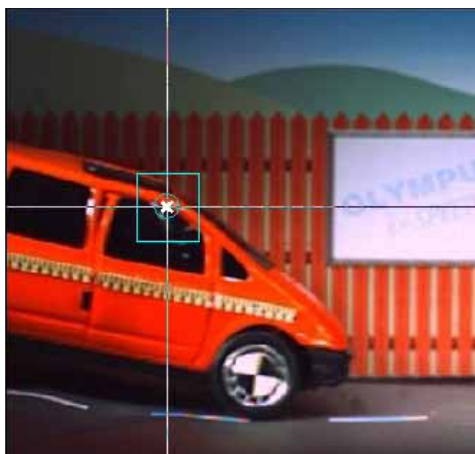
- 1 Click on the Analyze tab.
- 2 Click on the Start button to activate the analysis features. Highlight Feature 1 as the auto-track feature of interest.



- 3 Click on the Define Region button.
- 4 Within the video, draw a box around the feature of interest.



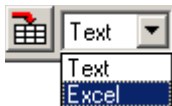
- 5 Click on the Select Region button. The feature is marked with a white X. (The marker's color was changed from red to white. Access the color edit dialog by double clicking on the marker under the "M" column.)



- 6 Click on the Track button. The *i-SPEED* Software Suite will track the feature of interest.



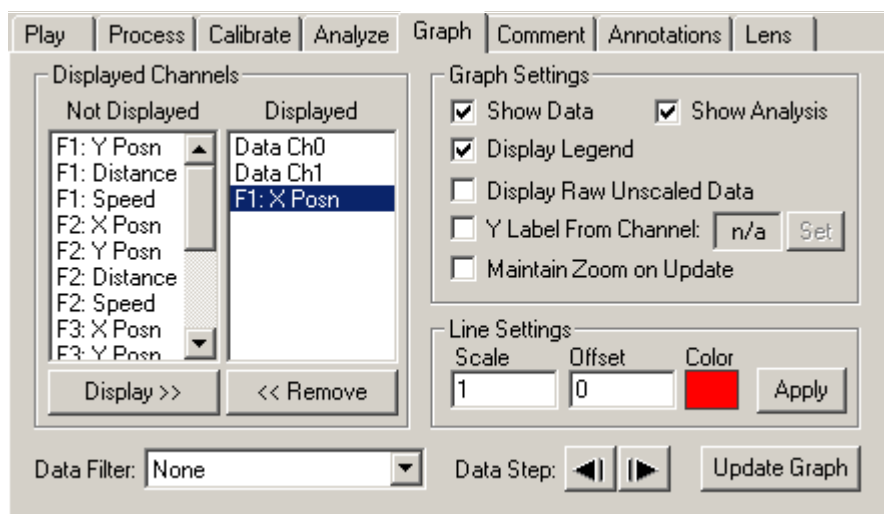
- 7 At the conclusion of the tracking, click on the Stop button.
- 8 Set the desired units.
- 9 Click on the Export button if you would like to export the motion analysis data. Select an export format from the drop-down box located next to the Export button.



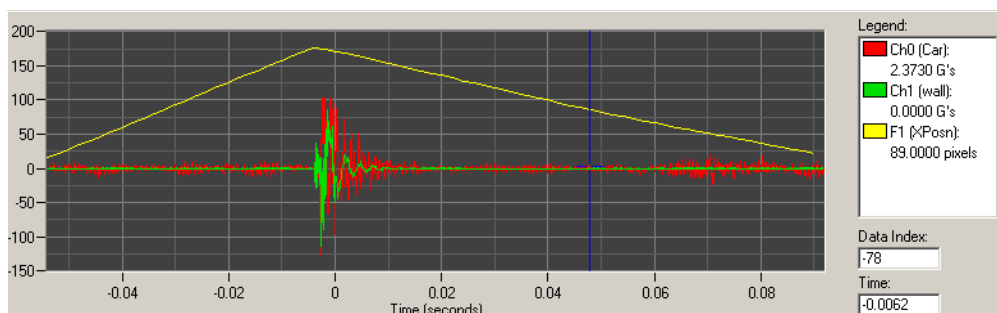
Graph the Results

The Graph panel will appear if the Control Pro version of the *i-SPEED* Software Suite is licensed. The Graph panel provides real-time feedback on the motion and user data.

- 1 Click on the Graph tab.

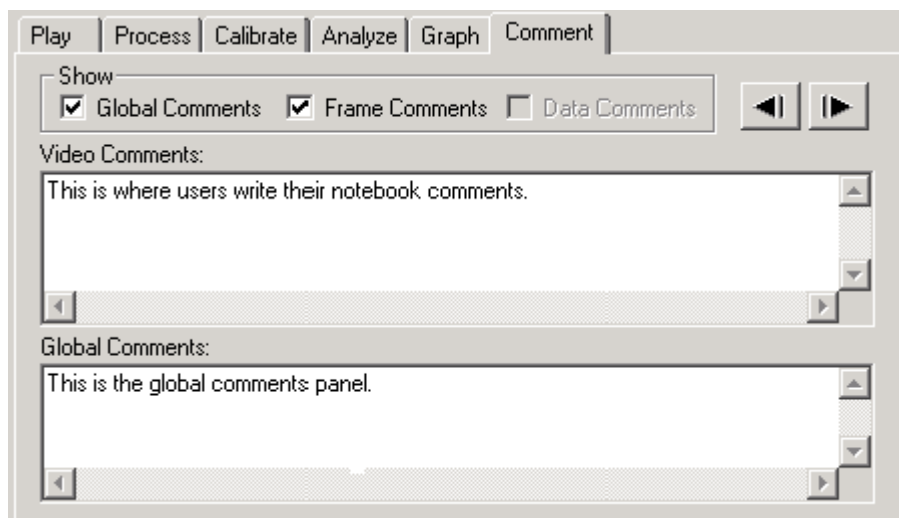


- 2 Click on Show Analysis checkbox in the upper-right corner.
- 3 Select the Feature 1 channel characteristics for graphing from the list of channels on the left. Move these characteristics from the left panel ("Not Displayed") to the right panel ("Displayed").
- 4 Click on the "Update Graph" button. The graph is now displayed with the resultant motion analysis.



Add User Comments

- 1 Click on the Comments tab.



- 2 Move to a frame in the video sequence.
- 3 Type in a video comment and a global comment.
- 4 Advance to another frame in the video sequence.
- 5 Type in a second video comment
- 6 Use the Comment step buttons to step through the commented frames.

***i-SPEED* Software Suite Interface**

General Description	30
The Title, Menu, Tool and Status Bars	34
Tool Tips	37
Image Size and Zooming	37
Context Menus	38
The Reticle	38
The Lens Calculator	39



i-SPEED Software Suite Interface

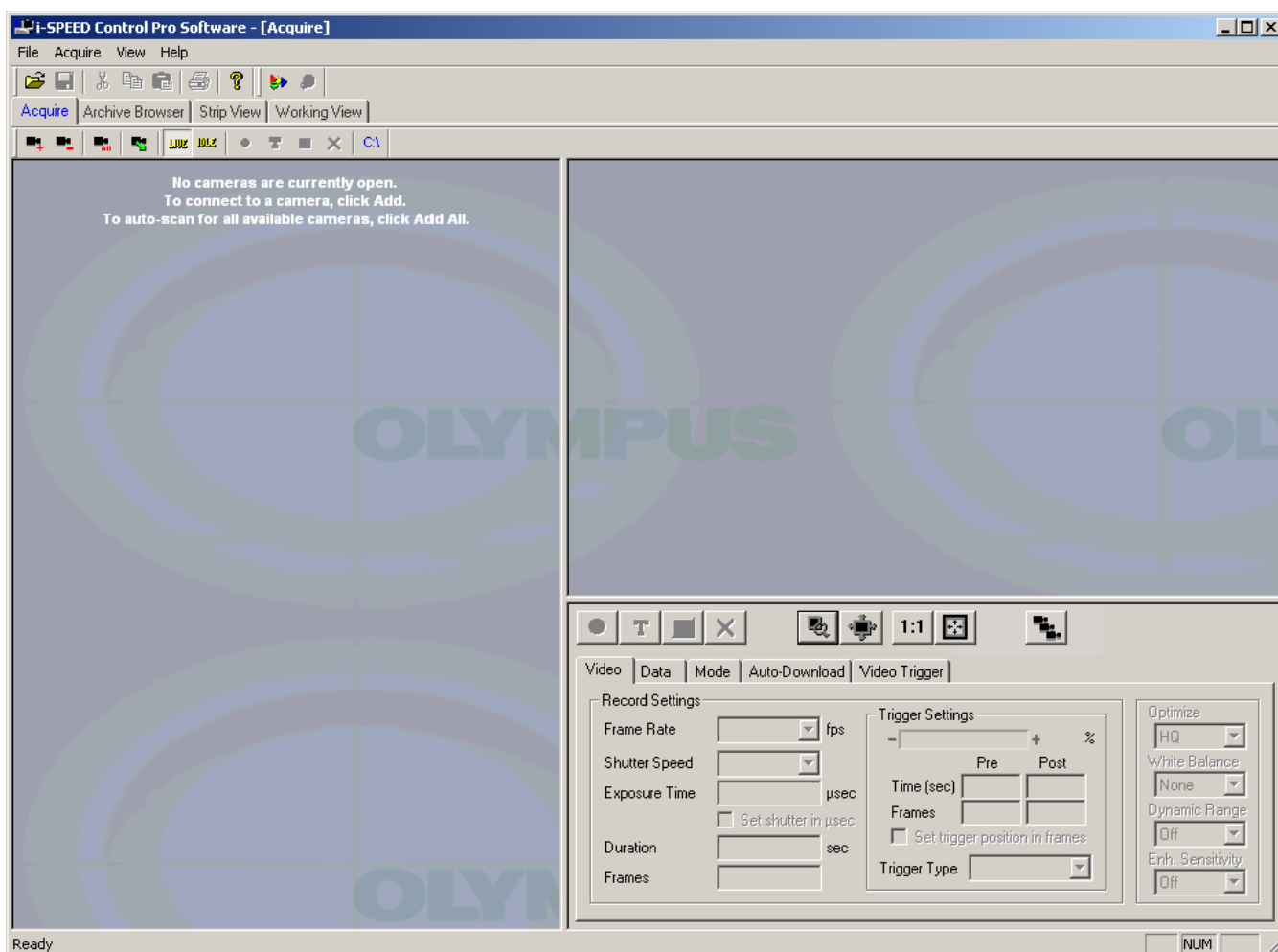
General Description

The *i-SPEED* Software Suite is a standard Microsoft Windows application. The software has been divided into four separate “views” named the Acquire Window, the Archive Browser, the Strip View and the Working View. Each of these views provides certain functionality for acquiring video with your *i-SPEED* camera(s) or managing information that was previously acquired. The individual views can be selected with the tab view across the top of the desktop workspace.



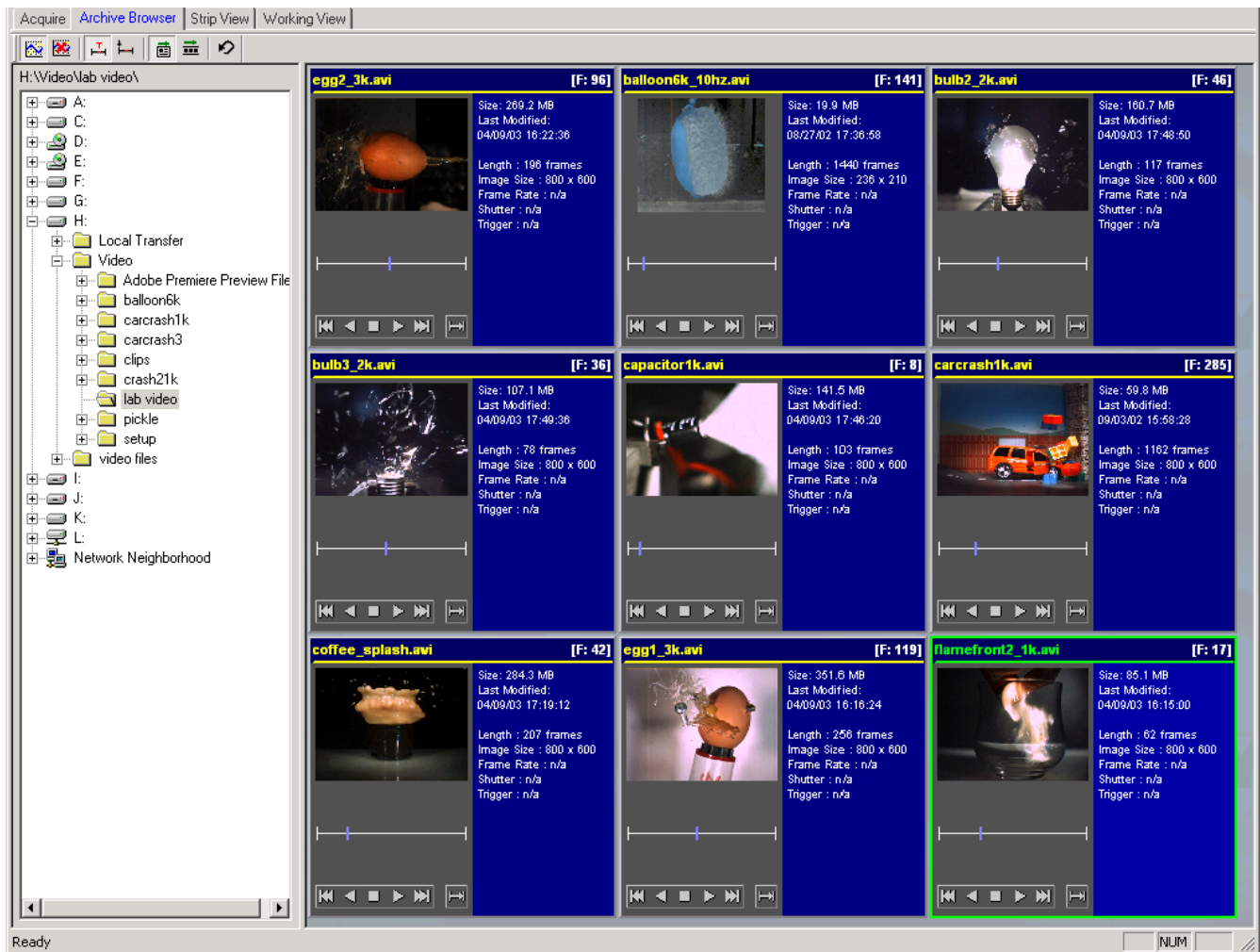
Acquire Window

The Acquire Window contains the tools for opening multiple cameras, setting the record parameters and recording both video and user data. The Acquire Window, shown below, contains multiple tab windows for setting record parameters.



Archive Browser

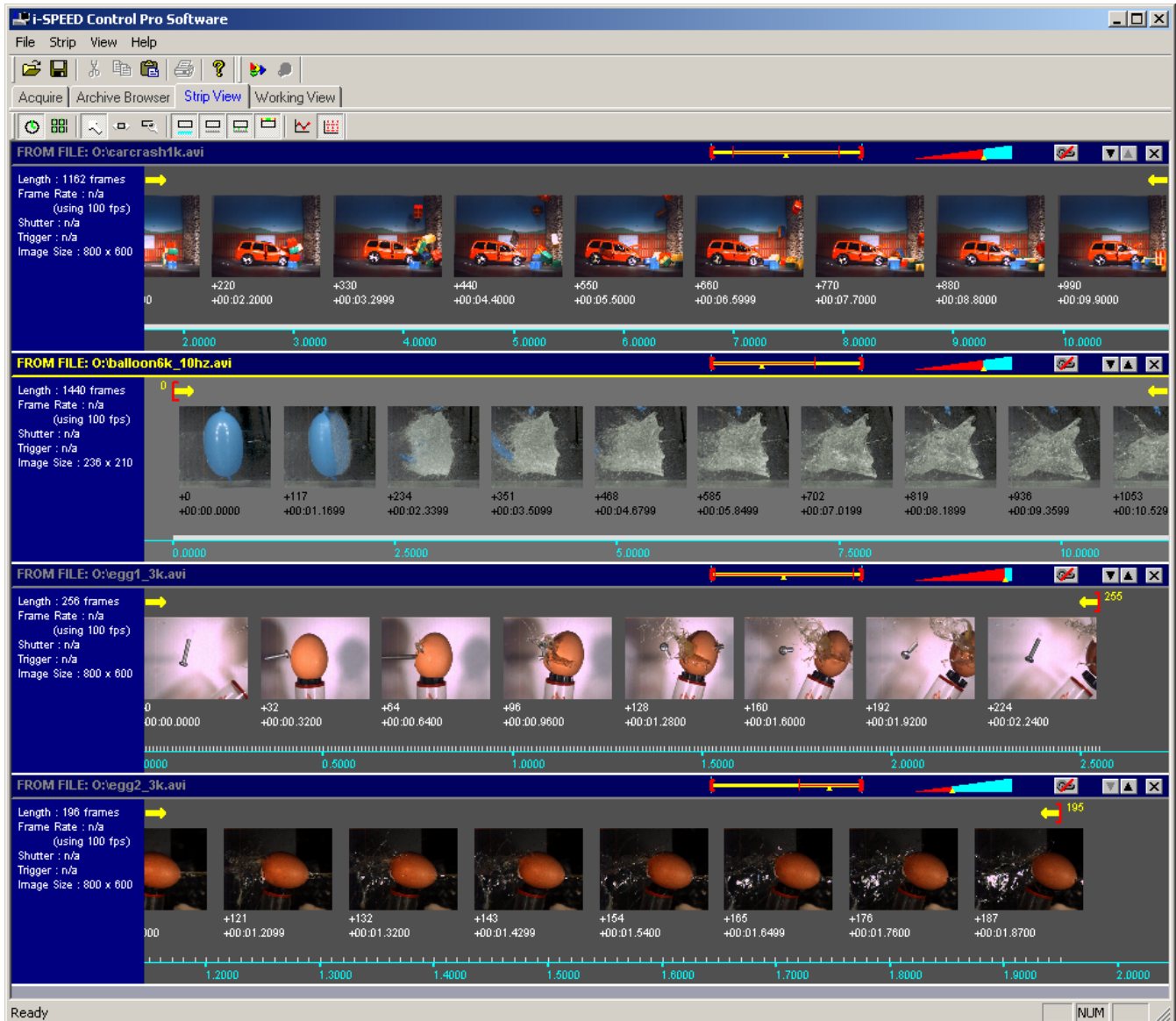
The Archive Browser view allows the user to open previously stored images and data. The Archive Browser contains playable thumbnails of images and a Windows explorer column along the left side.



Strip View

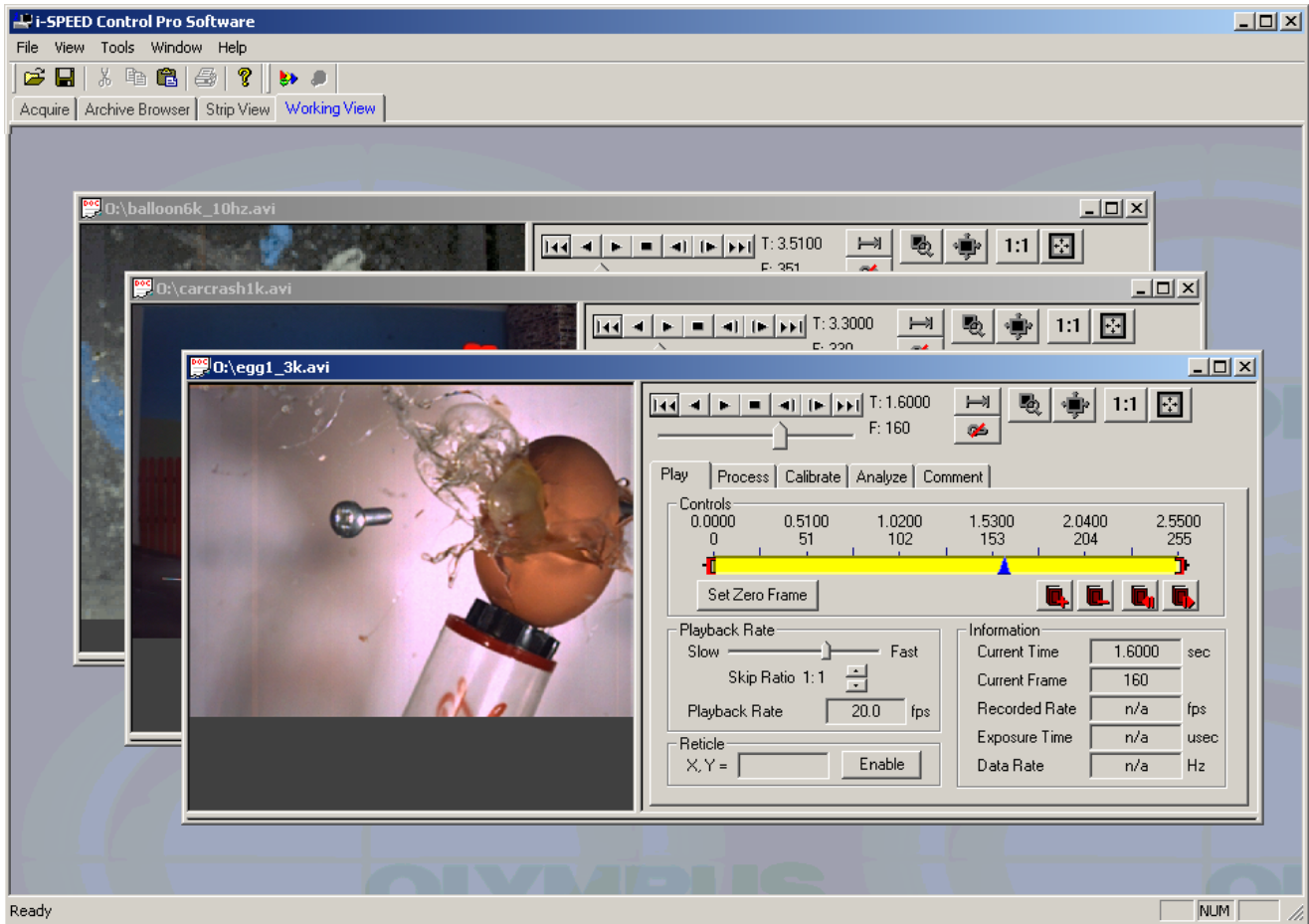
The Strip View shows all the open videos and recorded images in a filmstrip-type view, along a timeline. Thumbnail images are shown and the strips are synchronized in time for comparison. The advantage of the Strip View is best found when trying to visualize images as they are downloaded from the camera. The timeline can be expanded or contracted to zoom in or zoom out of certain events.

The Strip View is the ideal view for downloading images and data interactively.



Working View

The fourth view is named the Working View. In the Working View, each video is shown in conventional frame-by-frame basis. The Working View is used for analyzing motion, setting bookmarks, adding user notes and zooming in on certain important items.

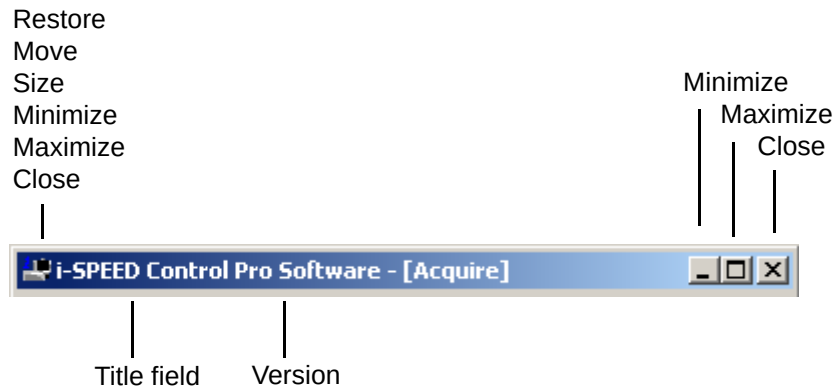


The Title, Menu, Tool and Status Bars

The desktop window is comprised of various elements and sections. *i-SPEED* Software Suite is based on conventional Windows applications, with a menu bar across the top and a series of sizing icons across the bottom. Standard Windows messages appear across the bottom row as well.

In addition, there are certain layout features that are common to all windows. The title bar, the menu bar, the tool bar and the status bar all appear on the desktop in the same location on the desktop.

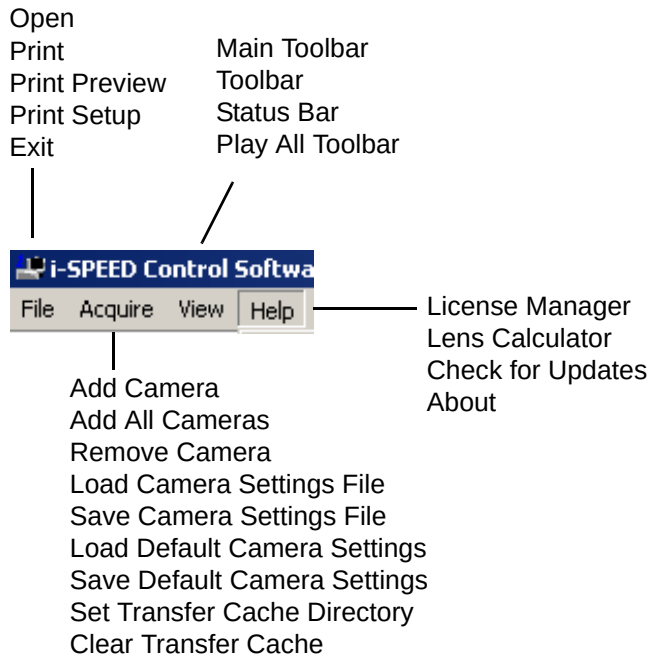
The *i-SPEED* Software Suite title bar is always at the top of the screen. The components of the title bar are as shown below.



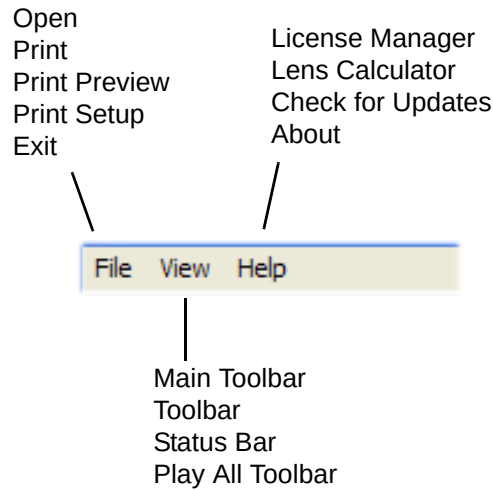
The version/subtitle field content depends on what windows are open. If no windows are open, the subtitle field shows the selected view (Archive, Strip, Acquire or Working) in addition to the version of software (Control or Control Pro).

Directly below the title bar is the menu bar. The *i-SPEED* Software Suite menu bar spans the top of the desktop, and changes depending on which window is active. If the Acquire Window has been selected, the menu options are as follows:

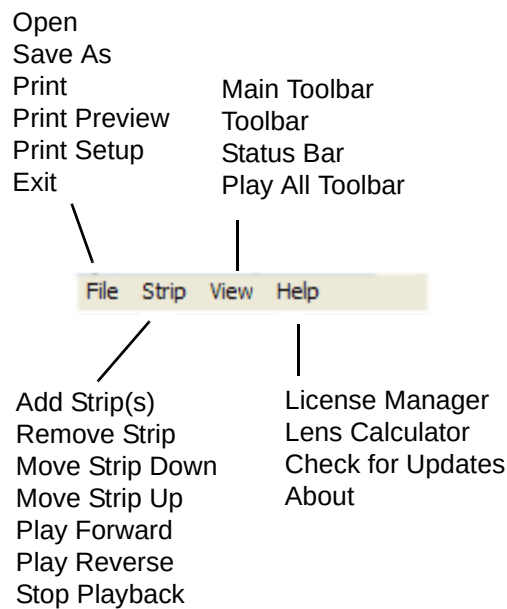
If the Acquire window is active, the menu options are as follows:



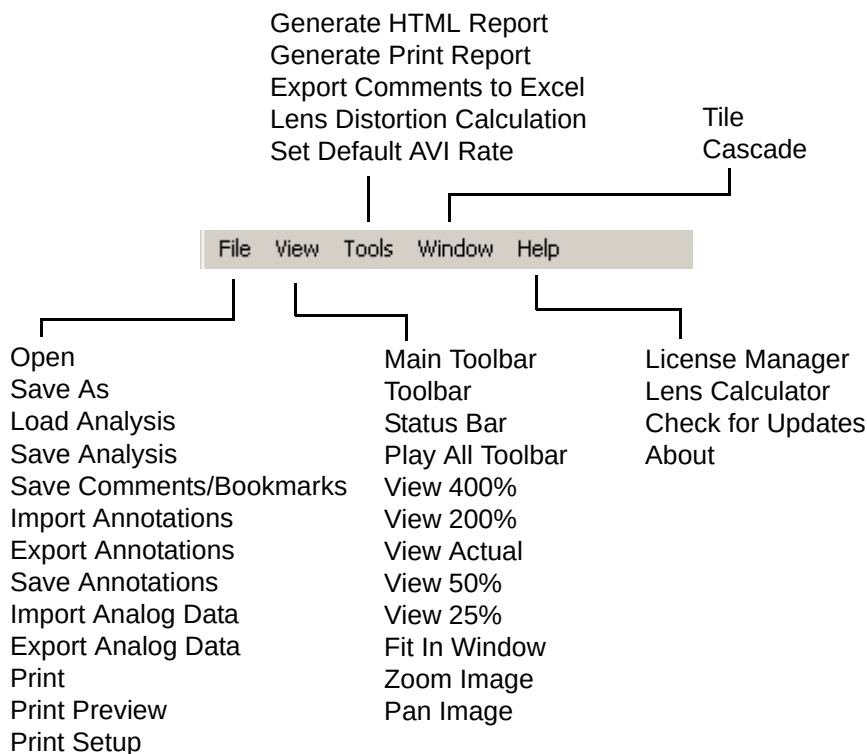
If the Archive Browser window is active, the menu options are as follows:



If the Strip View window is active, the menu options are as follows:

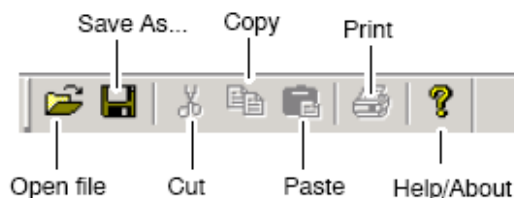


If the Working View window is active, the menu options are as follows:



The menu items contain standardized operations, as follows:

Below the menu bar is the icon tool bar. This icon bar does not change while the software is open. The features of the icon tool bar are as follows:



Next to the main toolbar is the Play All Toolbar, show below:



This toolbar allows for multiple video files to be played sequentially when in the Working View.

Below the icon bar is the tab selector. Tabs corresponding to the four views are shown:



At the bottom of the desktop is the "Status Bar". The *i-SPEED* Software Suite status bar contains information about the video file you are recording or viewing and about where you are pointing with your mouse cursor.

For optimum viewing area and to view images at their highest resolution, set your display to SXGA mode – 1280x1024 pixels - with a minimum of 24-bits of color. *i-SPEED* Software Suite is designed to operate on displays as low as 800x600 pixels and will generate an error message if your color depth is not set to High Color (16-bits) or above.

The display resolution will actively update during resizing. To resize a display window, grab any corner of the window by clicking down on the mouse, and, while holding the mouse down, drag it - *i-SPEED* Software Suite will maintain the correct aspect ratio.

Tool Tips

Throughout the *i-SPEED* Software Suite program, you will also find Tool Tips. These helpful messages or phrases describe the various functions within *i-SPEED* Software Suite. To view a Tool Tip, simply slide the mouse cursor over the function without clicking. For example, when the mouse cursor is placed over the **SET ZERO FRAME** button on the Play tab, the Tool Tip shown below appears.

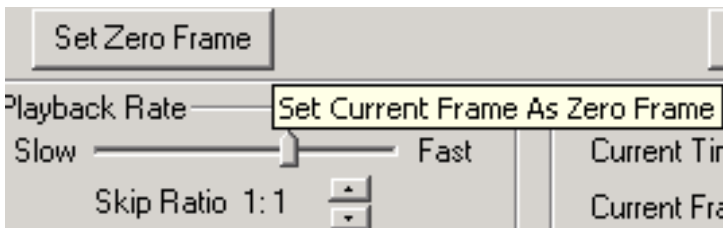


Image Size and Zooming

The image size is measured in pixels, horizontal by vertical. The actual image size is also expressed as 100% magnification. If selected, View 100% will present the image in the actual number of pixels as it was recorded (e.g. 1280 x 1024, etc.).

You may change the image size (e.g. “zoom in” or “zoom out” by changing the View % or by zooming the image manually.

The following zoom commands are very useful:

View 100%

When selected, this command sets the zoom region and the window frame to be equal to the actual image size. That is, everything is displayed within a frame at 1:1.

View x %

When selected, this command sets the window frame to be a multiplier times the actual image size. For example, if 200% is selected for a video that was acquired at 1280x1024, the image will be displayed at 2560x2048.

If the new frame size is larger than the desktop area permits, then the image is zoom magnified to the correct value and the window frame limited to the maximum size permitted by the window frame.

For example, if 400% is selected in the above example, the image is magnified 4x to 5120x4096, but only the available number of pixels will be displayed, as limited by the frame.

Fit in Window

When selected, this command fits the entire image into the window frame. This command does not change the window frame size, just the image size.

Zoom Image

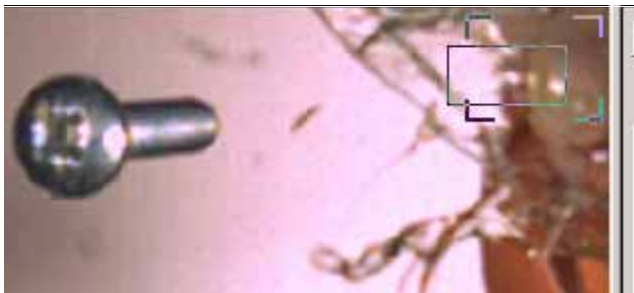
This command allows you to use your mouse or trackball to easily zoom the magnification up or down of the image. When selected, the mouse cursor turns to a 4-point star on the view window. Simply roll the mouse or trackball up the image to zoom up (magnify) or roll downward to zoom down (minimize).

Pan Image

This command allows you to use your mouse or trackball to easily pan the image – move the image in any direction to optimize its location. When selected, the mouse cursor turns to a 4-point star on the view window. Simply roll the mouse or trackball in any direction to scroll the image in that direction.

The location box appears in the upper right corner of the window showing you the relative size and location of the window on the actual image size.

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 LEGEND**.

Context Menus

In addition to the controls in the menu bar, tool bar, control panel and playback shortcut bar, there are menus that can be accessed by right-clicking within the video display itself. These menus are called Context Menus.

The use of Context Menus provides very quick access to common commands. It also allows the maximization of workspace without compromise of features.

When you click the right mouse button inside of an open view window (e.g. a camera view windows, a strip or a working view window, a menu of options is shown. In the below window, the right-click command can be used to set the drawn lines during analysis in the working view.



Virtually all program features can be performed via contextual commands. It is a worthwhile habit to examine the contextual commands available for all windows.

The Reticle

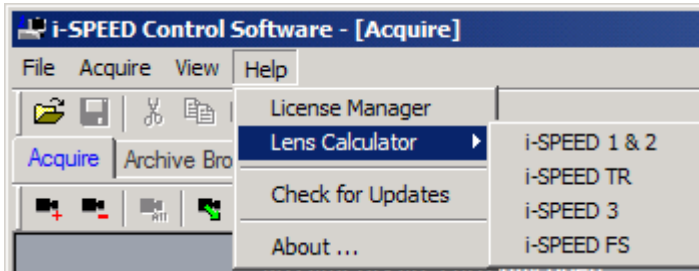
When enabled, the Reticle function displays a crosshair reticle on the view window (all types). The location of the reticle, in pixels from the upper left corner of the image (0,0) is displayed in the furthest left box on the status bar.

To enable and disable the reticle function, right click within any view window, then select/unselect Enable Reticle. The position of the reticle, in pixels from the upper right corner of the window is displayed in the Working View play tab.

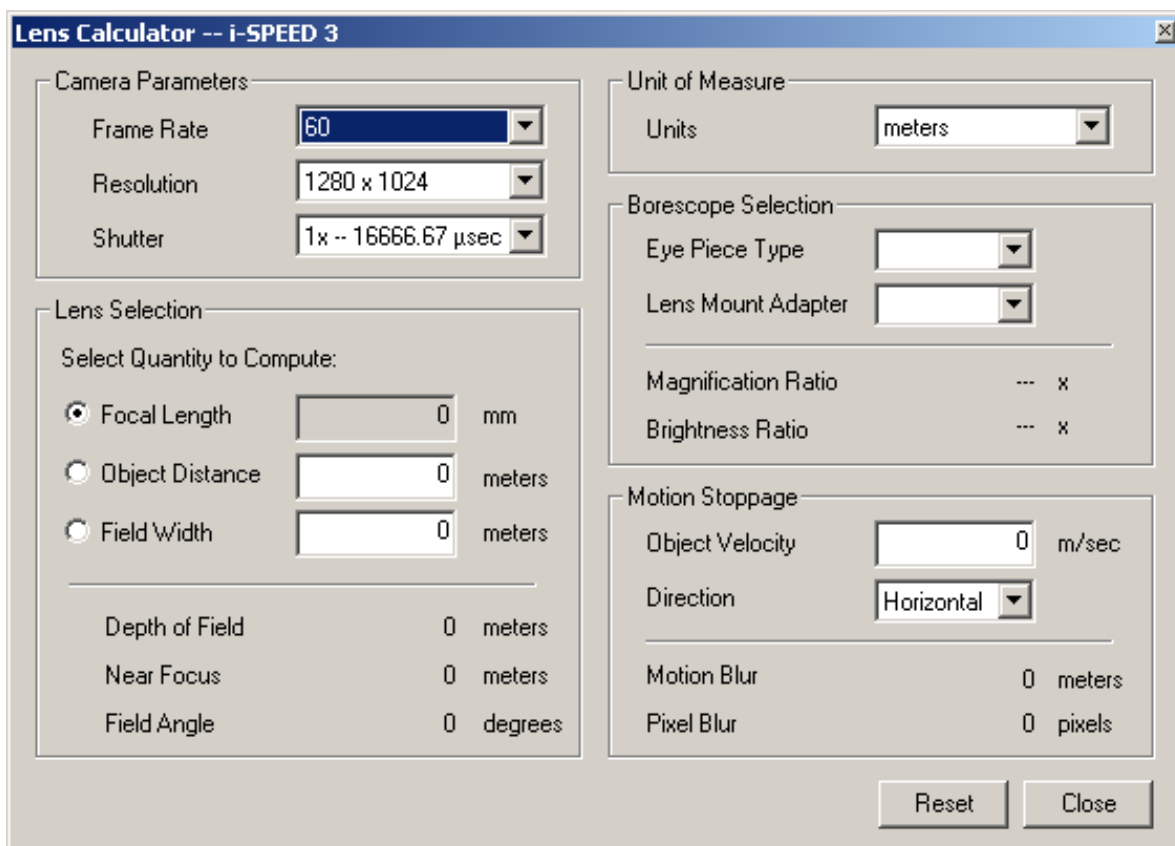
The Lens Calculator

The Lens Calculator is an important feature of the *i-SPEED* Software Suite. The Lens Calculator is designed to help videographers select the appropriate optics for a measurement.

To view the Lens Calculator, select Lens Calculator from the Help menu.



The following window appears:



The Lens Calculator provides a collection of information on selecting depth of field, field angle, format size, hyperfocal distance, and other parameters. It also helps you determine how much blur your image will have when capturing high-speed events.

The *i-SPEED* Lens Calculator allows you to select either a normal camera lens or an Olympus borescope as your optical system.

Normal Lens Selection

If you are using a normal camera lens, you may use the calculator to determine one of the three most common optical parameters of your test, if you know the other two parameters. The three common parameters are:

- Focal Length
- Object Distance
- Field Width

To use the *i-SPEED* Lens Calculator with a normal camera lens:

1 Select the parameter for which you wish to compute a solution.

Depending on which of these options you select, various entry fields will become active or disabled. (white or gray). You are only allowed to change the active (white areas).

2 After you have selected the parameter you wish to compute, select the Frame Rate, Resolution and Shutter Speed using the drop down boxes.

The Frame Rate will affect the resolution, which in turn affects the sensor size used in computations. The Frame Rate will also affect the motion blur calculations. The Shutter Speed affects only the motion blur calculations.

3 Fill in the information about the scene that you know.

For example, if you are using a 50mm focal length lens and you desire a 12m field of view, enter this information in the appropriate boxes.

4 Select your units of measure.

Note that the focal length of a lens is always expressed in mm by convention.

5 Type in the expected rate of motion of your object.

Motion blur and pixel blur calculations are made using the various camera, lens, and scene information. The motion blur quantity depends only upon the Object Velocity, Frame Rate, and Shutter Speed. The result is given in terms of distance the object has traveled during the exposure time. The pixel blur depends on the same values as the motion blur, and in addition, also depends on the sensor size in pixels, the direction of motion (horizontal/vertical), and the magnification. The pixel blur is given as the number of pixels that the object has “blurred” through during the exposure time.

6 Select the direction of motion.

The direction of motion is given with respect to the axes of the camera sensor. A selection of **HORIZONTAL** implies that the object of interest will be oriented/moving along the horizontal axis of the camera. This selection is used to control the sensor size since the horizontal and vertical resolution for cameras are often different. The final input is the Object Velocity. This quantity is used for the motion blur calculations.

Olympus Borescopes

The *i-SPEED* Lens Calculator also assists in the selection of an Olympus borescope as an optical system. Olympus borescopes are specified by their eye-piece type and C-mount adapters. For more assistance in selecting the borescope that is best for your application, contact your local Olympus sales and support agent.

To use the *i-SPEED* Lens Calculator with your Olympus borescope:

1 Select the eyepiece type

2 Select the c-mount adapter type.

3 Select the Frame Rate, Resolution and Shutter Speed using the drop down boxes.

The Frame Rate will affect the resolution, which in turn affects the sensor size used in computations. The Frame Rate will also affect the motion blur calculations. The Shutter Speed affects only the motion blur calculations.

4 Fill in the information about the scene that you know.

For example, if you are using a 50 mm focal length lens and you desire a 12 m field of view, enter this information in the appropriate boxes.

5 Select your units of measure.

Note that the focal length of a lens is always expressed in mm by convention.

6 Type in the expected rate of motion of your object.

Motion blur and pixel blur calculations are made using the various camera, lens, and scene information. The motion blur quantity depends only upon the Object Velocity, Frame Rate, and Shutter Speed. The result is given in terms of distance the object has traveled during the exposure time. The pixel blur depends on the same values as the motion blur, and in addition, also depends on the sensor size in pixels, the direction of motion (horizontal/vertical), and the magnification. The pixel blur is given as the number of pixels that the object has “blurred” through during the exposure time.

7 Select the direction of motion.

The direction of motion is given with respect to the axes of the camera sensor. A selection of **HORIZONTAL** implies that the object of interest will be oriented/moving along the horizontal axis of the camera. This selection is used to control the sensor size since the horizontal and vertical resolution for cameras are often different. The final input is the Object Velocity. This quantity is used for the motion blur calculations and is described in the next section titled “Motion and Pixel Blur”.

After all the relevant parameters have been entered, the calculations region is updated automatically with the corresponding results.

The *i-SPEED Software Suite* Lens Calculator calculates the following results:

Focal length	
	The distance from the rear principle plane to the focal point. A focal length equal to the diagonal of a sensor is generally considered to be “standard” - providing a perspective (viewpoint) consistent with the human eye. Focal lengths larger than the diagonal of the sensor are generally considered to be “telephoto”, providing narrow perspective. Focal lengths smaller than the diagonal of the sensor are generally considered to be “wide angle” or “retrofocus”. Focal lengths are always expressed in mm.
Magnification	
	The ratio of sensor size to field width. Magnifications less than unity have larger field widths. Magnifications are unitless.
Field width	
	The physical dimension, in chosen units, of the object field. If HORIZONTAL is chosen, the field width describes the long dimension of the field. If VERTICAL is chosen, the field width is the other dimension.
Object distance	
	The physical dimension, in chosen units, that will yield the sharpest image for a lens of specific focal length and field width. The object distance is theoretically computed from the front principle plane of the lens, not necessarily from the physical front of the lens, though this approximation is usually sufficient. The object distance is not dependent on the focus setting of the lens, though most lens designers will set the infinity (best) focus of the lens to be at the correct object distance.
Depth of field	
	The overall distance between near focus and far focus that an image will be perceptibly sharp to the average user.
Near focus	
	The distance from the lens to the closest point in object space that will be perceptibly sharp when the lens is focused at the optimum object distance.
Field angle	
	The full angle subtended by the field width to the lens, based on the object distance.
Motion blur	
	The amount of blur that will be evident in the image, in units of measure in object space.
Pixel blur	
	The number of pixels that will show blur of the motion.
Magnification ratio	
	The magnification ratio of the borescope when used at the chosen resolution. The magnification ratio shows the relative size of the object, as projected on the sensor and then on a standard video display.
Brightness ratio	
	The relative increase in brightness of the object. Numbers less than zero indicate a decrease in intensity. This number assists in the selection of lighting conditions.

Record Settings

Connecting to a camera network	44
The Acquire Tool Bar	45
Setting the record parameters	46
Setting the Record Modes	48
Burst Record on Command (BROC) Mode	48
Record on Command (ROC) Mode	49
IRIG Settings (FS Models Only)	49
Rotated and Flipped Video	49
Economy Mode	50
Transfer Format	52
Acquiring User Data	53
Differential Sensors	55
Single-Ended Grounded Sensors (Non-Referenced or NRSE)	55
Single-Ended Floating Sensors (Referenced or RSE)	55
Automatic Download (Control Pro only)	58
Video Trigger	60



Record Settings

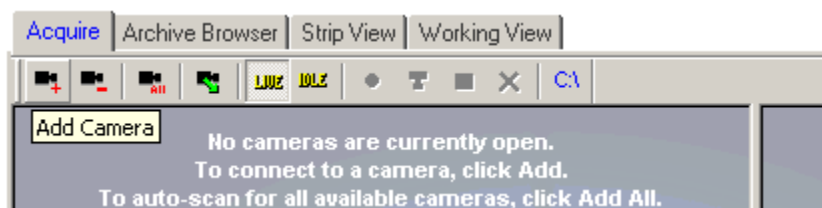
Connecting to a camera network

The *i-SPEED* Software Suite allows users to connect to a single camera at a time in the Control version and up to 255 cameras in the Control Pro version. The software uses the internal Ethernet TCP/IP functionality. The computer which houses the *i-SPEED* software must be on the same network as the cameras.

The *i-SPEED* Software Suite can connect to *i-SPEED* 1 and 2 cameras as well as *i-SPEED* cameras. Detection of the type of camera being connected is done automatically. This manual includes information about settings specific to the *i-SPEED* camera. When connected to an *i-SPEED* 1 or 2 camera, the user interface will revert to the subset of controls that are supported by the *i-SPEED* 1 or 2 camera. Please refer to the *i-SPEED* 1 or 2 User Manual for specific instructions on configuring those cameras.

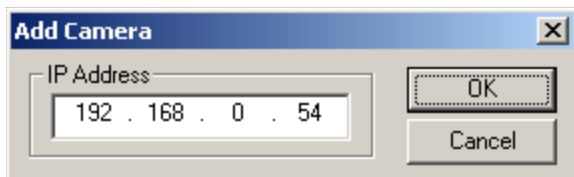
To connect a camera to the network:

1 Click on the Acquire tab.



2 Either click on the Add a Camera button or Add All Cameras button.

If you select the Add a Camera button, the following window will appear:

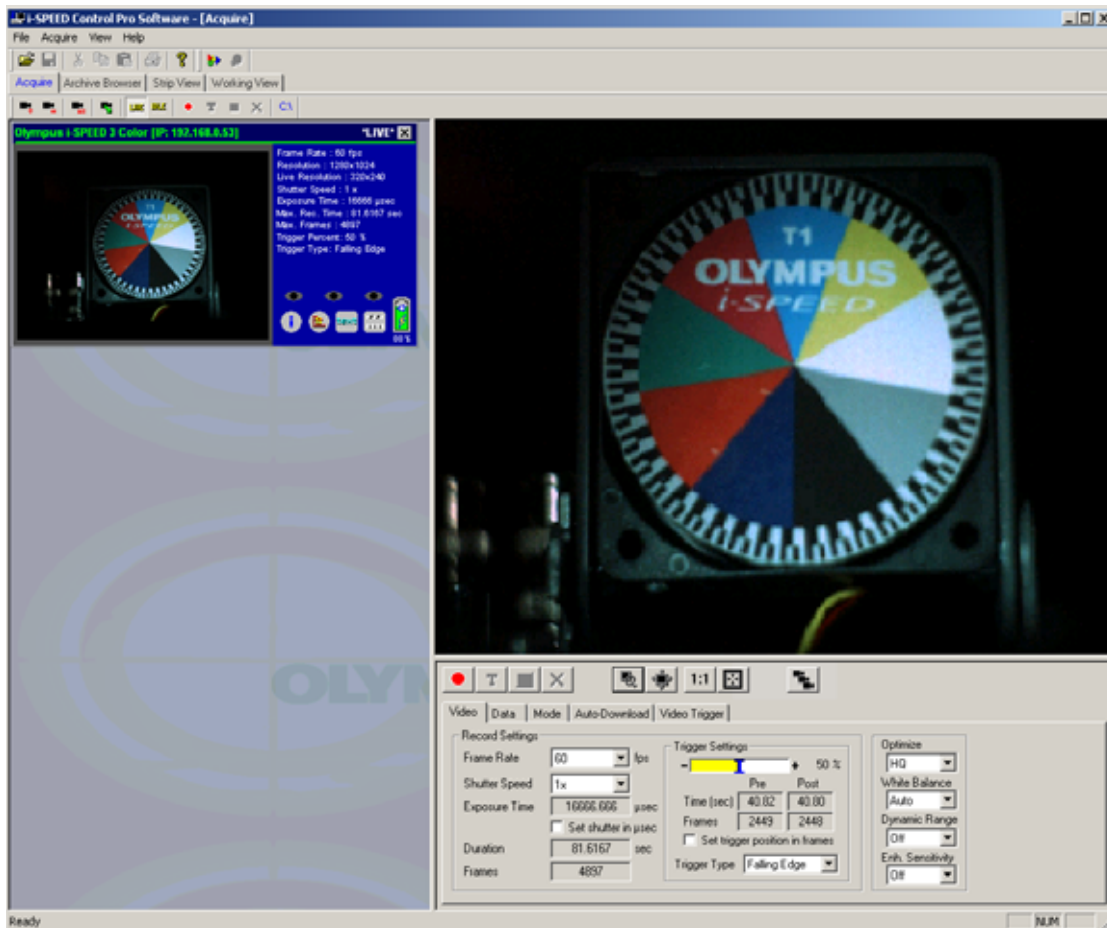


3 Type in the IP address of the camera you wish to add to the network.

The IP address can be found in the Home/Config/Ethernet menu screen on the CDU. The typical default address is 192.168.0.54. The IP address for the camera can be also be changed via the CDU.

If you selected the Add All Cameras command, the *i-SPEED* Software Suite will browse the network and automatically add all *i-SPEED* cameras it finds on the network with valid IP addresses. This process may take some time.

Once a camera has been added to the network, a thumbnail view of that camera appears in the left pane of the Acquire Window, as shown below:

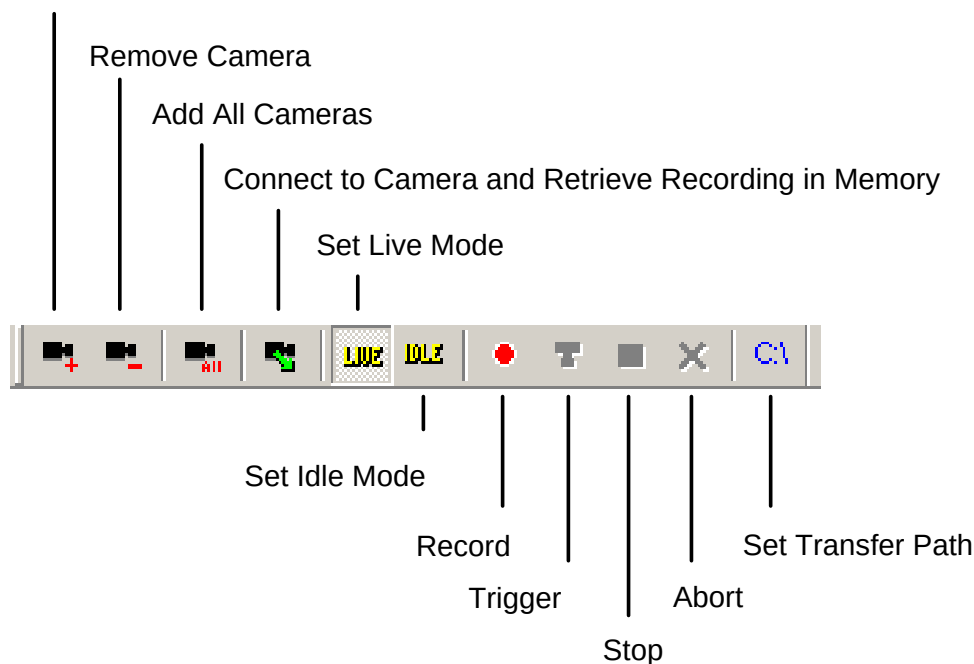


The camera that is currently “active” is shown in the upper right pane of the Acquire Windows. You can select the active camera simply by clicking on a camera in the left column. The active camera information is shown in the lower right pane. When a camera is active, the record settings can be modified. The settings can only be changed for each camera individually.

The Acquire Tool Bar

The Acquire tool bar is found directly above the Acquire window. The Acquire tool bar provides the tools to connect cameras to the *i-SPEED* Software Suite. The tool bar has the following components:

Add Camera



The functions of the Acquire Tool Bar are described as follows:

Add Camera	When this button is selected, the IP Select window appears. Type in the IP address of the camera you wish to add to the network. The list of cameras on the network is listed along the left side of the window.
Remove Camera	Click on this button to remove the highlighted (active) camera from the network.
Add All Cameras	Click on this button to instruct the <i>i-SPEED</i> software to browse a selected subset of the TCP/IP network and automatically add all available cameras to the list of cameras.
Connect to Camera and Retrieve Recording in Memory	Click on this button to connect to a camera and immediately download the recording currently in memory. If clip selection limits have been set with the CDU, then the selected range will be downloaded only. Use this feature to connect to a camera whose recording is complete (made with the CDU or with the <i>i-SPEED</i> Software, then disconnected from the network). This feature does not perform a camera memory reset unless a button is pressed on the CDU after completion.
Set Live Mode	Set all open cameras into live mode.
Set Idle Mode	Set all open cameras into idle mode.
Record	Start recording with all open cameras.
Trigger	Trigger all cameras in accordance with the instructions in the Trigger tab.
Stop	Stop a recording immediately.
Abort	Abort the current recording and reset the cameras.
Set Transfer Path	Set the path for transferring thumbnail images and data.

Setting the record parameters

The record parameters for the currently active (highlighted and displayed camera) are set via the settings information in the lower right panel. The number of tab windows in this panel is dictated by the version of software you have licensed. The tab options are as follows:

	Control	
Video record	x	x
Data record via external box		x
Mode	x	x
Auto-Download		x
Video Trigger		x

The basic record parameters are found on the Video record tab:

The screenshot shows the 'Record Settings' dialog box with the 'Video' tab selected. The 'Record Settings' section contains: Frame Rate (60 fps), Shutter Speed (1x), Exposure Time (16666.666 μsec), Duration (81.6167 sec), and Frames (4897). The 'Trigger Settings' section contains: a yellow trigger bar, Time (sec) (Pre: 40.82, Post: 40.80), Frames (Pre: 2449, Post: 2448), and Trigger Type (Falling Edge). The 'Optimize' section contains: HQ, White Balance (Auto), Dynamic Range (Off), and Enh. Sensitivity (Off).

The settings available in this window are as follows:

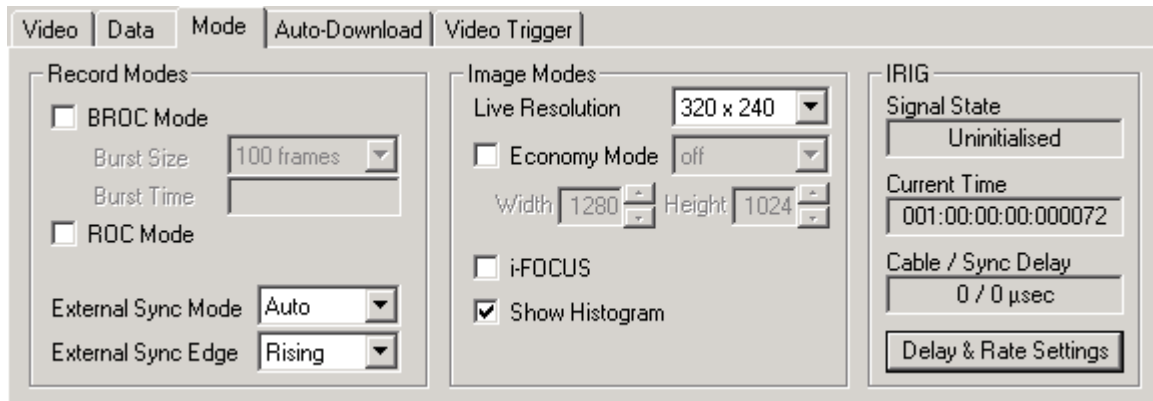
Frame Rate	The frame rate drag-down box displays the available video frame rates. The rates are determined by the camera hardware in the computer. The default is set to 60 fps.
Shutter Speed & Exposure Time	The shutter speed and the exposure time denote the amount of time that the electronic shutter of the 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). Shutter speeds can be set in terms of fractions of the frame rate or in microseconds. To set the speed in fractions of the frame rate, select the shutter speed from the drop-down box. The corresponding exposure time will be displayed in the gray box below the selected shutter speed. To set the speed in microseconds, check the "Set shutter in μsec" box and enter the desired shutter speed in the Exposure Time edit box.
Duration & Frames	The maximum amount of time that can be recorded during a video sequence, in seconds. The corresponding number of video frames that can be recorded during a video sequence. Note that few frames can be acquired by setting the trigger percent accordingly and using the stop button.
Trigger Percent	The percentage trigger puts the Reference Frame 0 at the desired position and dictates the amount of time prior to the trigger and after the trigger is received. The listed number is the pre-trigger percentage of the total acquisition. For example, a trigger percentage of "0%" instructs the <i>i-SPEED</i> 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 <i>i-SPEED</i> 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. The Reference Frame 0 is placed at the exact frame when the trigger input is received. To see frames before and after the trigger input time, use trigger percentages in the range of 10% to 90%. 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. Trigger percentages are selectable from 0% to 100% in 1% increments. The default is 100%. The trigger percent has no effect when the <i>i-SPEED</i> software is set to Record on Command or Burst Record on Command modes (see below). The trigger position may also be set directly in number of frames rather than as a percentage. To set the trigger position in frames, check the "Set trigger position in frames" box and enter the desired pre or post trigger frames in the corresponding edit box.
Trigger Type	The external trigger input is always enabled on the <i>i-SPEED</i> camera. The Trigger Type box is used to instruct the <i>i-SPEED</i> software as to which type of external and internal (software button) triggers to accept. Select Rising Edge if your event trigger generates a positive going pulse. Select Falling Edge if your event trigger generates a negative going pulse.
Pre-Trigger Time	The amount of record time to be acquired prior to the trigger input.
Post -Trigger Time	The amount of record time to be acquired after the trigger input.
Pre-Trigger Frames	The number of frames to be acquired prior to the trigger input.
Post-Trigger Frames	The number of frames to be acquire after the trigger input.

Setting the Record Modes

The *i-SPEED* camera has two optional record modes that can be selected during the acquisition process:

- Burst Record on Command (BROC) Mode
- Record on Command (ROC) Mode

The record modes are set in the Mode tab under the Acquire window.



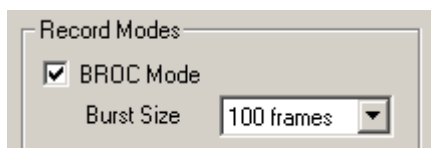
Burst Record on Command (BROC) Mode

In this mode of operation, the *i-SPEED* software will record video in user-defined bursts every time a valid trigger is received. A valid trigger is either a software trigger (when available) or an external trigger input. Video is recorded after the trigger is received.

The *i-SPEED* software will continue to concatenate (append) video every time a valid trigger input is received until either (a) the memory buffer fills or (b) the user presses the **STOP** button.

To set the *i-SPEED* software into Burst Record on Command mode:

- 1 Select the Video tab.
- 2 Set the Trigger Type to either RISING EDGE, or FALLING EDGE.
- 3 Select the Mode tab.
- 4 Check the BROC Mode checkbox.



- 5 Set the duration of the burst in the drag-down menu box.

NOTE: It is important to note that, when the BROC mode has been selected, the Trigger button and an external trigger input have the same effect. Also, the trigger percent has no effect on the trigger – all triggers are 100% post trigger.

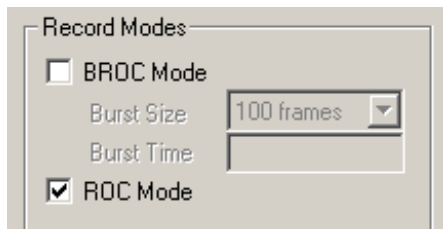
Record on Command (ROC) Mode

In this mode of operation, the *i-SPEED* software will record video only when a valid external trigger input is received. A valid trigger is defined as either (a) a voltage that exceeds a threshold determined by your camera hardware or (b) a voltage that falls below a threshold determined by your camera.

i-SPEED software will continue to concatenate (append) video every time a valid trigger input is received until either (a) the memory buffer fills or (b) the user presses the **STOP** button.

To set the *i-SPEED* software into Record on Command mode:

- 1 Select the Mode tab.
- 2 Check the ROC Mode checkbox.



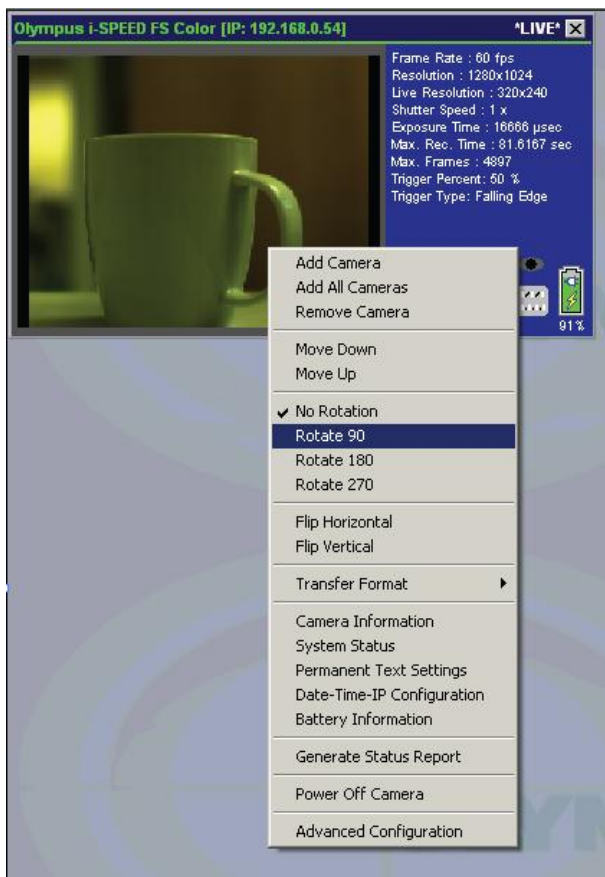
NOTE: It is important to note that, when the ROC mode has been selected, the trigger percent has no effect on the trigger.

IRIG Settings (FS Models Only)

Refer to Chapter 19 on page 166 for a further explanation of the IRIG Settings.

Rotated and Flipped Video

The *i-SPEED* software has the capability of rotating and/or flipping the image from the camera during capture. The image may be rotated 90, 180, or 270 degrees or flipped horizontally, vertically, or both. To enable rotation or flipping, right-click on the camera that you wish to rotate/flip and select the desired option(s) from the contextual menu that appears.



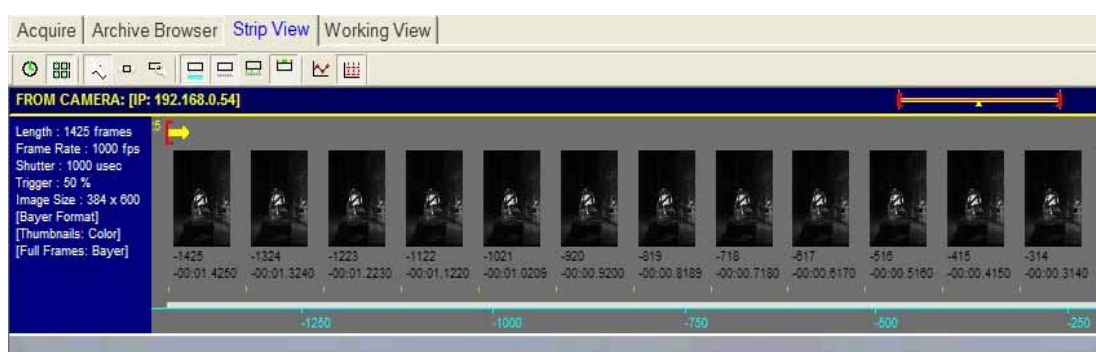
Economy Mode

Economy mode lowers the camera resolution to gain longer record times. As economy mode is an advanced feature of the camera software, please follow these instructions fully. Failure to do so could result in the loss of captured video or introduce frame errors. To place the camera into economy mode:

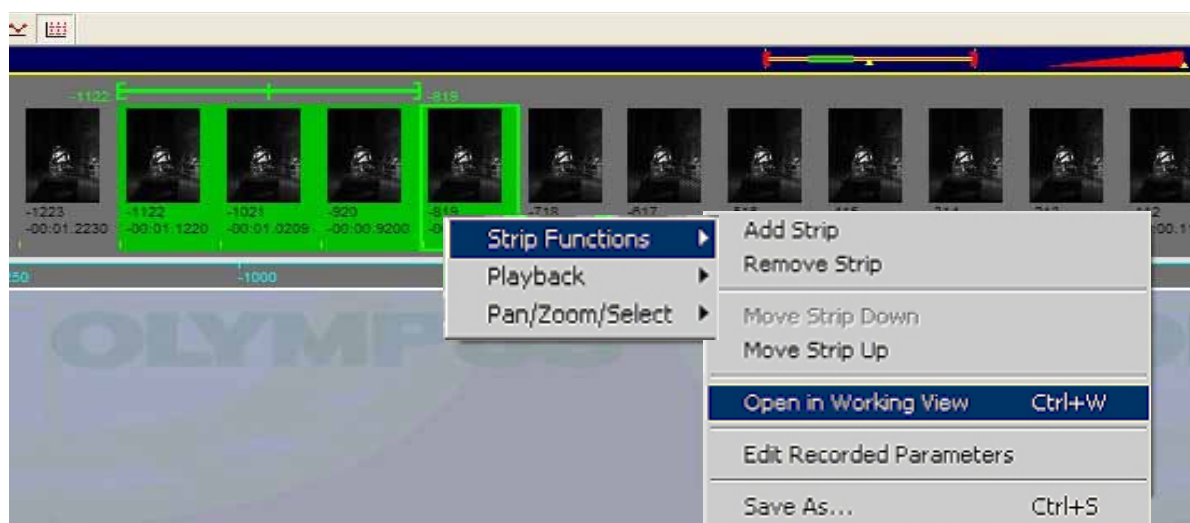
- 1 Select the Mode tab.
- 2 Check the Economy Mode checkbox.
- 3 Select the desired economy mode from the drop-down list, in the following example, "tall" is chosen.
- 4 If the economy mode is set to "manual", the width and height may be set by using the up/down controls next to each field. The width and height may only be specified in specific increments.



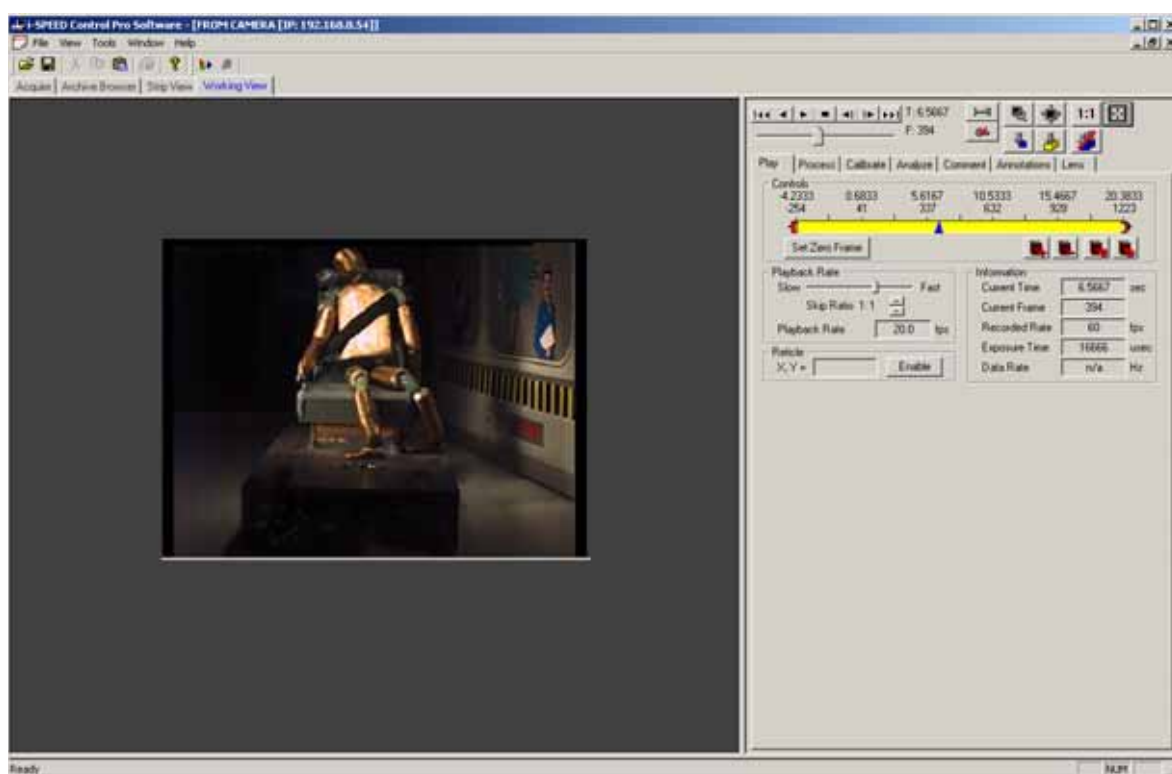
- 5 Now record as per normal, when the recording is complete, you will be passed through to the strip view.



- 6 Select the area of interest and right click the mouse button to enable the working view workspace to be opened.



- 7 You may now review your video frame by frame, conduct analysis, or perform other functions on your video in the Working View.



Transfer Format

The i-SPEED camera supports transferring images in JPEG or raw Bitmap format. Transferring images in JPEG format results in smaller files and greater download speed. There are three quality settings for transferring JPEG images. To select the transfer format, right-click on the camera and select the desired format from the menu that appears.



The transfer format can also be changed from the playback strip after the recording has completed. Right-click on the playback strip and select the desired format from the menu that appears.

"Compressed" or "Uncompressed" (TR Only)

If you have an i-SPEED TR model camera, only two transfer options are available, either "Compressed" or "Uncompressed." The "Compressed" setting transfers images from the cameras in JPEG format using extra compression. The "Uncompressed" setting transfers images from the camera in an uncompressed bitmap format.

Checking the Camera Status

The i-SPEED camera has a number of features to report the current status of the camera. These status reports can be accessed by clicking on the icons at the bottom of the camera information display or via the contextual menu. These status reports are available in the Control Pro version. A subset of these features is available in the Control version.



From left to right, the icons across the bottom open windows to display Camera Information, System Status, Permanent Text Settings, Date-Time-IP Configuration, and Battery Information. Above the icons are three status LEDs that mimic the LEDs that are located on the back of the camera.

Please refer the i-SPEED Camera Manual for specific details about the information contained in each of these windows.

Acquiring User Data

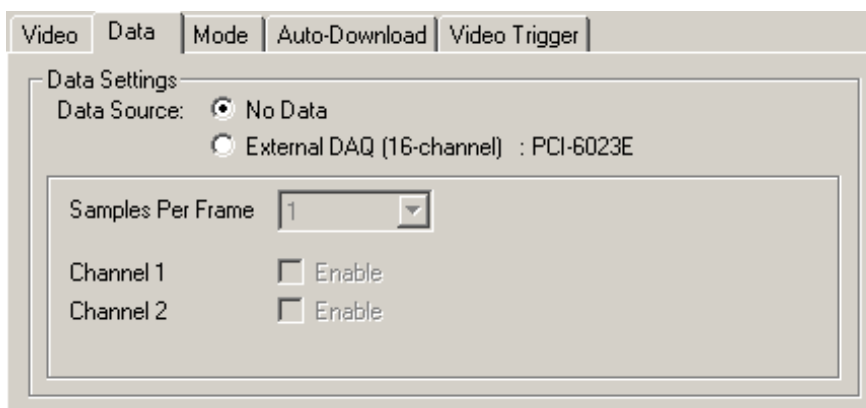
The *i-SPEED* camera has the capability of acquiring user data through an external piece of data acquisition (DAQ) hardware.

The acquisition of user data is highly synchronized to the video using proprietary technologies. The capabilities of the data acquisition system via the external hardware device is as follows:

	External DAQ Hardware
# of Inputs	16
Rate	200 kHz
Inputs	+/-10V
Settings	Diff, RSE, NRSE, Scale, Offset, Label, Gain

Acquiring User Data via the external box is enabled in the Control Pro version of the *i-SPEED* software with the additional upgrade module.

The user data input parameters are set through the Data tab on the Acquire window:



User Data via External Box (Control Pro only with Add-on Data Module)

With the external box, you have much more flexibility as to configuring the input channels. Channels are configured based on the type of sensor that is hooked up the input channel and to the calibration information provided with that sensor. This professional data acquisition system provides a complete flexibility to the user for acquiring professional data with video.

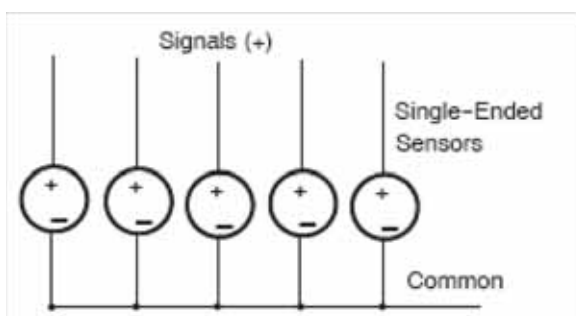
There is no live display of data when using the external data source.

Sensor Types

First, it is important to understand the different types of sensors and gauges that can be connected to the external data box.

Sensors have different characteristics that must be considered when connecting to the *i-SPEED* software 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.



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.

i-SPEED software is designed to work with all these sensor types. The operator must simply instruct the software as to which sensor type is being connected and the software automatically makes all the proper adjustments and switch settings. For example, if you are using a Referenced Single Ended sensor, the *i-SPEED* software 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, *i-SPEED* software knows which terminals to assign to the sensor and makes the appropriate switch changes to measure the difference between + and – leads.

Differential sensors are always recommended for better signal integrity. Single ended sensors are recommended only under controlled conditions, the most important of which is that you need more channels than are currently available. If your signal environment is the least bit noisy, your cable lengths exceed 3 meters (10 ft), or your signal level is less than 1V P-P, then it is highly recommended that you use Differential sensor types with two leads.

In the following sections, each type of sensor is summarized.

Differential Sensors

In this configuration, the Differential sensor has two leads – one positive (+) and one negative (-). Most commercial data acquisition systems are designed in a Differential configuration, especially if significant signal conditioning is required.

The negative lead of the sensor may be tied to earth or building ground and is therefore already connected to a common ground point with respect to the board (assuming that the computer is plugged into the same power system). This is termed “Grounded” or “Ground Sourced”. In this configuration, the little rocker switch under the BNC jack on your external data box should be placed in the “GS” position.

The negative lead of the sensor may not be tied to earth or building ground and is therefore “floating” with respect to the amplifier. Therefore, to reduce the effects of signal drift relative to the board ground, you must tie the ground reference of the floating signal to your board’s analog input ground through a bias resistor. In essence, you are “biasing” the drift toward ground. Technically, you should bias both the signal lead and the negative lead, but little improvement is gained by adding a bias resistor to the positive lead. You can add this bias automatically by sliding the little rocker switch under the BNC jack on your external data box to the “FS” position.

Single-Ended Grounded Sensors (Non-Referenced or NRSE)

Single-Ended sensors have one wire that carries the signal (+) and one common wire. Typically, single ended sensors are used in specialized applications such as crash testing where many additional sensors are required and the test environment is very well controlled. If you are using single ended sensors, you may tie the common wires of the sensors together.

On a Grounded Single-Ended sensor, the common lead of the sensor is also tied to earth or building ground and is therefore already connected to a common ground point with respect to the board (assuming that the computer is plugged into the same power system). However, since the differential amplifier needs both a positive (+) and negative (-) input, the common lead must be tied to a point on the External Box called the “AISENSE” – an internal ground sensing point.

When using Single-Ended Grounded sensors, the common lead gets tied to AISENSE at the BNC Breakout Box. All other connections and switches are handled automatically by the *i-SPEED* PC Software.

Single-Ended Floating Sensors (Referenced or RSE)

Single-Ended sensors have one wire that carries the signal (+) and one common wire. Typically, single ended sensors are used in specialized applications such as crash testing where many additional sensors are required and the test environment is very well controlled. If you are using single ended sensors, you may tie the common wires of the sensors together.

On a Floating Single-Ended sensor, the common lead of the sensor is not tied to earth or building ground and is therefore floating relative to the ground of the amplifier. Therefore, to reduce the effects of signal drift relative to the board ground, you must “reference” the floating signal to the amplifier analog input ground through a bias resistor. In essence, you are “biasing” the drift toward ground. Technically, you should bias both the signal lead and the negative lead, but little improvement is gained by adding a bias resistor to the positive lead.

You must add the bias resistor yourself, even if you are using the BNC Breakout Box (Single-Ended sensors do not use the negative lead of the BNC jack). For sources with low impedance, no bias resistor is needed and you may simply connect the common lead(s) to the AIGND terminal on your External data box directly.

For sources with large impedance, however, you must put a bias resistor in-line to de-couple the noise from the amplifier. Place a bias resistor of minimum 100x the equivalent source impedance between the negative terminal (common) of the sensor and the AIGND terminal on your External data box.

Configuring the External Data Acquisition Software

To set up your external data acquisition software:

- 1 Connect your external data box to the computer.
- 2 Select the Data tab.
- 3 Select the External DAQ source.

For each channel of data, perform the following steps:

On	Channel	Input Mode	Label	Units	Lower Limit	Upper Limit	Factor (units/volt)	Offset (units)	Plot Color	
☒	2	RSE	Vref	V	0	10	1	0	Yellow	Set

Chan	Input M...	Low...	Uppe...	Label	Factor	Offset	Units
0	DIFF	-5.00	5.00	Pressu	1.0000	0.00	psi
1	NRSE	-10.00	10.00	Speed	1.0000	0.00	m/s
2	RSE	0.00	10.00	Vref	1.0000	0.00	V

- 4 Select the channel number that you will be connecting your sensor. Start with Channel 0 and proceed incrementally upward. If a channel is not available (e.g. in use), the software will not allow you to input any input parameters. Skip all unusable channels.
- 5 Connect your sensor to the data box.
- 6 Select the type of sensor input from the software.
- 7 Select the sensor parameters (gain, offset, label, etc.)
- 8 Click on update button.

The input parameters are defined as follows:

Channel	<i>i-SPEED</i> automatically determines and displays which channels are available based on which type of sensors you have already configured. Always start with Channel 0 and check the box to enable that channel.
Input Mode	The type of sensor you are connecting to that channel. The three options here are DIFF, RSE and NRSE.
Label	A short label for the analog input channel.

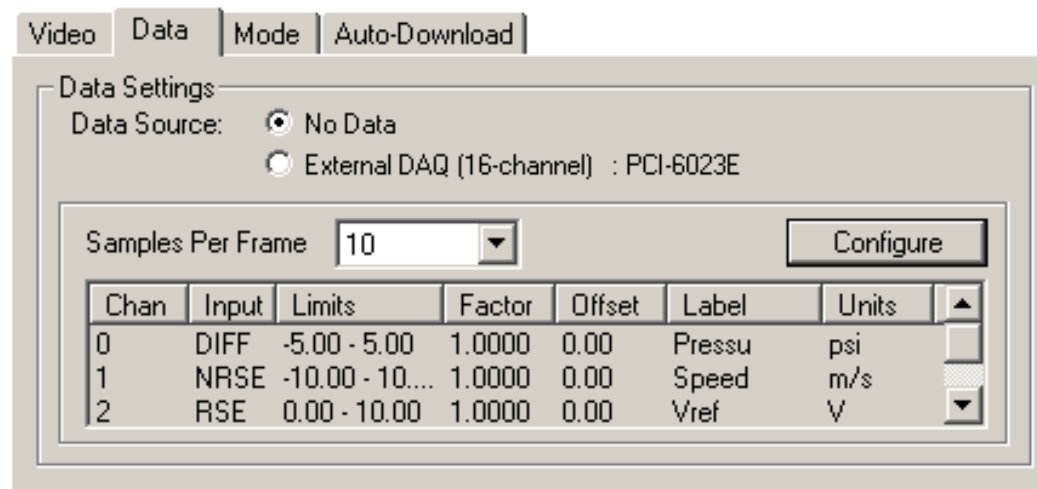
Units	A short field for placing units in the graphs.
Lower Limit	The lower limit, in volts, that you expect to see from your sensor. <i>i-SPEED</i> adjusts the dynamic range of the input from Lower Limit to Upper Limit based on the user inputs.
Upper Limit	The upper limit, in volts, that you expect to see from your sensor. <i>i-SPEED</i> adjusts the dynamic range of the input from Lower Limit to Upper Limit based on the user inputs.
Factor	The scale factor to be applied by the graphing and saving routine 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
Plot color button	The color of the line to be used in multiple-line graphs. Select this button to bring up the color palette.

Choosing the Data Sample Rate

The maximum data sample rate is 200,000 data points/second. You can acquire data at a much faster rate than you can acquire video. To set the data sample rate:

- 1 Select the Data tab.
- 2 Select the samples per frame rate from the drop-down list.

The total data sample rate is the product of the number of channels times the sample rate per channel. For example, if you have 4 channels active and wish to acquire 10,000 samples per second per channel, the total sample rate is $4 \times 10,000 = 40,000$ samples/second. Likewise, if you have 8 channels active, the maximum rate per channel is $50,000/8 = 6,250$ samples/second.



Automatic Download (Control Pro only)

Automatic Download allows you to set your system to record data and video automatically. Every time the system receives a trigger, the recording will complete, the results will be saved, and the system will restart the recording process automatically. This feature is very useful for applications that require capture of information at a remote site (e.g. a test range or hazardous environment) or when the event happens intermittently (e.g. a production line failure or explosion). This feature is available in the Control Pro version of the *i-SPEED* software.

To set the cameras to automatically download video and data to the PC, first configure the video and data settings normally as described above. However, instead of pressed the **RECORD** button, the Auto-Download parameters are configured and then activated.

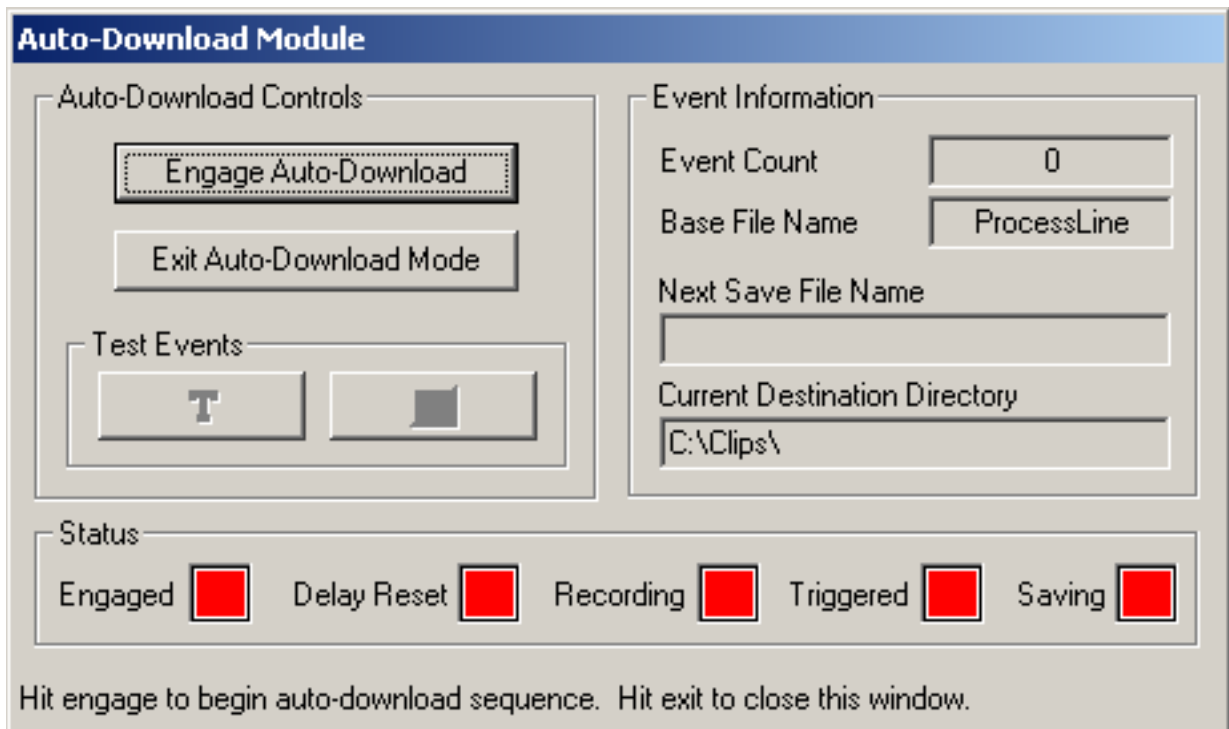
- 1 Set the video and data settings for each camera.
- 2 Select the Auto-Download tab.

- 3 Configure the Auto-Download Settings. The possible settings are:

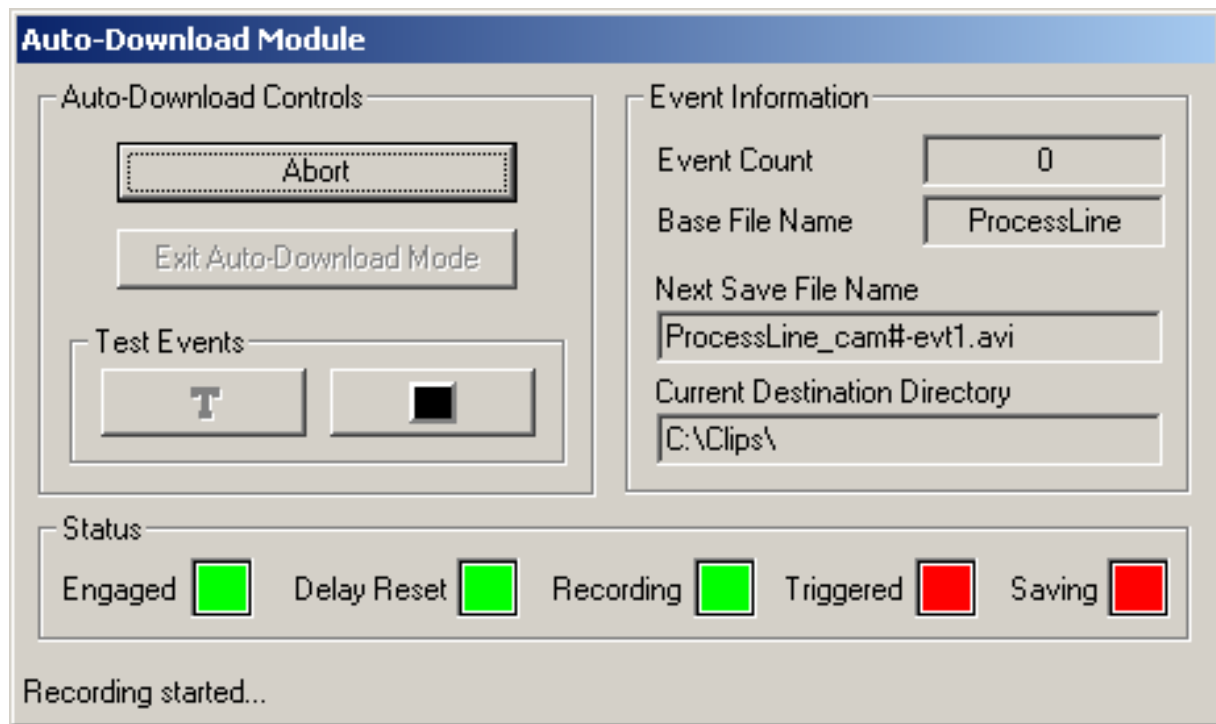
Continuous Reset	Will continuously save and re-arm until the operator disables Auto-Download mode.
Reset [n] times	Will download only a finite number of recordings, then disable Auto-Download and return to local recording mode. This feature helps prevent unintentional filling of hard drives.
Auto-Trigger/Stop	If this option is selected, every time that <i>i-SPEED</i> re-engages it will automatically (via software) re-trigger or re-stop. This means that it will wait the pre-trigger amount of time, and then automatically send a software trigger (if available) or a software stop command to the cameras. There is no need for an external trigger event to occur. (If an external trigger event occurs, then <i>i-SPEED</i> will not send the automatic trigger/stop command and will proceed as normal for that particular event only.) This feature is great if you would like to get as continuous a recording as possible. The only gap, being the amount of time that it takes to save to disk.
Delayed Reset [n] sec	If this option is selected, after <i>i-SPEED</i> finishes saving a recording, it will not re-engage itself until after the indicated number of seconds. If, for example, your line stays down for 30 minutes after it sends out the trigger signal to the cameras, you would enter 1800. After <i>i-SPEED</i> receives a trigger it saves to disk, and waits 1800 seconds (30 minutes) before it re-engages into record mode waiting for the next trigger.
Frame Range	The range of frames to be saved. In most cases, you will not want to save the whole range of frames recorded. This would potentially take a prolonged amount of time (during which you may miss other events). The frame range allows you to select a specific set of frames relative to the trigger frame to save for each event. This allows you to save on both disk space and save time.
Save as images	If this option is selected, your videos will be saved as bitmap or JPEG sequences instead of AVI files. If the transfer format from the camera is set to "Bitmap (Uncompressed)", bitmap images will be saved. If the transfer format from the camera is set to any of the JPEG options, JPEG images will be saved.

Name Format	The naming of the resulting saved videos is controlled by specifying a desired "Name Format" which is composed of normal text and special "tags". These tags are replaced with the current values when each save occurs. Below is a list of possible tags and the resulting output associated with each tag: <\> Create a new folder <Date> Current date as specified by the computer clock <Time> Current time as specified by the computer clock <CamIP> IP address of the camera being saved <CamID> Camera ID from the camera being saved <CamNum> Number of the camera being saved <EventNum> Event number currently being saved You may use any combination of the above tags. Certain tags are required to prevent identical naming of videos from multiple cameras. For instance, one of <CamIP>, <CamID>, or <CamNum> are required to uniquely identify which camera captured a given video. <EventNum> is also required to indicate the event number for a given video. For example, the following string can be specified as a name format: "<Date><\><Time>_IP_<CamIP>_Event_<EventNum>". One resulting video filename would be "2011-02-20\09-30-000000_IP_192.168.0.54_Event_5.avi", if the video were captured on "2011-02-20" at "9:30AM" from a camera with IP address "192.168.0.54" and for event number "5". The folder "2011-02-20" would be created if it did not exist already. Another example of a very simple name format would be "C<CamNum>_E<EventNum>", which would generate files like "C1_E1.avi", "C2_E1.avi", "C1_E2.avi", "C2_E2.avi", "C1_E3.avi", "C2_E3.avi", etc. for two cameras and three+ events.
Save to Folder(s)	Select the list of possible destination folders for auto-download. Multiple folders can be specified. When saving videos, the Auto-Download module will attempt to save to the first destination folder. If the folder has insufficient space, it will attempt to save in the second destination folder. It will proceed down the list until all destinations are full. You can add and remove destination folders by using the '+' and '-' buttons.

- 4 Press the **ACTIVATE** button.



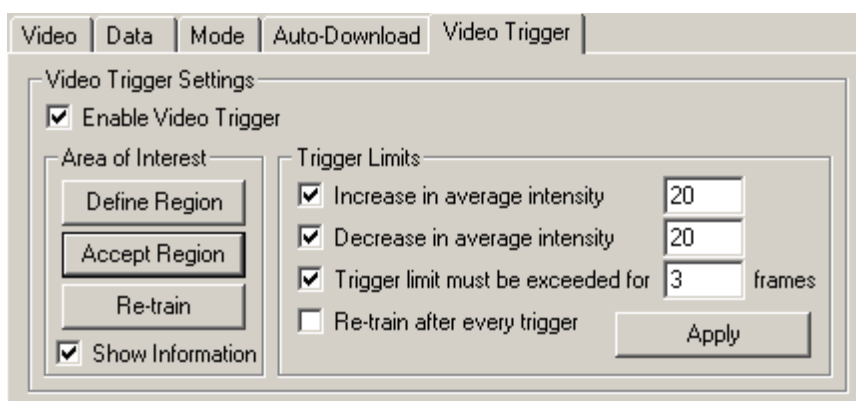
- 5 The Auto-Download Module now has control over the *i-SPEED* program. At this moment, you can exit the module and reconfigure any settings or you can engage the module and begin the recording.



- 6 Once engaged, the current status of the Auto-Download Module is shown by the colored squares along the bottom.
- 7 Test Events allow you to simulate an external trigger event in software. If software triggering is available, the **TRIGGER** button will be enabled. If software stopping is available, the **STOP** button will be enabled. These test events allow you to make a test run of the record and save procedure to ensure that all pieces are functioning properly.
- 8 If "Reset [n] times" was set, after n events, the system will automatically end. If you wish to stop before n events, or if the system was set to continuous reset, you can abort Auto-Download by pressing the **ABORT** button.

Video Trigger

The Video Trigger panel allows you to trigger your system based upon changes in the live video image. The Video Trigger panel is available in the Control Pro version of the software.



To enable the Video Trigger, click on the "Enable Video Trigger" check box in the Video Trigger Panel. Click on the Define Region button and draw a rectangular region in the live video image. To change the size of the rectangular region, click on Define Region again and redraw the rectangle. To move the position of the region, click on a new center location for the region and it will move. When you are satisfied with the location of the region, click on the Accept Region button.

The Video Trigger "trains" itself by determining the average intensity of the image in the area that you have defined. If the average intensity of the region of the image changes by a sufficient amount, the Video Trigger will send a trigger signal to the open camera(s). The average intensity determined during the training procedure is displayed below the rectangular region in the live image. The intensity value ranges between 0 (black) and 255 (white). The current intensity is displayed below the trained intensity.



The sensitivity of the Video Trigger can be set by defining the Trigger Limits. The Video Trigger can be set to trigger on positive or negative changes in intensity or both. Click on the appropriate checkbox to enable change detection on increase or decrease of intensity. The values next to each line indicate the sensitivity of the change detection. The intensity must increase or decrease by an amount larger than the value entered.

Trigger Limits	
☒ Increase in average intensity	20
☒ Decrease in average intensity	20
☒ Trigger limit must be exceeded for	3 frames
☐ Re-train after every trigger	
Apply	

The Video Trigger system can be set to require a fixed number of frames that exceed the detection limits before sending the trigger signal to the open camera(s). This can be used to eliminate false triggers that only momentarily change the intensity of the image. Click on the checkbox to enable this feature and enter the number of frames required before triggering and click on Apply.

The Video Trigger system normally is trained only when the region is first defined, or if the “Re-train” button is pressed. There may be situations where the system should be re-trained after every trigger event (for instance, if using the Auto-Download module to detect multiple events that permanently change the live image after each event). If you wish the system to re-train itself after every event, click on the “Re-train after every trigger” checkbox and click on Apply.

Triggering your Recording

Overview of Triggering	63
Trigger Command	63
STOP Command	63
Defining the Reference Frame and Reference Datum	64
Defining a Frame, Exposure Time, and Buffer	64
Camera Trigger Modes	65
Record on Trigger (ROT) Mode	65
Record on Command (ROC) Mode	66
Burst Record on Command (BROC) Mode	67



Triggering your Recording

Overview of Triggering

When *i-SPEED* software is in record mode, *i-SPEED* software controls the acquisition process precisely, keeping track of time and location of frames and data from the external sensors. *i-SPEED* software also keeps track of time from external phase lock devices.

i-SPEED software 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:

Stop the recording at the desired time.

Isolate the exact point in time that the trigger impulse was received by *i-SPEED* software hardware.

The user sets the Trigger Percent (on the Record tab) to tell *i-SPEED* software 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 *i-SPEED* 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 *i-SPEED* 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.

There are three methods for stopping a recording:

- Sending a hardware pulse to the trigger in line of the camera or other *i-SPEED* software hardware
- Clicking on the **TRIGGER** button (when available)
- Clicking on the **STOP** button.

Not all optional modules support both types of software triggers. Only those modes available to you are highlighted or displayed.

Trigger Command

i-SPEED software treats pressing the **TRIGGER** button and an external hardware trigger the same. Upon receipt of a trigger stop (software or hardware) command, *i-SPEED* software executes the stop record function per the trigger settings (pre-record time and post-record time). The **TRIGGER** button places the Reference Frame 0 at the trigger point of the video sequence and the Reference Datum 0 at the trigger point of the data.

STOP Command

Pressing the **STOP** button immediately stops the recording function and places the Reference Frame 0 at the end of the sequence. In other words, the **STOP** button behaves like the trigger percent is set for 100% regardless of its actual setting.

Defining the Reference Frame and Reference Datum

i-SPEED software places the Reference Frame 0 and the Reference Datum 0 per the following rules. The term “buffer” refers to a single memory buffer, “Trigger Stop” refers to either clicking on the **TRIGGER** button or executing an external trigger, and “Stop” refers to clicking on the **STOP** button.

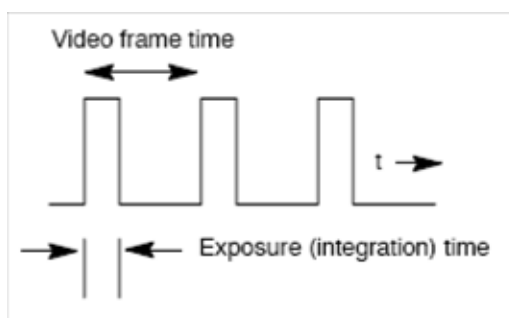
If...	What is returned...	Reference Frame is ...
Buffer has been filled prior to Trigger Stop	A full buffer of video/data	On the frame corresponding to when the trigger was received.
Buffer has been filled prior to Stop	A full buffer of video/data	On the last frame and on the last data point.
Buffer has not been filled prior to Trigger Stop	All frames acquired prior to Trigger Stop and the desired number of post-trigger frames.	On the frame corresponding to when the trigger was received.
Buffer has not been filled prior to Stop	All frames acquired prior to Stop.	On the last frame and on the last data point.
Buffer has not been filled, Trigger Stop executed, then Stop	All frames acquired prior to the Stop	On the last frame and on the last data point.

NOTE: Some cameras do not add a frame after receiving an external trigger. That is, if the *i-SPEED* software trigger percent is set to 100% and an external event trigger is received in the middle of a video frame, the camera immediately stops and only returns all the frames prior to the trigger frame. In this case, there is no Reference Frame 0 and the last frame is frame number –1. Most cameras continue recording for one or two frames after receipt of an external trigger to provide a trigger frame.

Defining a Frame, Exposure Time, and Buffer

Most often, the time that a video camera is actually acquiring images of the scene is only a small fraction of the total time. The actual acquisition time is termed the Exposure Time or integration time, and is most often measured in microseconds.

A video frame is defined to be the total time between exposures. A buffer is a sequential collection of video frames. The following time line drawing shows this relationship:



For example, if the video acquisition rate is 1000 fps, the video frame duration is 1 ms. The exposure time might only be 20 microseconds in duration. Therefore, the camera is only acquiring scene information (e.g. light) for 2% of its operation time.

In *i-SPEED* software, frame counting is done at the leading edge of the frame. In this example, the exposure time (the time the camera shutter is open) is at the beginning of the frame. Some cameras integrate at the end of the frame. Consult your camera manual for information about your specific camera.

The Reference Frame is the frame in which the external event trigger is received. Whether a trigger is received during the exposure period or during the dark period has no impact on labeling the Reference Frame.

This subtle definition is very important. In the above example, if a trigger pulse is received after an exposure period is complete, then the first post-trigger image is on frame 1, not frame 0. Consequently, the image of frame 0 was acquired prior to the event trigger.

Camera Trigger Modes

i-SPEED software has three camera trigger modes. Each mode acquires video (and data and time information) according to specific rules, as described in the following three sections.

To set the *i-SPEED* software Camera Trigger mode, click on the Mode tab in the Acquire window.

In summary, the three record modes are:

- **Record on Trigger (ROT) mode.**

In this mode, *i-SPEED* software records video in accordance with the trigger percent setting on a one-time basis when a valid trigger is received.

- **Record on Command (ROC) mode.**

In this mode, *i-SPEED* software records video only during the periods when a valid external trigger input is received. When a valid external trigger input stops, *i-SPEED* software stops recording. *i-SPEED* software will continue in Record on Command mode until either the STOP button is pressed or the memory buffer fills.

- **Burst Record on Command (BROC) mode.**

In this mode, *i-SPEED* software records preset bursts of video frames every time a valid trigger is received. *i-SPEED* software continues recording additional bursts on every input trigger until either the STOP button is pressed or the memory buffer fills.

After a recording is stopped, *i-SPEED* software automatically returns the valid video frames and sets itself into Playback mode.

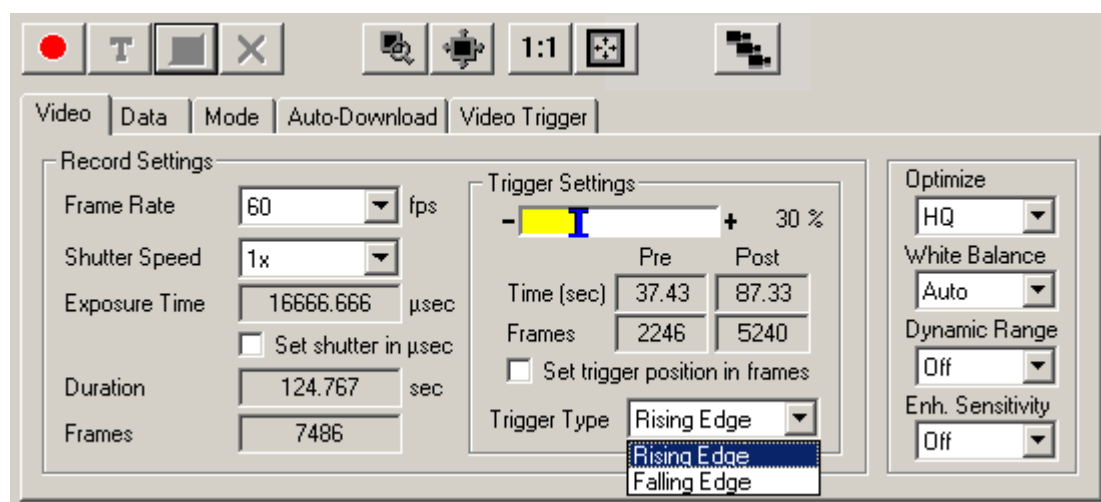
i-SPEED software defaults to Record on Trigger (ROT) mode for all camera types.

Record on Trigger (ROT) Mode

In this mode of operation, when a trigger event occurs (either an external trigger pulse is received or the user presses the TRIGGER or STOP buttons), the desired number of pre-trigger and post-trigger frames are acquired and displayed.

To set *i-SPEED* software into Record on Trigger (ROT) mode:

- 1 Click on the Mode tab in the Acquire window.
- 2 Ensure that neither the ROC Mode nor the BROC Mode boxes are checked.
- 3 The camera should then default to Record on Trigger (ROT) mode.
- 4 Configure the trigger parameters in the Video tab.



In Record on Trigger mode, *i-SPEED* software will return the following frames, depending on when the trigger event is received relative to the record buffer size

If the trigger % is...	and you have recorded...	and the event is...	then i-SPEED software....
100%	a full buffer	Trigger Stop or Stop	stops and returns a full buffer, as recorded
100%	a partial buffer	Trigger Stop or Stop	stops and returns only those frames that were recorded
0%	a full or partial buffer	Trigger Stop	continues recording one full buffer more and stops
0%	a full buffer	Stop	stops and returns a full buffer, as recorded
0%	a partial buffer	Stop	stops and returns only those frames that were recorded
$0% < t < 100%$	a full buffer	Trigger Stop	continues recording the prescribed number of post-trigger frames, then stops and returns a full buffer
$0% < t < 100%$	a partial buffer	Trigger Stop	continues recording the prescribed number of post-trigger frames, then stops and returns all the post-trigger frames and the available pre-trigger frames.
$0% < t < 100%$	a full buffer	Stop	stops and returns a full buffer, as recorded
$0% < t < 100%$	a partial buffer	Stop	stops and returns only those frames that were recorded

Record on Command (ROC) Mode

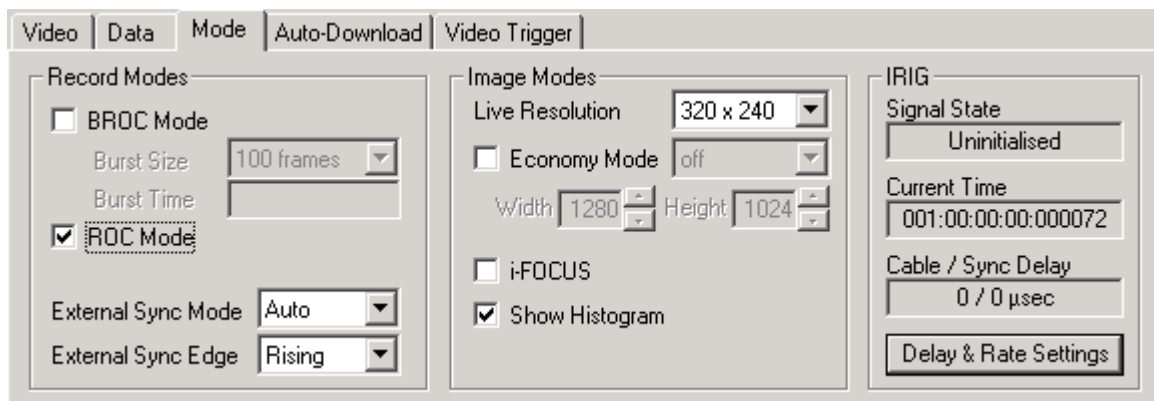
In this mode of operation – also called Record on High/Low Level Mode, *i-SPEED* software will record video only when a valid external trigger input is received. A valid trigger is defined as either (a) a voltage that exceeds a threshold determined by your camera hardware (Record on High) or (b) a voltage that falls below a threshold determined by your camera (Record on Low).

i-SPEED software will continue to concatenate (append) video every time a valid trigger input is received until either (a) the memory buffer fills or (b) the user presses the STOP button.

While the cameras are in Record on Command mode, the TRIGGER button is always disabled. Also, Record on Command mode is disabled when multiple cameras are connected on the network.

To set *i-SPEED* software into Record on Command mode:

- 1 Click on the Mode tab in the Acquire window.
- 2 Select the ROC Mode checkbox.



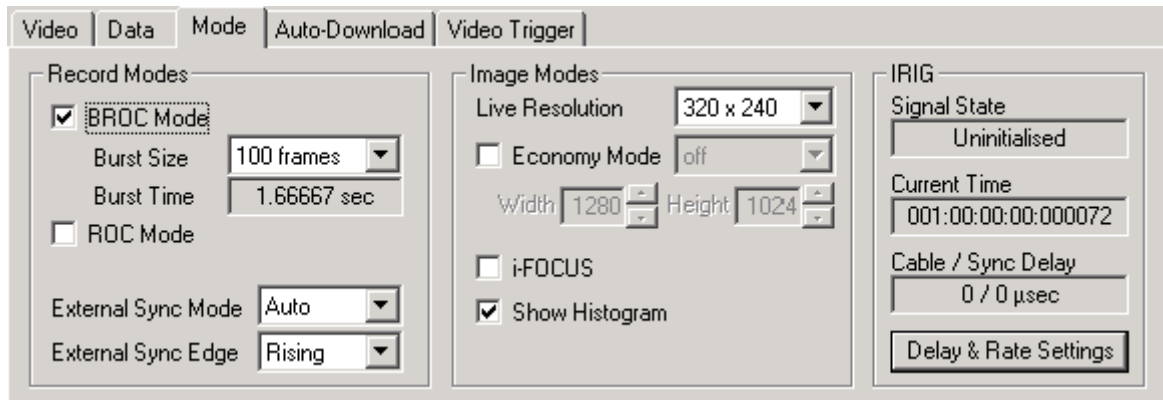
Burst Record on Command (BROC) Mode

In this mode of operation, *i-SPEED* software will record video in user-defined bursts every time a valid trigger is received. A valid trigger is either a TRIGGER button or an external trigger input. Video is recorded after the trigger is received.

i-SPEED software will continue to concatenate (append) video every time a valid trigger input is received until either (a) the memory buffer fills or (b) the user presses the STOP button.

To set *i-SPEED* software into Burst Record on Command mode:

- 1 Click on the Mode tab in the Acquire window.
- 2 Select the BROC Mode checkbox.
- 3 Select the desired duration for each burst.



NOTE: In Burst Record on Command mode, the Trigger Percent function is disabled. *i-SPEED* software will only post-trigger in this mode (record frames AFTER receiving a trigger).

Making a Recording

The Record Sequence	69
Making a Recording	69
Zooming, Panning and Viewing Live Images	70
Apply Changes to All Cameras	70



Making a Recording

The Record Sequence

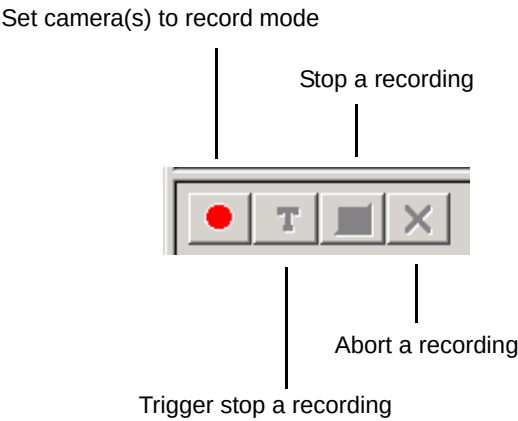
To record a video (and synchronized data, if enabled), follow these steps:

- 1 Add your camera(s) to the network.
- 2 Set the video record parameters for each camera.
- 3 Set the record and image modes for each camera.
- 4 Set the data record parameters for each camera.
- 5 Adjust the field of view, optics and lighting for each camera.
- 6 Press the Record button.
- 7 Trigger or stop your recording.

Making a Recording

Chapter 5 describes the process of adding, highlighting and setting the parameters of a video and user data recording.

After the cameras are set up, use the four functions found on the Acquire window top and lower right panel to record.



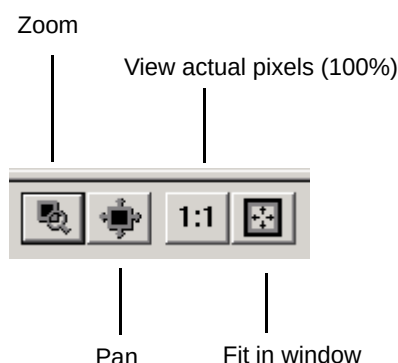
- 1 Press the Set Camera(s) to Record button (tool tip shortened to “Record”).
- 2 When the event of interest occurs, press the Trigger Stop button or send an external trigger pulse or press the Stop button. Note that the software trigger button may not be highlighted depending on which Record Mode (BROC, Time Lapse, etc.) has been selected.

Trigger	The TRIGGER button executes the stop record function per the trigger settings (pre-record time and post-record time). The TRIGGER button places the Reference Frame 0 at the trigger point of the sequence.
Stop	The STOP button immediately stops the recording function and places the Reference Frame 0 at the end of the sequence. Also called a “Panic Stop” button, the STOP button behaves like the trigger percent is set for 100%, regardless of its actual setting.
External Trigger Pulse	An external trigger pulse is treated like a TRIGGER event. For more information on how to connect an external trigger input, consult your <i>i-SPEED</i> camera hardware user manual.

- 3 In the event of a failed test, click on the Abort button. The camera is stopped and no frames of video or user data are recorded.

Zooming, Panning and Viewing Live Images

You can zoom, pan, magnify and maximize your live images using the shortcut buttons on the Acquire window panel.



View Actual Size	When selected, this command sets the zoom region and the window frame to be equal to the actual image size. That is, everything is displayed within a frame at 1:1.
Fit in Window	When selected, this command fits the entire image into the window frame. This command does not change the window frame size, just the image size.
Zoom Image	This command allows you to use your mouse or trackball to easily zoom the magnification up or down of the image. When selected, the mouse cursor turns to a triangle with an up-down arrow next to it on the view window. Click and drag the mouse upward to zoom in (magnify) or drag the mouse downward to zoom out (minify).
Pan Image	This command allows you to use your mouse or trackball to easily pan the image – move the image in any direction to optimize its location. When selected, the mouse cursor turns to a 4-way arrow on the view window. Click and drag the mouse in any direction to scroll the image in that direction. The location box appears in the upper right corner of the window showing you the relative size and location of the current view relative to the actual image size.

Other zoom, pan, view and image functions are available through use of the context (right-click) menus.

Apply Changes to All Cameras

When controlling multiple cameras, you may want to have all cameras have the same settings. Basic record settings can be applied to multiple cameras simultaneously. The button on the upper right of the control panel area can be pressed to enable "Apply Changes to All Cameras".



When this mode is enabled, changes made to the frame rate, shutter speed, resolution, record mode, and other basic settings will be applied to all open cameras.

Downloading Images and Data

Thumbnails and Full Frames	72
External Data	73
Downloading in the Working View	74
Saving Prior to Downloading	74



Downloading Images and Data

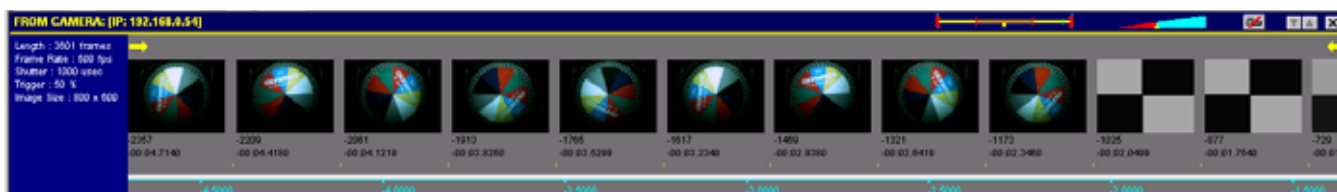
Thumbnails and Full Frames

For most recordings, the complete sequence of recorded frames from the camera is not required. Most often, a subset of the frames near some occurrence of a special event is particularly of interest. In order to speed the location and isolation of the particular frames of interest in a recorded video, low resolution thumbnails are transferred from the camera first whenever possible. Once the desired event is localized, the specific set of full resolution frames near the desired event may be downloaded. This selective downloading of frames greatly reduces the amount of time transferring memory from the camera to the PC.

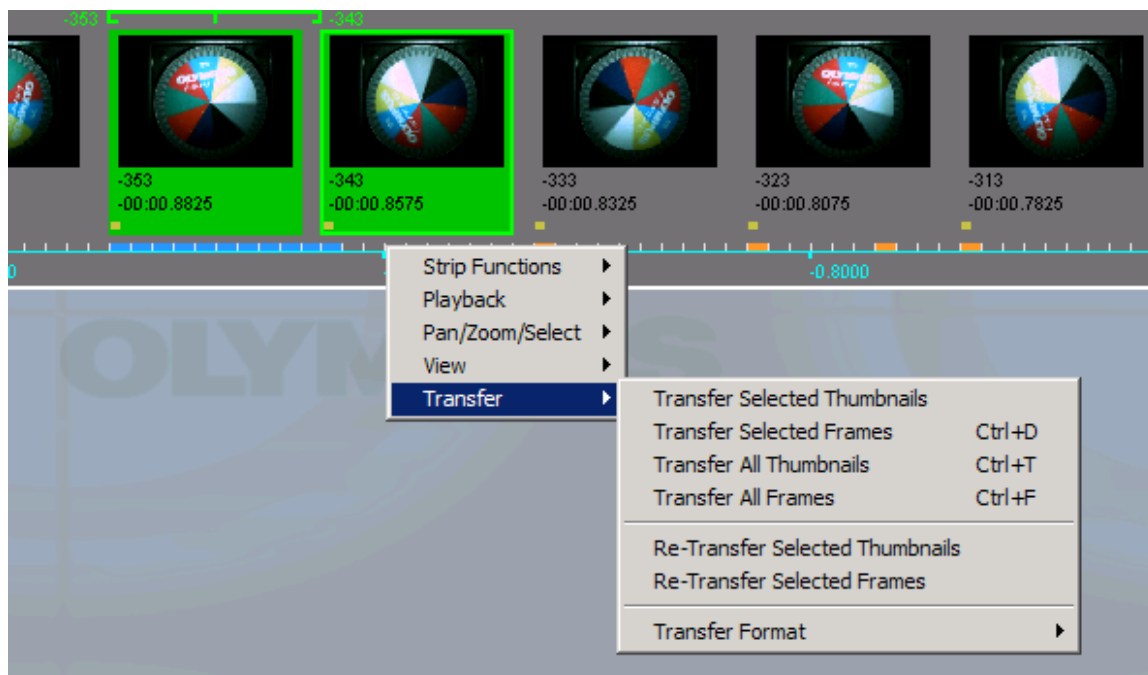
The Strip View was specifically designed to aid in localizing events of interest. Strips within the Strip View may be directly from a recording from a camera or may be a previously recorded video stored on your hard drive.

Strips that are directly from a camera recording are special instances of both the video and the data strips described in the previous section. These “playback strips” are specially programmed to interface with the camera and download frames as needed. Whenever possible, the strips will transfer low resolution thumbnails of each frame as needed. The strip maintains a cache of transferred thumbnails and frames in the directory set as the Transfer Path (see section 5).

Navigation inside of a camera playback strip is identical to a normal strip, however, there will be slight delays as the necessary thumbnails are being downloaded from the camera. Frames that are waiting to be transferred will be represented by a checkerboard pattern.



If the timeline is visible, within the frame markers, there will be color codes to denote whether the thumbnail or full frame has been transferred. If there is no color between the frame tick marks, then neither the thumbnail or the full frame have been transferred yet. An orange marker indicates that the thumbnail has been transferred. A blue marker indicates that the full frame has been transferred. For example, in the following image, we see that the full frames -353 to -343 have been transferred, and thumbnails have been transferred for -333, -323, -313 (recall that the drawn images can be thought of as flags, with the flag pole aligned to the left side of the drawn image region).



Users can transfer selected thumbnails or full frames by selecting a region and then using a keyboard shortcut or the context menu to access the desired command. All download operations in the strip view use the current selection (green) to determine which frames to operate upon. The software will not re-transfer any frames that have already transferred. If for some reason, a frame or range of frames needs to be re-transferred, the user can force a re-transfer of any thumbnail or full frame via the context menu.

Transfer Format

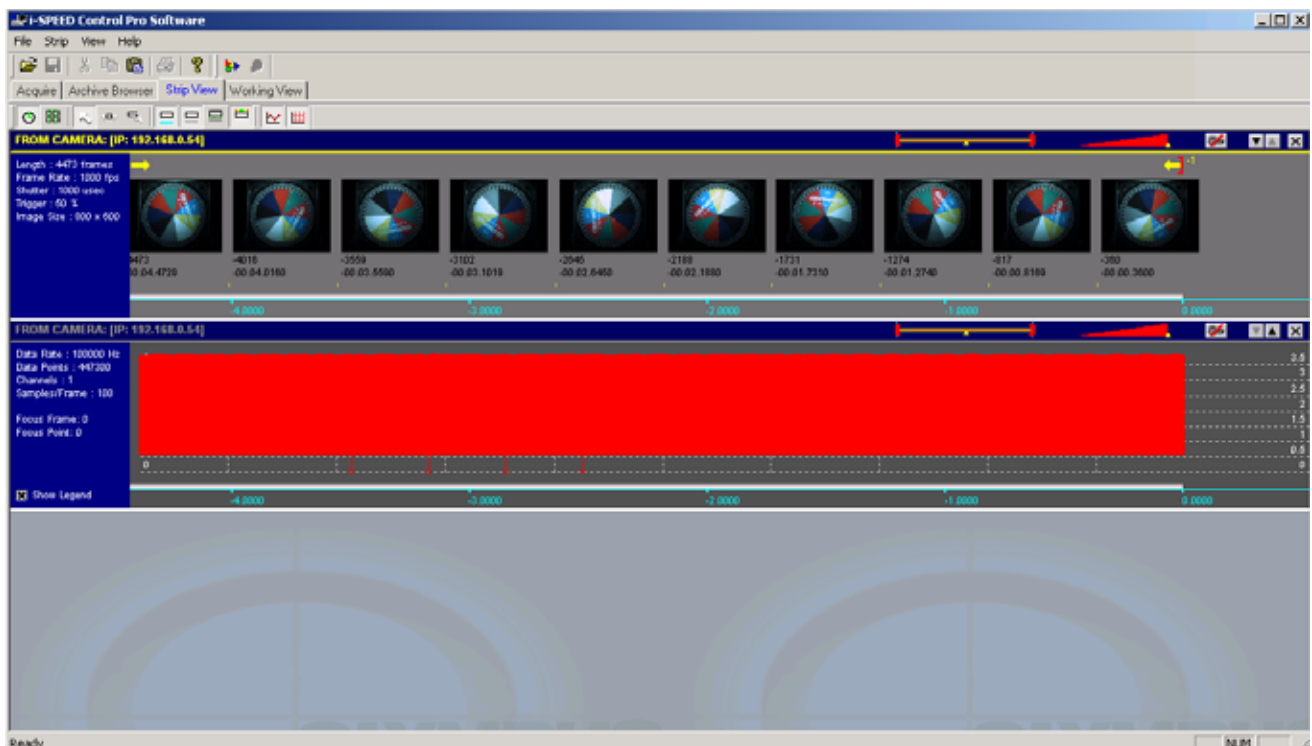
The camera supports transferring images in JPEG or raw Bitmap format. The transfer format of the camera may be changed at any time. If the transfer format is changed after some frames have already been downloaded, the downloaded files remain unchanged, however, all future transfers will use the new transfer format. To change the transfer format, right-click on the playback strip and select the desired transfer format from the menu that appears.



External Data

If a recording was done using the external data acquisition source (Control Pro version only), the data has already been stored in the local PC memory. Therefore, a complete view of the data is immediately available, independent of whether the thumbnails (or full frames) have been transferred.

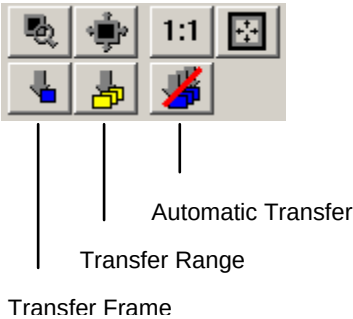
Data from the external source will display automatically in a data strip once the recording has been completed.



There are no gaps in the data and there is no additional transfer time required when using the external data source since the data is already stored in local PC memory.

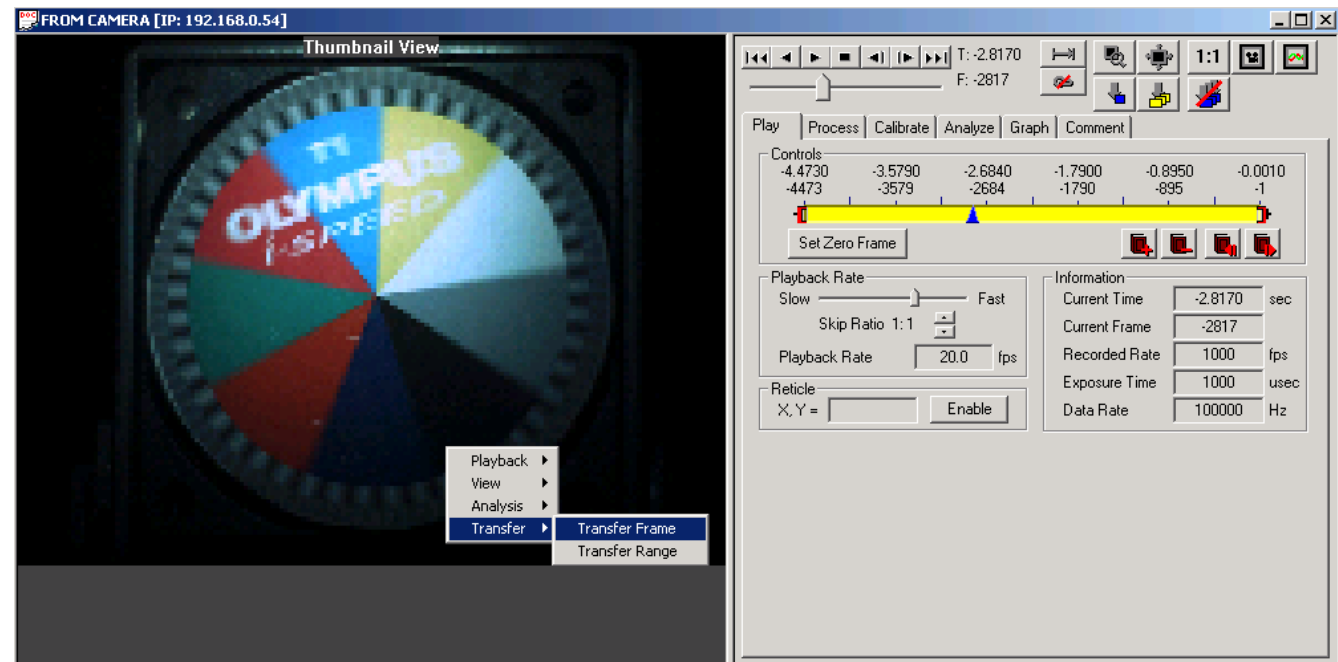
Downloading in the Working View

Thumbnails and full frames may also be transferred in the Working View (described in more detail in a later section). Thumbnails are automatically transferred on demand. Full frames may be transferred by using the additional controls underneath the pan/zoom buttons in the control panel.



Transfer Frame	Transfers the current full frame from the camera.
Transfer Range	Transfers the current selected range from the camera. The range is set by dragging the red end sliders on the main slider control in the play tab.
Automatic Transfer	Enable automatic transfer of full frames on demand. As the video is playing or as the slider is moved around, if a full frame has not been transferred yet, it will be transferred as necessary. With this mode enabled, a thumbnail view will never be shown. Instead of transferring thumbnails on demand, full frames are always transferred.

Indicators on the top and bottom of the image viewing area in the working view show whether a given displayed frame is a thumbnail or a full frame and also show the transfer progress when transferring a full frame. If the top of the image window says “Thumbnail View”, then the currently displayed image is a thumbnail.



The full frame may be transferred by using the context menu as shown, or via the control panel buttons

Saving Prior to Downloading

It is not required to download full frames before saving a video to file. The save operation will automatically download any full frames that have not already been transferred. Thumbnails are never saved to a video file. They are only temporary images used to facilitate region selection for camera recordings.

Strip View

Strip View Overview	76
Strip View Layout	76
Strip View Definitions	76
Strip View Settings	77
Adding and Removing Strips	79
Navigating in a Strip	79
Playing Strips	80
Bookmarks	80
Edit Recorded Parameters	80
Data Strip Interaction	81



Strip View

Strip View Overview

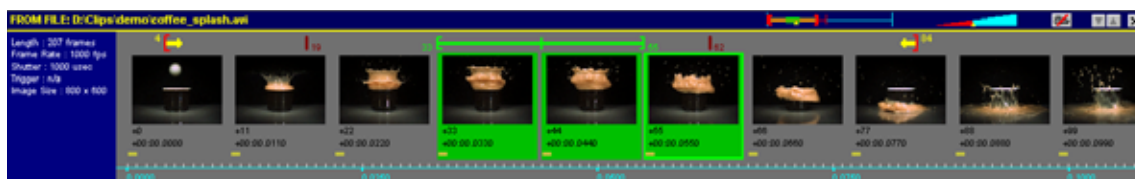
The strip view is a specially designed view that allows a user to see an overview of a complete event in a filmstrip format. This view enables a user to zoom in on specific moments in time while still maintaining a view of the context before and after the moment of interest. In addition, the strip view allows a user to view multiple events that may have been recorded at different frame rates to be displayed aligned to one another.

As one event is zoomed and panned, the other events will also zoom and pan simultaneously, maintaining perfect alignment with one another.

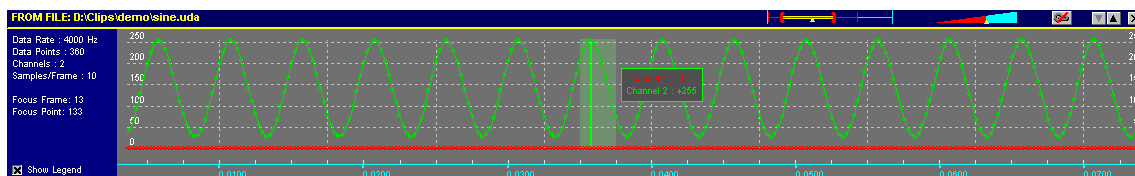
Strip View Layout

The strip view is comprised of a toolbar across the top that controls the strip view settings, and a main region that contains the strips. Each strip is comprised of three regions: a title bar, an information section, and a drawing area.

There are two possible types of strips that can be drawn: a video strip and a data strip. The video strip shows individual frames from the video and the data strip plots data or analysis.



The video strip draws as many frames as possible along a horizontal time line without overlapping any of the frames. The exact time corresponding to a drawn frame is the value on the time line corresponding to the left edge of the frame. (This can be visualized like a flag pole planted in the time line at the left edge of the drawn frame, and the frame is the flag extending to the right of the pole). Additional information is drawn beneath each frame, such as the frame number, time, and a bar indicating the exposure duration.



The data strip draws any associated data or analysis corresponding to a given video. The data strip is always permanently aligned to the corresponding video strip. If the video strip is panned or zoomed, the data strip will pan and zoom simultaneously, and vice versa.

Strip View Definitions

Alignment Mode

The alignment mode controls how linked strips are drawn relative to one another. Linked strips can be aligned so that frames correspond to one another in time (Time Alignment) or frame number (Frame Alignment).

Linking

One of the powerful features of the strip view is the ability to draw multiple events recorded at different frame rates in a time or frame synchronized fashion. When one event is panned or zoomed, all linked events are simultaneously panned or zoomed by the same amount. Linking is enabled by clicking on the chain link icon in the title bar of each strip.

Range

These are the frames that are within the yellow and red end markers. The range is used to control the playback in the Working View and the default save range when saving. The range may be modified in the Strip View by dragging the yellow and red end markers above the video frames or in the Working View by dragging the red end markers in the Play tab controls. The range may also be set to the current selection by using the context menu, or hitting "Space".

Selection

These are the frames highlighted in green. The selection is used primarily for zooming in on a set of frames of interest. Most often, a user will select a set of frames by clicking and dragging the mouse over the frames and then hit "Enter" to expand and center these frames. The selection is not used for saving or setting the play range for the Working View.

Frame ticks

These marks show the number and location of actual image frames relative to the visible time line. These marks are equally spaced along the time line.

Timeline

The timeline drawn is across the bottom of each strip and shows either the corresponding time value or frame value across the strip. The timeline must be displayed in order to see the frame ticks and some of the comment markers.

Comment markers

Indicate where user comments have been added to the event. If the mouse is held in place above one of these green markers, a small window will appear that displays the associated comment.

Data markers

Circles at locations in the graph where there are data points. This helps to visualize exactly where data points were acquired relative to the shown video.

Bookmark markers

Bookmark markers are brown lines that show the existence and location of user-defined bookmarks.

Strip View Settings

The following settings control how the strips are drawn and manipulated. These settings can be changed via the toolbar across the top of the window.



Alignment Mode

There are two possible alignment modes that control how linked videos are drawn relative to one another. These modes are: Time Alignment Mode and Frame Alignment Mode.

In time alignment mode, the videos are aligned such that a vertical line on the screen will intersect each linked strip at the exact same time value. For example, if you have one video that was recorded at 1000 fps and a second video recorded at 2000 fps, when they are linked, they will display such that the frames from the 2000 fps video that are aligned vertically with a frame from the 1000 fps video should have a frame number that is twice that of the 1000 fps frame number.

In frame alignment mode, the videos are aligned such that a vertical line on the screen will intersect each linked strip at the exact same frame number. Record rates are not used when videos are aligned in this mode. Only the frame number is used for alignment.

Mouse Mode

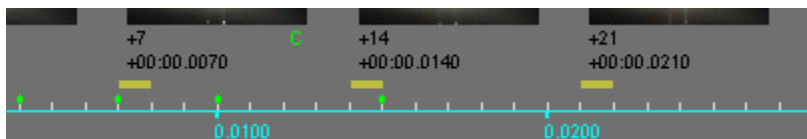
There are three possible mouse modes that control how clicking and dragging the mouse interacts with the drawn strips. These modes are: Selection, Pan, and Zoom.

Selection mode will allow you to highlight specific frames, set the focus point in the graph, and manipulate range bounds. This is the most general mode, and users will most likely remain in this mode. Panning and zooming can be accomplished in this mode either by using the pan and zoom controls in the title bar or by using keyboard or context menu controls.

For finer control of panning and zooming, the pan and zoom mouse modes are provided. When either of these modes are selected, clicking and dragging the mouse horizontally will increase or decrease the current pan or zoom setting.

Displayed Items

Many of the displayed items in the strips can be shown or hidden via the buttons in the toolbar. When objects are shown or hidden, the contents of the strip will resize to fill the available space. The configurable displayed items are: Time Line, Frame Ticks, Comment Markers, Range, Selection, and Bookmark Indicators, Data Markers, and Data Gridlines.



The time line draws a line across the bottom of each strip that shows either the corresponding time value or frame value across the strip. The time line must be displayed in order to see the frame ticks and some of the comment markers.

Frame ticks are drawn directly above the time line and indicate the presence of a video frame at that location. Depending on the current zoom level, not all video frames will be drawn. A single displayed frame may overlap many hidden frames. The Frame Ticks provide a means for knowing where and how many hidden frames are present.

Comment markers indicate where user comments have been added to the event. If the mouse is held in place above one of these green markers, a small window will appear that displays the associated comment.



Range, selection, and bookmark indicators are drawn across the top of the video strips just below the title bar. The range is shown with yellow and red indicators, the selection is shown with a green bar, and the bookmarks are shown in brown. As described above, the range controls what range is used for playback in the working view and what range is used for saving. The selection is a tool used to highlight specific frames for panning and zooming and downloading (when viewing a recording from a camera). The bookmarks are indicators that can be used to mark special frames. Bookmarks can be set or removed from the working view. Only the range markers are interactive, the selection and bookmarks are only indicators. The range markers may be clicked and dragged to modify the range. If a range marker moves outside of the displayed region, an indicator will appear on the edge of the strip. If this indicator is clicked, the strip will be panned to show the range marker.

Data markers will draw circles at locations in the graph where there are data points. This helps to visualize exactly where data points were acquired. Note however that the display of many data markers will result in slower interactivity due to the additional drawing requirements.

Data gridlines are the horizontal and vertical lines drawn behind the graph and the vertical scale values drawn on the left and right of the strip. The vertical lines correspond to the point where the corresponding video frame is drawn.

Title Bar Controls

The title bar contains the source of the displayed strip and a set of controls on the right side. These controls are: Pan, Zoom, Link, Move Down, Move Up, and Close.



The pan and zoom controls operate very similar to typical scrollbars. If you click and drag the red bar in the pan control, the strip will pan. If you click and drag the right edge of the red triangle in the zoom control, the strip will zoom. If you click outside of the red bar in the pan control or away from the right edge of the triangle in the zoom control, the pan or zoom setting will jump a fixed amount. These controls can be used in any mouse mode.

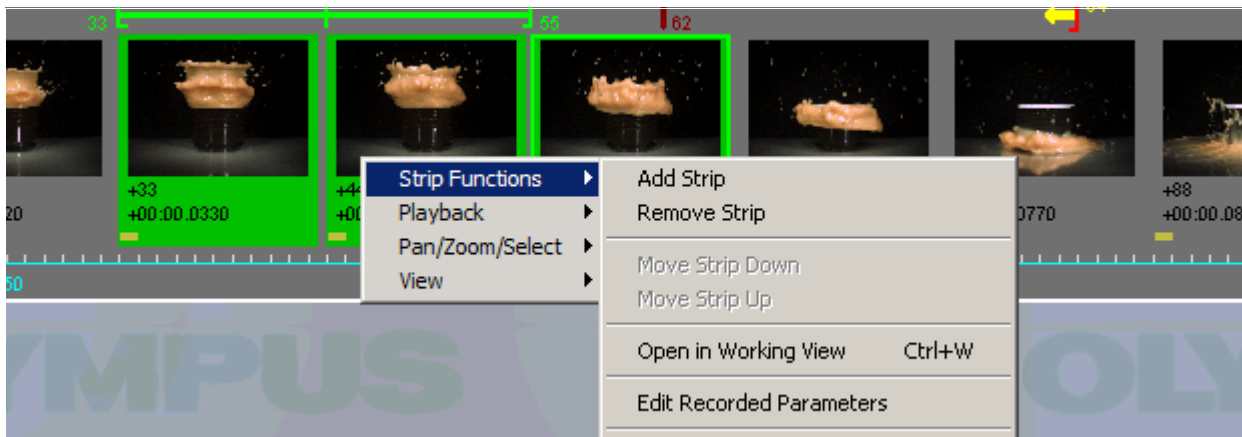
The link button indicates whether or not the strip is linked with other strips. Linking either a video or data strip for a given event will automatically link both. When linking, the strip pan and zoom settings may change in order to be in alignment with any other linked strips.

Move up and move down allow you to reorder the drawn strips. The order does not have any other effect upon the strip view other than to change the ordering of the strips.

The close button will close the strip. Closing a data strip for an event will not close the corresponding video strip, however, closing a video strip will automatically close any corresponding data strip.

Adding and Removing Strips

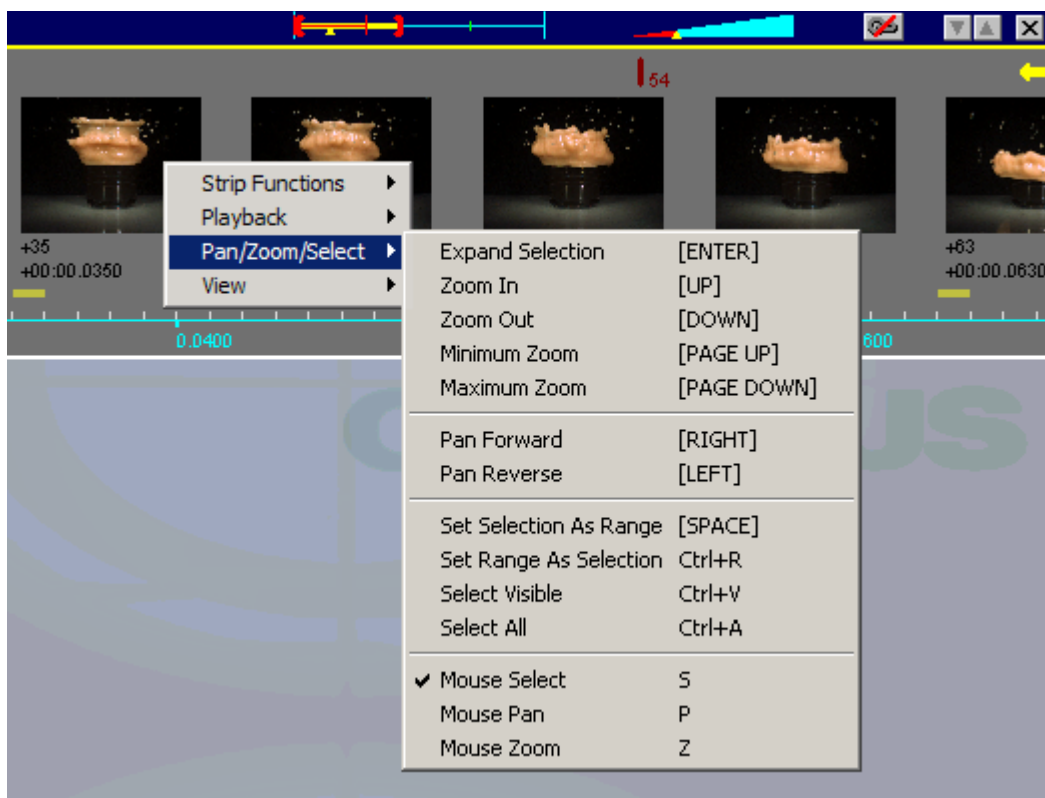
Strips may be added by using the File menu or Strip menu, using the context menu in the strip view, or by double clicking on a video in the Archive Browser.



Strips may be removed by clicking on the close button in the upper right corner of each strip or via the context menu.

Navigating in a Strip

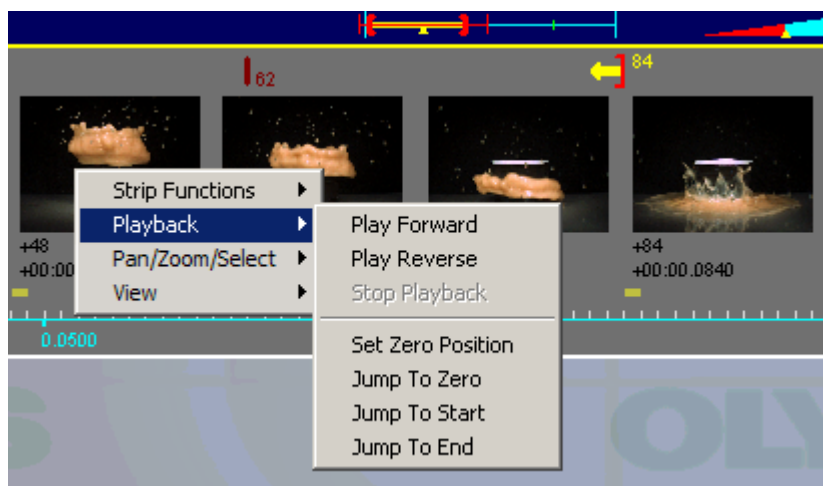
There are multiple ways to navigate around a strip. A strip may be panned or zoomed using the controls in the title bar of each strip, via context menu, using keyboard shortcuts, or by using the pan or zoom mouse mode and clicking and dragging in the strip.



A quick way to zoom in on a set of frames of interest would be to select a set of frames by clicking and dragging the mouse over these frames (in selection mouse mode), and then hit “Enter”. This will center and zoom in on the current selection that was just made (shown in green).

Playing Strips

Strips may be played in forward or reverse by using the commands in the context menu, or via the Strip menu.

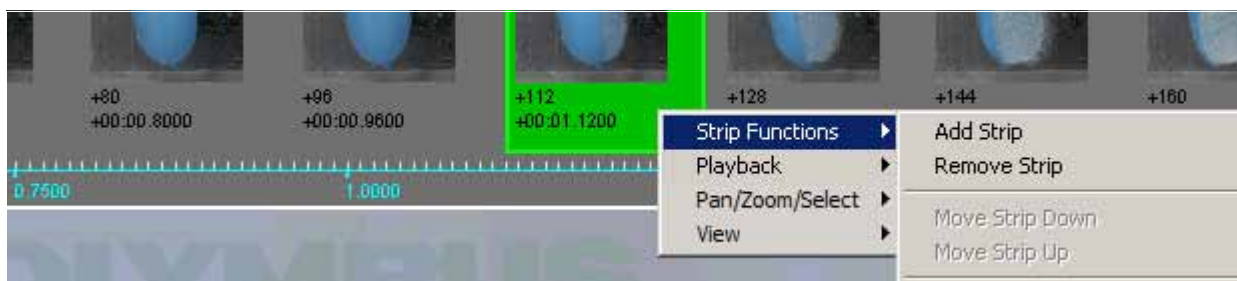


Bookmarks

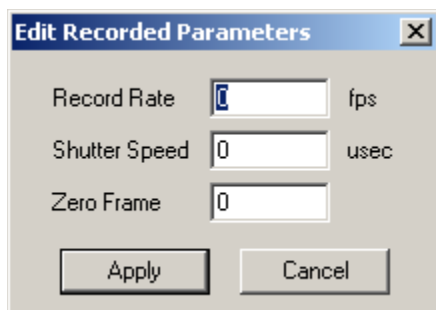
Bookmarks may be viewed in the strip view by ensuring that the “Range, Selection, and Bookmark Indicators” button is selected in the toolbar. Bookmarks will be shown as brown indicators drawn above the frames in the video strips. Bookmarks cannot be edited in the strip view, a working view must be opened for the strip and bookmarks can be edited within the working view.

Edit Recorded Parameters

Typically, video files are accompanied by a configuration file which contains information such as record rate, shutter speed, and trigger frame. If a video is opened without an associated configuration file, the software will assume a default record rate (100 fps) and leave the other fields empty. These values can be edited with correct values if they are known. Select the “Edit Recorded Parameters” option under “Strip Functions” in the context menu.



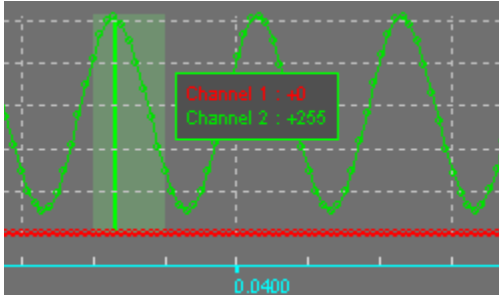
This allows you to set the record rate, shutter speed, and zero frame directly.



Data Strip Interaction

Data strips are automatically and permanently linked to the corresponding video. If the data strip is panned or zoomed, the corresponding video strip will also be similarly panned or zoomed.

When in selection mouse mode, clicking on a data strip will have a different effect than clicking on a video strip. Clicking on the data strip will not set the selection, but rather will set a location for a focus point and focus frame. The focus frame will be shown in a blended green color and the focus point by a solid green vertical line. If enabled, a legend will be drawn that displays the labels and values for each value plotted. As the strip is panned, the focus point remains at the same fixed point on the screen and will display the values of the points underneath it.



10

Working View

Working View Overview	83
Working View Layout	83
Adding and Removing Working View Windows	86
The Graph Panel	87
Synchronizing Multiple Windows	88



Working View

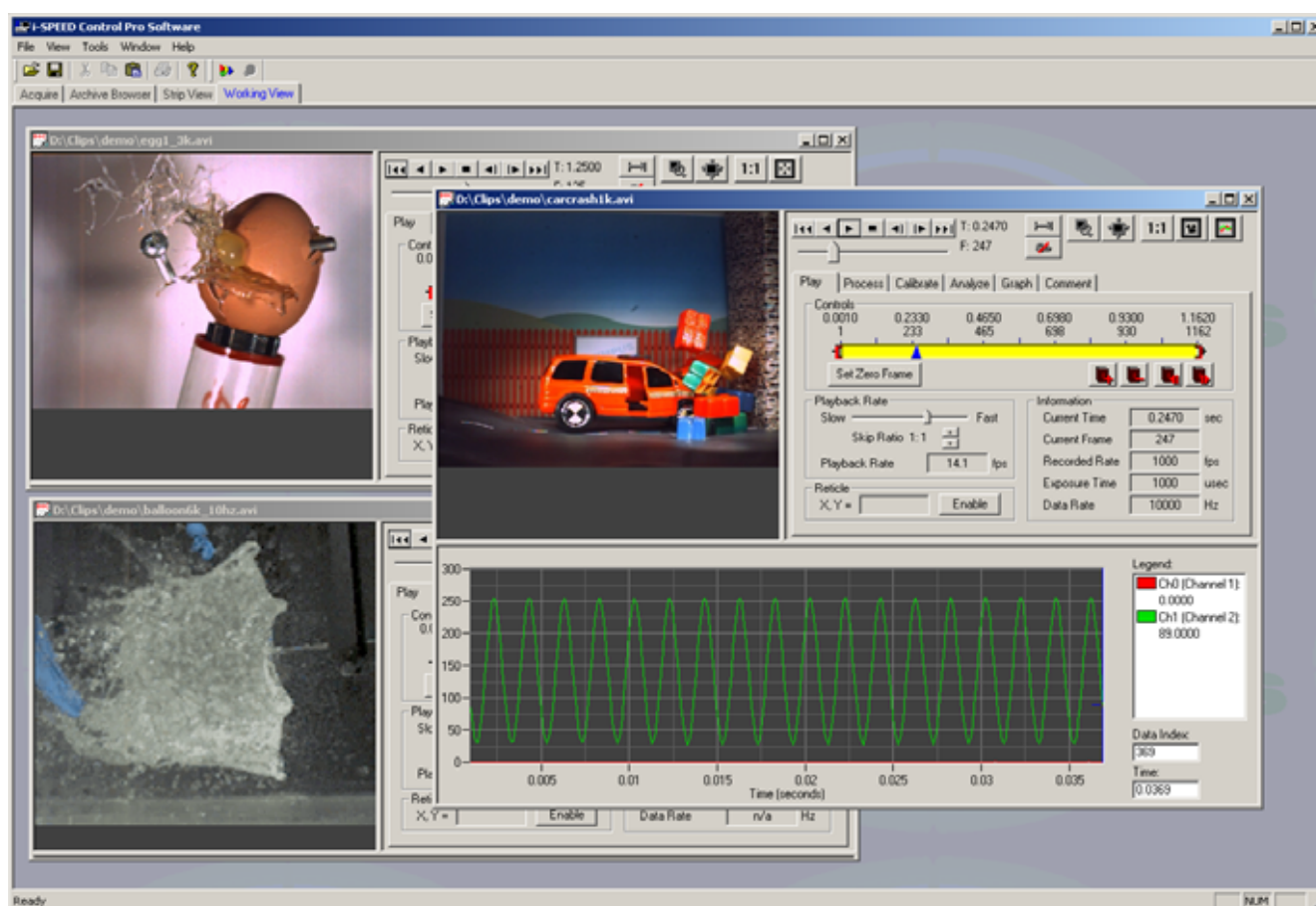
Working View Overview

The Working View is a multiple paned view that allows a user to interact with the video and data in a more traditional frame-by-frame format. This view enables a user to perform motion analysis, add user comments, show data and video in the same window and enhance the image quality using advanced image processing.

The Working View is where the majority of study of recorded events will occur. The Strip View is primarily used to view broad contexts of events, to be able to narrow down sections of interest, and to be able to view temporal relationships between events. In contrast, the Working View is the more conventional view, showing a single frame at a time, where the viewing window may be enlarged, the image may be panned and zoomed, and other types of analysis can be carried out.

Working View Layout

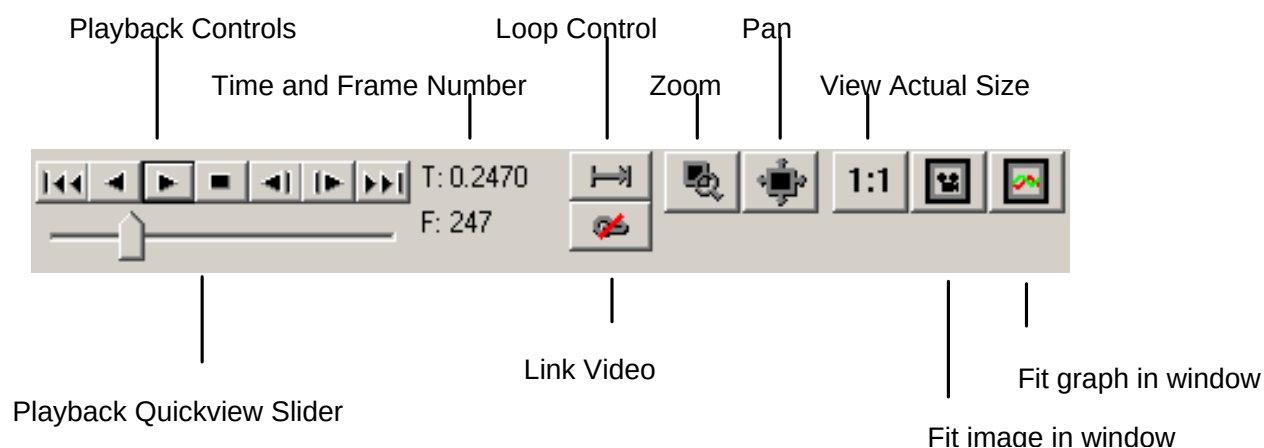
The Working View layout is comprised of a large workspace. Each individual video is contained in a working window. Multiple windows, corresponding to multiple video sequences, can be cascaded or tiled in the large workspace.



Each of the Working View windows has three sections:

- Video panel
- Graph panel
- Control panel

The following controls are available for the manipulating the image and graph within the video panel:

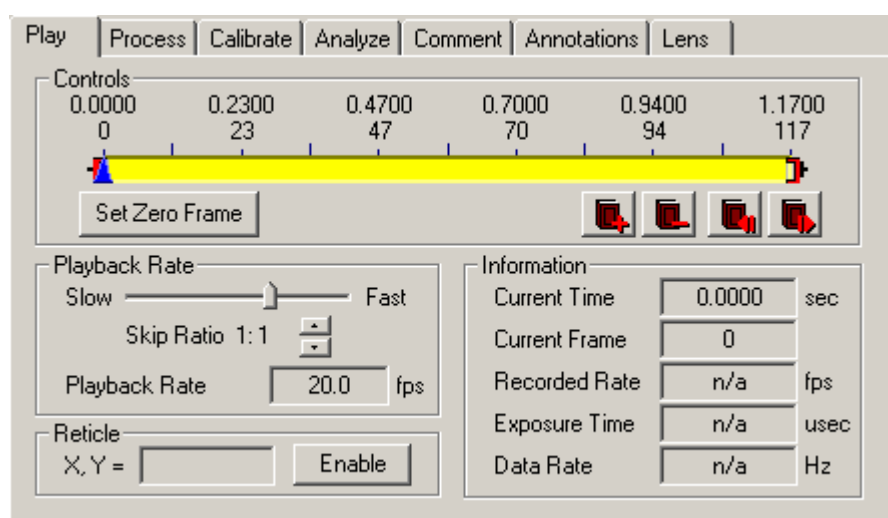


These functions are described as follows:

Playback Controls	The following controls are available by clicking on the playback control buttons (from left to right): - Skip to the beginning of the entire recording - Play backward - Play forward - Stop - Step back one frame - Step forward one frame - Skip to the end of the entire recording
Playback Quickview Slider	Use this slider to quickly scan the video to find an event or location of specific feature.
Loop Control	By clicking on this button, the playback is continuously looped over the selected range. When this button is not selected, the playback stops at the end of the selected range.
Time and Frame Number	The time of the current image and the frame number within the video sequence
View Actual size	When selected, this command sets the zoom region and the window frame to be equal to the actual image size. That is, everything is displayed within a frame at a zoom ratio of 1:1.
Fit Image in Window	When selected, this command fits the entire image into the window frame. This command does not change the window frame size, just the image size in the window.
Fit Graph in Window	When selected, this command fits the entire graph into the window frame. This command does not change the window frame size, just the graph viewing size in the window.
Zoom Image	This command allows you to use your mouse or trackball to easily zoom the magnification up or down of the image. When selected, the mouse cursor turns to a triangle with an up-down arrow next to it on the view window. Click and drag the mouse upward to zoom in (magnify) or drag the mouse downward to zoom out (minify).
Pan Image	This command allows you to use your mouse or trackball to easily pan the image – move the image in any direction to optimize its location. When selected, the mouse cursor turns to a 4-way arrow on the view window. Click and drag the mouse in any direction to scroll the image in that direction. The location box appears in the upper right corner of the window showing you the relative size and location of the current view relative to the actual image size.
Link Videos	Links and unlinks individual windows (videos) that are contained in the working view. When linked, the videos are synchronized and played back in unison. That is, when the play button is pressed, all videos that are linked play together.

The Working View control panel has a variable number of tab windows, some examples are:

- Play
- Process
- Calibrate
- Analyze
- Graph (Control Pro only)
- Comment
- Annotations
- Lens (Control Pro only)



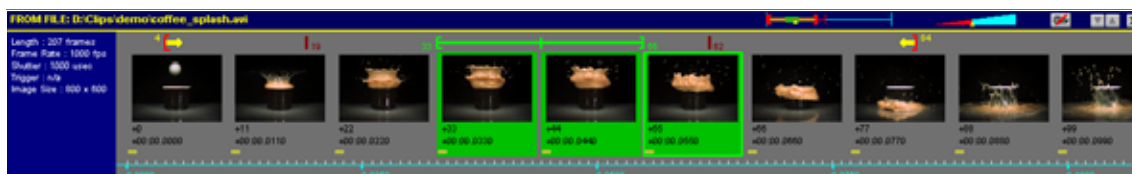
The functions of these control panels are described in Chapters 11 through 16.

Adding and Removing Working View Windows

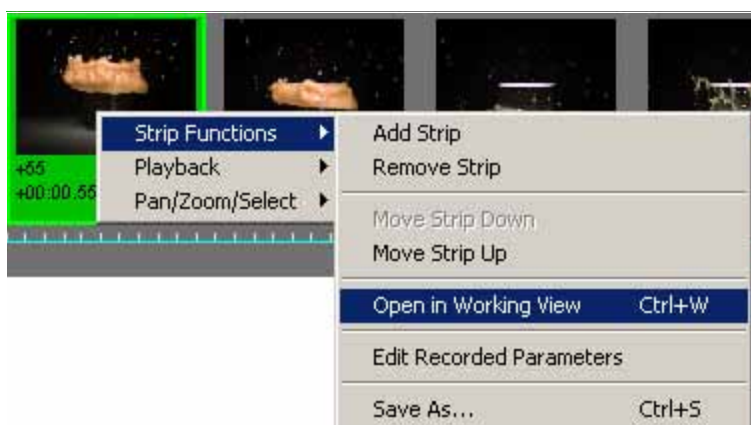
To bring an image into the Working View, perform one of the following steps:

From the Strip View:

- 1 Highlight the strip of interest.

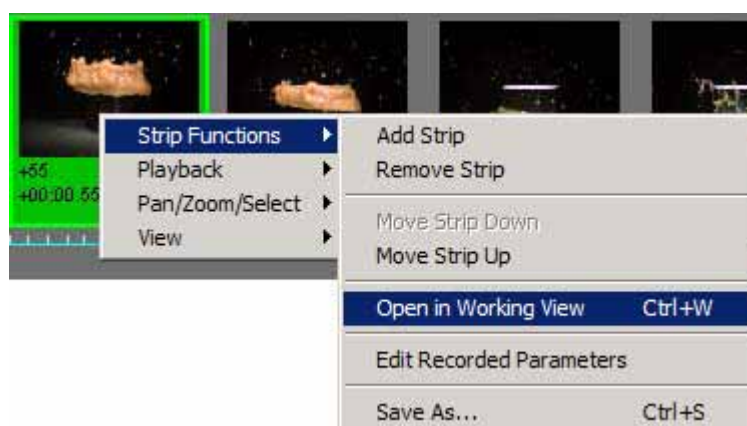


- 2 Open the context menu by clicking the right mouse button on the strip. Select “Strip Functions” and select “Open in Working View”. (Keyboard shortcuts from the Strip View are (1) CTRL-W or (2) double click within an image).



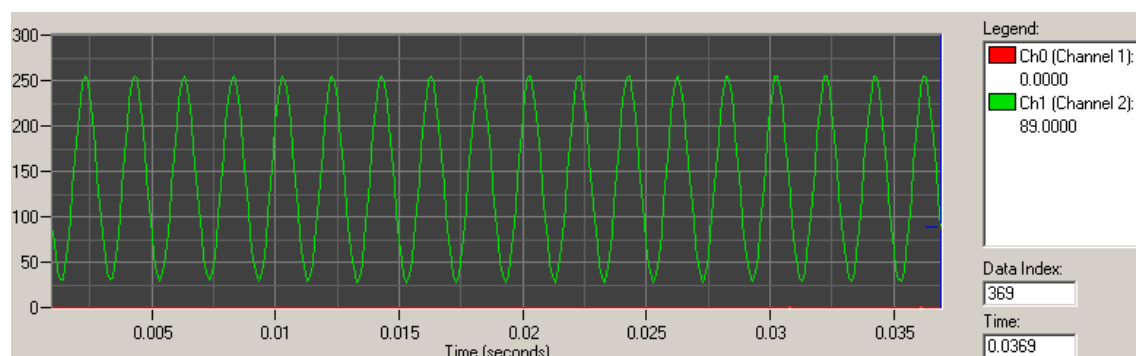
From the Archive Browser:

- 1 Highlight the video of choice.
- 2 Open the context menu by clicking the right mouse button on the video. Select “Open in Working View”.



The Graph Panel

The graph panel is available with the Control Pro version of the software only. The graph shows both user data from sensors and motion analysis data. The content of the graph panel is controlled by the Graph tab in the control panel.



On the right side of the graph panel are the following features:

Legend	Shows the various graph lines and color assignments
Data index	The number of the data point that is currently highlighted by the vertical blue line
Data time	The time of the data point that is currently highlighted by the vertical blue line.

The graph also supports panning and zooming. To pan the graph, set the mouse mode to Pan by clicking on the Pan button in the control panel. The cursor will change to a 4-way arrow. The panning works identically like in the image window. To zoom in on a region in the graph, set the mouse mode to Zoom by clicking on the Zoom button on the control panel. The cursor should change to a dotted box with a pointer next to it. Click the left mouse button on the graph and drag the mouse to define a zoom region. To zoom back out, double click in the graph window when in pan or zoom mode.

Synchronizing Multiple Windows

To synchronize multiple windows, simply click on the chain-link button in the control panel. When the chain-link button is in the unlinked position, this window is not linked to any other window within the Working View or Strip View. When the chain-link button is in the link position, the window is linked to all other linked windows and strips. If a video is linked in the Working View, it is also linked in the Strip View.

The type of synchronization that is in effect is dependent upon the alignment mode in the Strip View. If the strip view alignment mode is Time Alignment, then the working views will be aligned to the same time. If the alignment mode is Frame Alignment, then the working views will be aligned to the same frame number. See section 9 for information about alignment modes.

This powerful feature lets users view images, data and analyses relative to other views, camera angles or pre-recorded images. This feature allows recordings that were captured at different frame rates to be played back in true time synchronization. For example, if video 1 was recorded at 1000 fps and video 2 at 100 fps, when these are played back synchronized in Time Alignment mode, video 1 will display 10 frames for every 1 frame that is displayed for video 2.

11

Playing Back in Working View

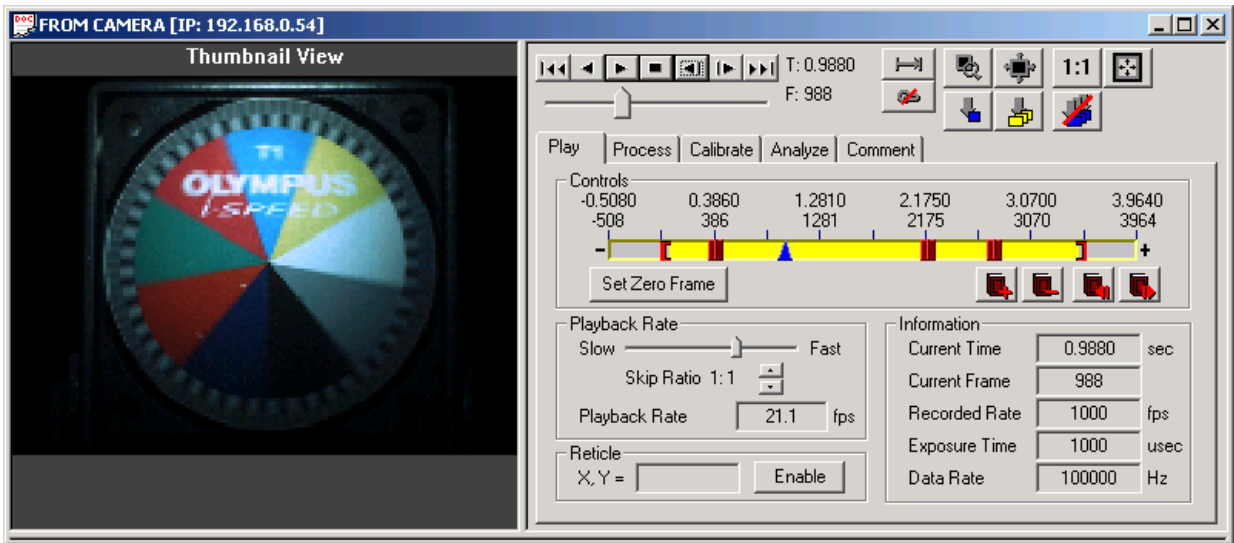
Components of the Play Tab	90
Setting Bookmarks	92



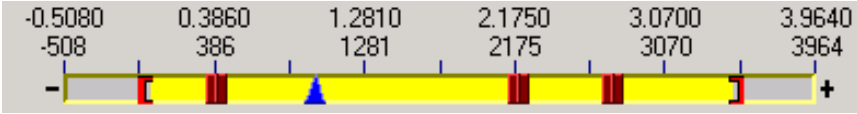
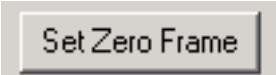
Playing Back in Working View

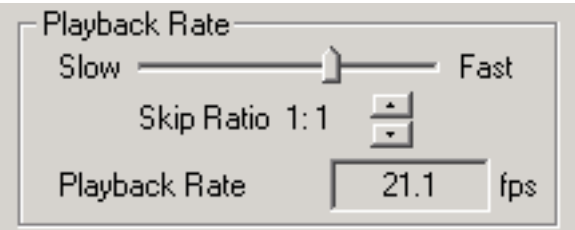
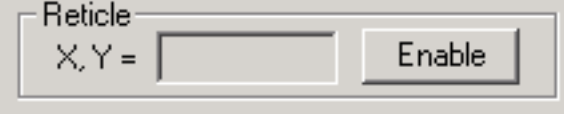
Components of the Play Tab

The Play tab within the working view contains many valuable functions for navigating the video sequence.



The components of the Play tab are described as follows:

Slide Bar	 The slide bar allows the operator to quickly move to a specific part of the playback cycle. Just click on the center blue triangle of the slider and, holding down the left mouse button, drag the slider to the desired position. The time and the frame numbers are displayed directly above the slide bar. The active area is displayed in yellow. 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. 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. Note that the range bracket information is carried back to Strip View and to the Save window.
Set Current Frame to Zero	 By clicking the SET ZERO FRAME 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 Frame to Zero cannot be undone from within the i-SPEED PC software.

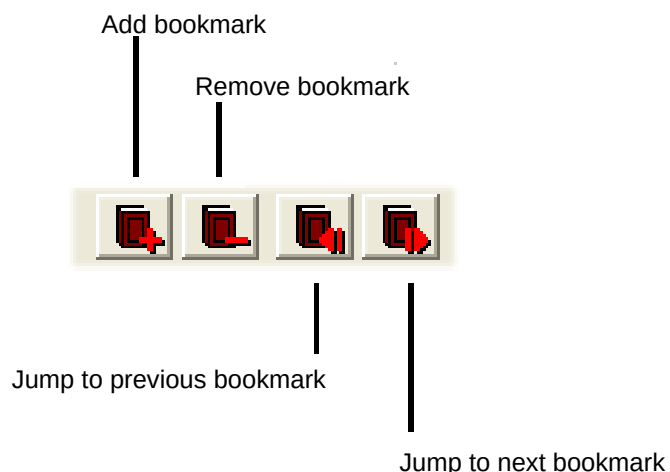
Set Playback Rate	 The actual playback rate on the computer screen is determined by many factors, including the number of synchronized images, the video RAM and the speed of the computer processor. Therefore, the <i>i-SPEED</i> PC Software provides a slider between "slow" and "fast". Set the relative 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.
Skip Ratio	This feature allows users to speed up the display update rate by skipping frames. Use the up/down arrows to select the number of frames to skip. The default is 0 frames (all frames are shown).
Reticle	 The actual position of the reticle on the image is shown here, in pixels from the upper left corner (0,0).
Current Time	The time of the visible frame is displayed.
Current Frame	The frame number of the visible frame is displayed.
Recorded Rate	The rate at which the video was originally acquired, in frames/second, is displayed. If the image was not originally recorded with the <i>i-SPEED</i> Software Suite, then N/A (not available) is displayed.
Recorded Data Rate	The rate at which the data was originally acquired, in Hz, is displayed. If the data was not originally recorded with the <i>i-SPEED</i> Software Suite, then N/A (not available) is displayed.
Exposure Time	The exposure time, in microseconds, of the original recording is displayed. If the image was not originally recorded with the <i>i-SPEED</i> Software Suite, then N/A (not available) is displayed.

Setting Bookmarks

The *i-SPEED* Software Suite allows users to bookmark key events. Bookmarks are user-defined and editable markers for important events in the sequence, denoted by red rectangles on the yellow slider bar.



Bookmarks are set, removed and reviewed by using the bookmark icons on the play tab:



To set a bookmark:

- 1 Play or single step the video to the desired location.
 - 2 Click on the Set Bookmark icon. A red rectangle is placed at that location on the slider bar.
- To step through bookmarks, use the Jump to Previous Bookmark and Jump to Next Bookmark icons.

To remove a bookmark:

- 1 Use the Jump to ... Bookmark feature to select the bookmark that you wish to remove.
- 2 Click on the Remove Bookmark icon. The red rectangle is removed from the slider bar.

Bookmarks are displayed in the Strip View and in the Archive Browser.

Adding User Comments

The Comments Tab	94
The Annotations Tab	95

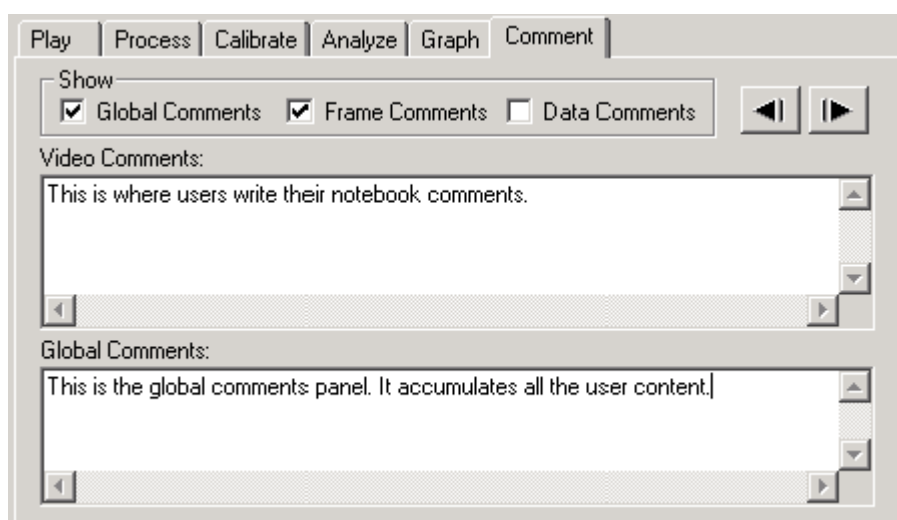


Adding User Comments

The Comments Tab

i-SPEED Software Suite allows users to record comments in conjunction with analysis and other studies of the acquired video and data. These comments are categorized and indexed to specific locations (frames for video notes, data for data notes).

The comment tab in the Working View is shown below:



i-SPEED Software Suite Notes are saved in the *i-SPEED* software Binary File that is created along with your video sequence and your data file. Comments are saved any time that you save your video to a new file, in its entirety, or as a reduced number of frames. You can also force a save of modified comments by selecting File, then Save Comments/Bookmarks.

There are two forms of the *i-SPEED* Software Suite Notes window. A two-tiered window appears when you have recorded with video alone, as shown above

A three-tiered window appears when you have recorded with video and data.

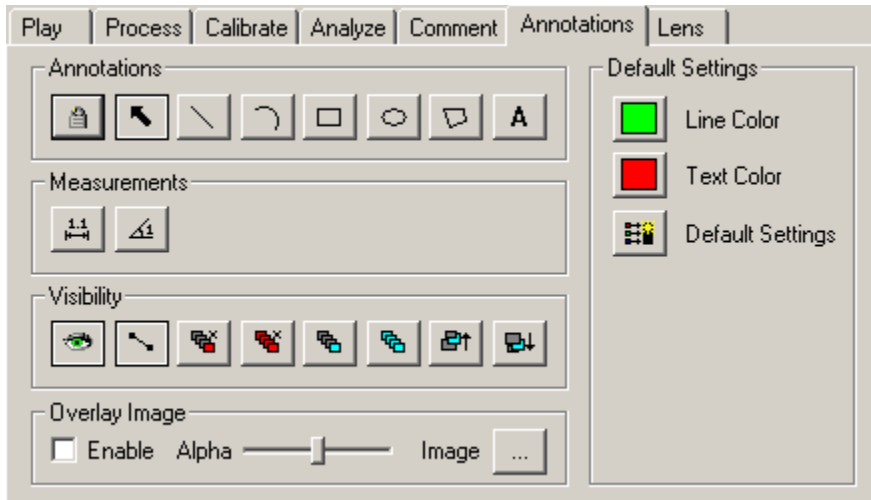
The features of the comments tab are as follows:

Video comments	These comments are saved alongside each frame of video.
Data comments	These comments are saved alongside each data point in the data sequence.
Global comments	These comments are free form – not assigned to any particular frame or data point.
Comment step	 Step to the previous or next comment in the sequence.
Show	 Checkboxes to selectively display video, data or global comment field locations.

To review *i-SPEED* software comments saved with an image sequence or with a data sequence, simply click on **FORWARD STEP** button or **BACKWARD STEP** button. You will be automatically advanced to the next sequential comment (video or data).

The Annotations Tab

i-SPEED Software Suite allows for annotations to be drawn directly onto the video image. Only the measurement annotations are available for the Control version. The complete set of annotations shown below are available in the Control Pro version.

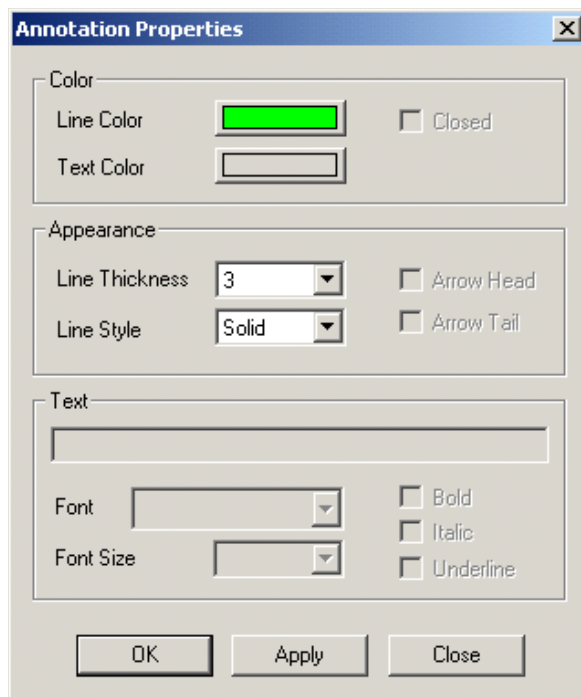


Annotations are objects that can be drawn on top of the video in a single frame or in multiple frames. Standard objects such as lines, arcs, rectangles, ellipses, and polygons are available.

To add an annotation to a video, click on the desired annotation button and then click in the video image to place the annotation. Different annotations require a different number of clicks to fully define the annotation.

Editing Annotations

Once an annotation has been placed in the video, you can click on the cyan colored handles to change the location of points in the annotation. You can also click anywhere along the annotation to move the annotation. Double-clicking on the annotation will bring up a properties dialog, where you can set line properties and colors.

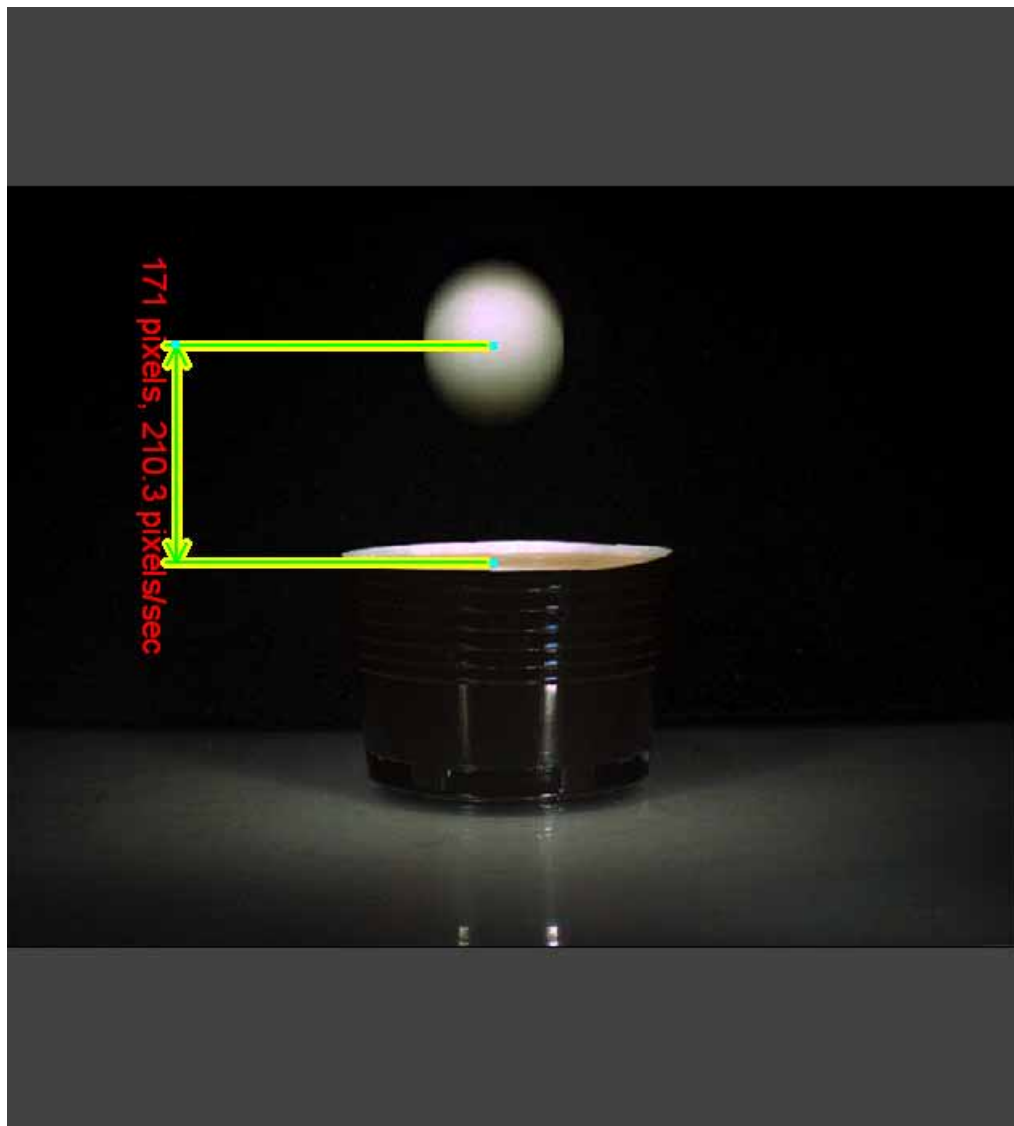


The visibility of each annotation can also be set in the Control Pro version. Each annotation can be set to display in the current frame only or in all frames. Select the desired annotation you wish to modify by clicking on that annotation. Then select the desired visibility attribute in the Visibility section of the Annotations tab.

Once all your annotations have been placed, you may wish to lock the annotations so that no more modifications can be made accidentally. Click on the padlock icon in the Annotations tab to lock all annotations.

Measurements

The measurement annotations are special since they use the currently defined calibration to provide distance, velocity, angle, and angular velocity measurements. To obtain velocity and angular velocity measurements, place the annotation in one frame of the video, then advance to another frame in the video and modify one of the end points of the annotation. This will have the effect of tying one end point to the initial frame and the other end point to a different frame. The time between these two frames is used to calculate the velocity and angular velocity.

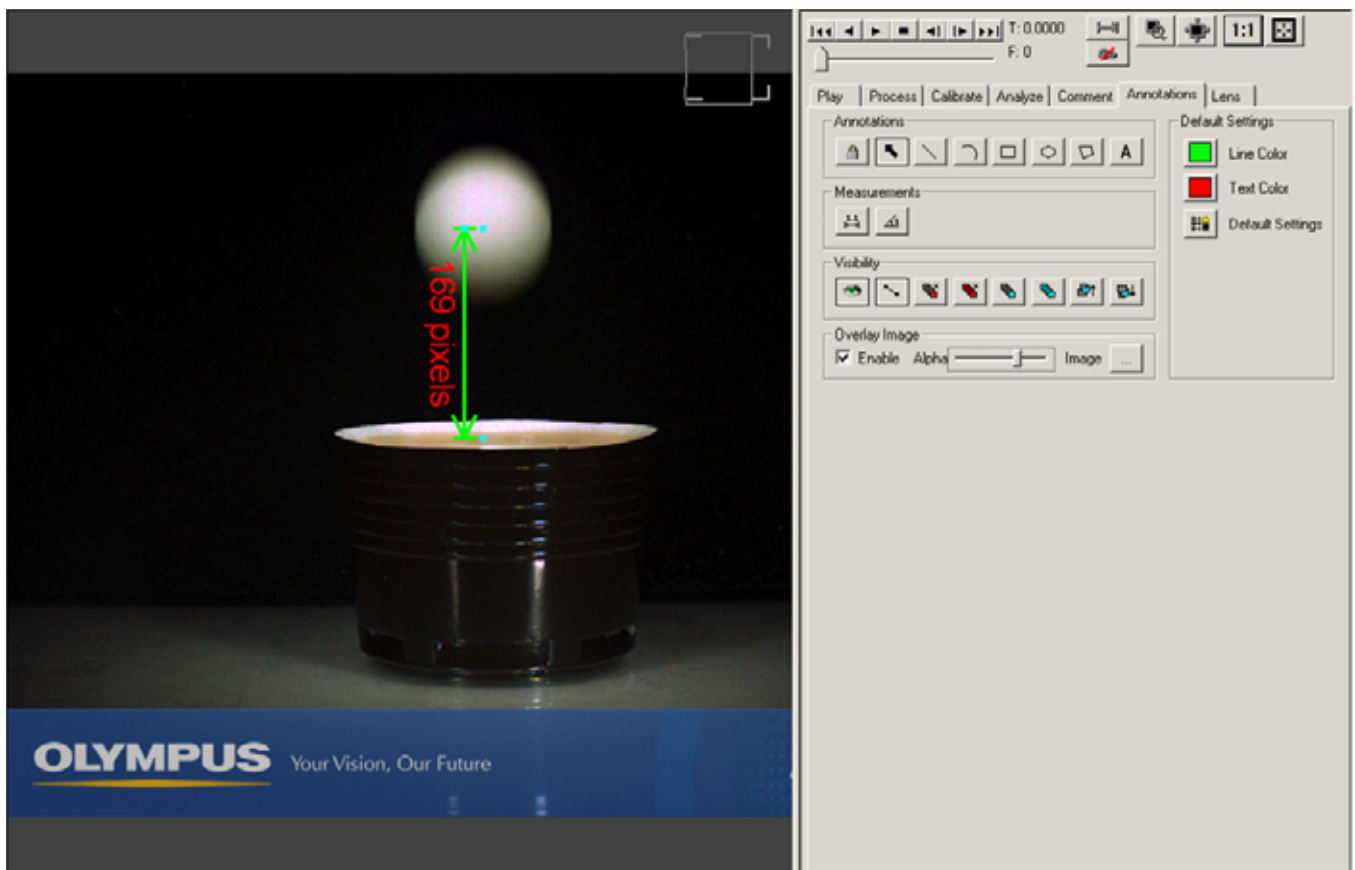


Overlay Image

The Control Pro version of the software also allows for the overlaying of a watermark image on top of each frame of the video. The overlay image is simply drawn on top of the each video frame. No scaling is done on the overlay image, so the image should be sized appropriately. Black pixels in the overlay image are rendered transparently.

To select the overlay image, click on the “...” button next to the Image label. Any BMP, TIFF, or JPEG image may be used as an overlay.

Check the Enable box to enable rendering of the overlay image. Select the desired opacity of the overlay by adjusting the Alpha slider. Dragging the slider completely to the left will result in a completely transparent overlay. Dragging the slider completely to the right will result in a completely opaque overlay.



13

Image Processing

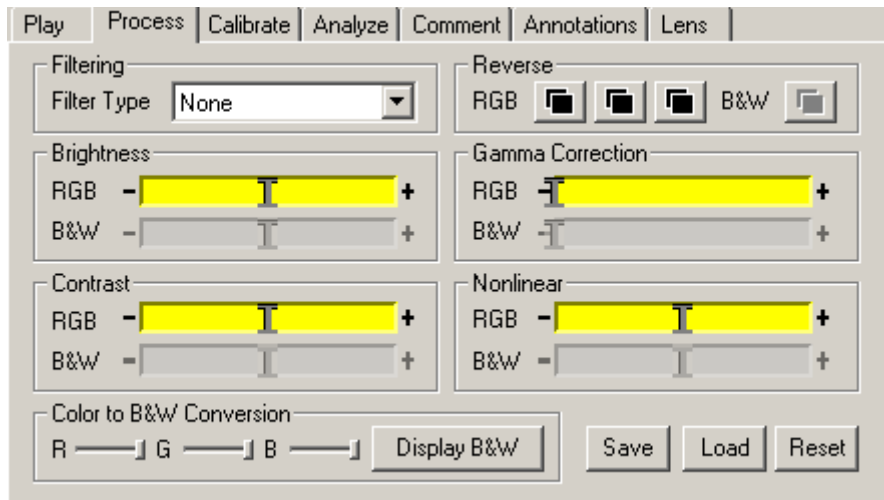
The Image Processing Tab	99
Image Filtering	99
Image Enhancement	100
Detailed Input/Output Mappings	101
Saving and Loading Processing Settings	103



Image Processing

The Image Processing Tab

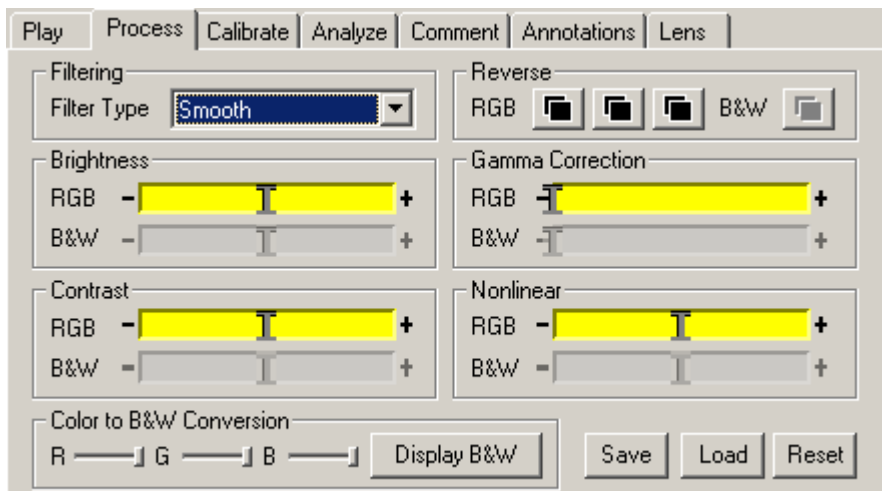
The image processing tab is the second tab found in the Working View, named “Process”, as shown below.



The various components of the Process tab are described in the following sections.

Image Filtering

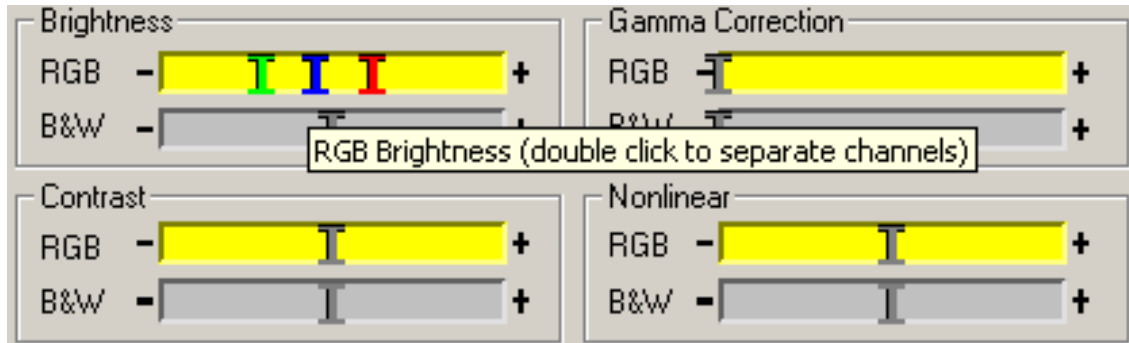
To improve the appearance of the video image, you can apply an image filter from the Filter Type drop-down box.



None	When selected, the image is displayed unprocessed.
Smooth	When selected, the video is passed through an image smoothing algorithm that reduces the edge contrast and improves appearance of the image
Sharpen	When selected, the video is passed through an image sharpening algorithm that enhances the edges and removes some of the pixelization effects that occur during low resolution recordings.
Smooth More	When selected, the video is smoothed multiple times using the smoothing filter, resulting in additional reduction of contrast and smoothing of edges in the image.
Sharpen More	When selected, the video is sharpened multiple times using the sharpening filter, resulting in additional increase in contrast and sharpening of edges in the image.
Edge Detect	When selected, the video is passed through an edge detection filter that highlights changes in intensity in the image.
Edge Threshold	When selected, the video is passed through the edge detection filter and then passed through a threshold filter to remove low intensity noise in the image.

Image Enhancement

This image processing windows allow 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 red, green and blue channels are modified as a group when the slider is the default gray color. By double clicking on the slider control, the slider bars will separate into red, green, and blue sliders that can be adjusted independently.



The various image settings are:

Brightness

Adjusts the brightness of the image. Higher brightness values will cause the image pixels to move closer to white (255). Lower brightness values will cause the image pixels to move closer to black (0).

Contrast

Adjusts the contrast of the image. Higher contrast will try to move colors toward white or black and reduce the grays. Lower contrast will move all colors closer to gray.

Gamma Correction

Adjusts the gamma of the image. The gamma of the image affects the brightness of the displayed result on your monitor. Higher values will brighten the image more.

Nonlinear

Adjusts the nonlinear palette function. By adjusting this value, you can change the mapping of input to output colors to be either exponential (more blacks) or logarithmic (more whites). A more detailed explanation is provided below.

Reverse

Changes the color palette such that whites and blacks are reversed. Each channel can be inverted independently for color images.

Display B&W

Converts color images to monochrome images using the conversion factors indicated by the R, G, and B sliders.

R Scale

Amount of red channel to include when converting from color to monochrome.

G Scale

Amount of green channel to include when converting from color to monochrome

B Scale

Amount of blue channel to include when converting from color to monochrome.

Save

Allows you to save certain image settings into an LUT (Look Up Table) format for later retrieval.

Load

Allows previously stored image settings to be loaded for this image.

Reset

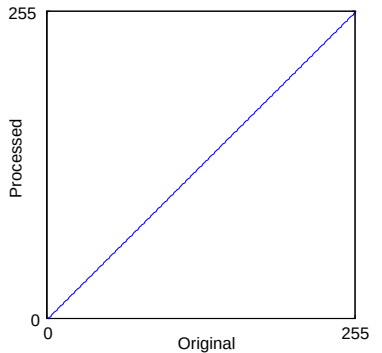
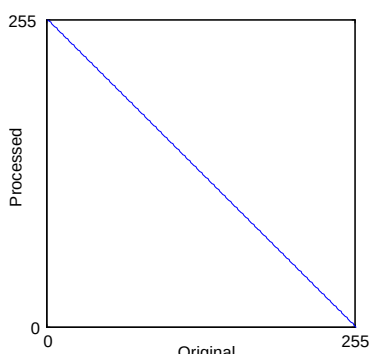
Sets all the values to their default levels.

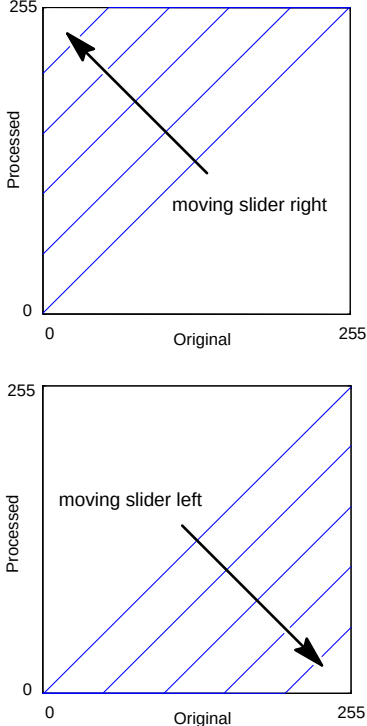
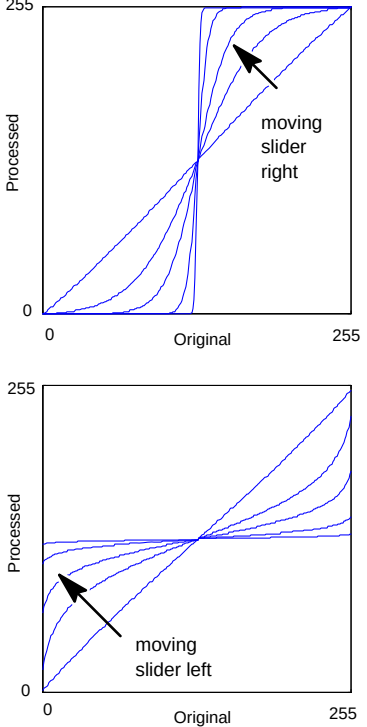
Detailed Input/Output Mappings

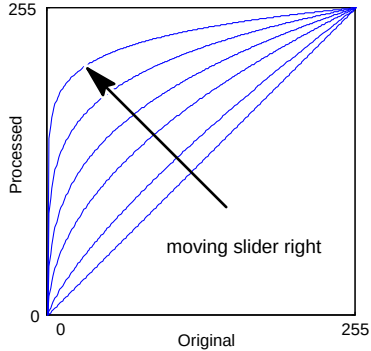
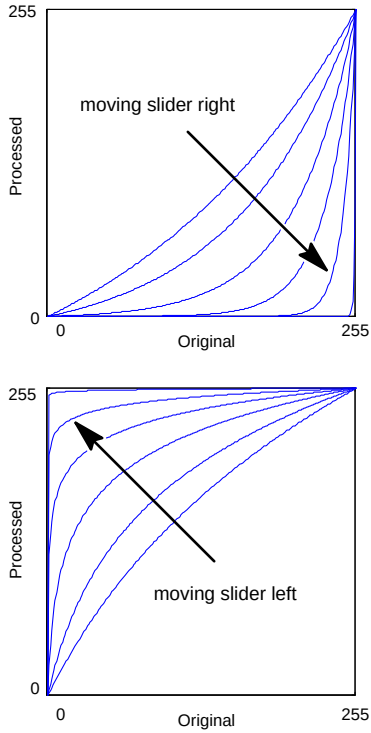
The Nonlinear and Reverse features allow you to improve the image contrast to enhance the tracking success. Understanding that *i-SPEED* software looks for objects that have some “color” or, more specifically, a “level of greyscale”, changing these values adjusts the “palette” to improve the white-on-black image contrast. A level of greyscale is best described as the level between black (a value of ‘0’ on an 8-bit gray scale) and white (a value of ‘255’ on an 8-bit gray scale).

A description of these image processing palette options is given below. The images on the left are examples of the effects of each of the palette options. The plots on the right show the mapping of pixel intensity values from the original (horizontal axis) to the processed (vertical) image after applying the new palette.

To help in understanding the palette mapping plots, here is an example using the reverse palette. For a given pixel intensity of X in the original image, we move upward at coordinate X until we intersect with the blue line, then we move horizontally to find the new pixel value in the processed image, in this case it would be Y. This is done for every pixel in the image, producing the final processed image as shown in the figures on the left.

Normal	This is the default and standard palette with no processing occurring. In other words, the processed pixels are identical to the original pixels.	
Reverse	This option uses a reverse palette, where ‘255’ is black and ‘0’ is white. This will invert the image so that light regions are dark and dark regions are light. Contrast is not affected.	

Brightness	Adjusts the brightness of the image. Moving the slider to the right will increase the brightness of the image by uniformly increasing the pixel intensity values. Moving the slider to the left will decrease the brightness of the image by uniformly decreasing the pixel intensity values.	
Contrast	Adjusts the contrast of the image. Moving the slider to the right will increase the contrast of the image. This has the effect of moving pixel intensity values towards white (255) or black (0). Moving the slider to the left will decrease the contrast of the image. This has the effect of moving pixel intensity values towards gray (128).	

Gamma	Adjusts the gamma of the image. Gamma correction is typically used to adjust for differences in the way monitors display brightness and colors. Adjusting this slider is similar, although not identical, to adjusting the nonlinear slider. Moving the slider to the right will increase the brightness of the image in a nonlinear fashion as shown.	
Nonlinear	Adjusts the image using nonlinear input/output mappings. This slider is a combination of a logarithmic (moving slider to the right) and exponential (moving slider to the left) palette. The logarithmic palette increases the contrast in dark regions and decreases the contrast in light regions. This has the effect of bring out more detail in the dark regions and making light regions very light. The exponential palette increases the contrast in light regions and decreases the contrast in dark regions. This has the effect of making dark regions darker and bringing out more detail in lighter regions.	

Saving and Loading Processing Settings

Image processing settings may be saved to a file and later reloaded (Control Pro version only). Different processing settings can be saved to different files and loaded as necessary. The Save button will prompt you for a destination. Image processing files have the “lut” file extension.

Image Calibration

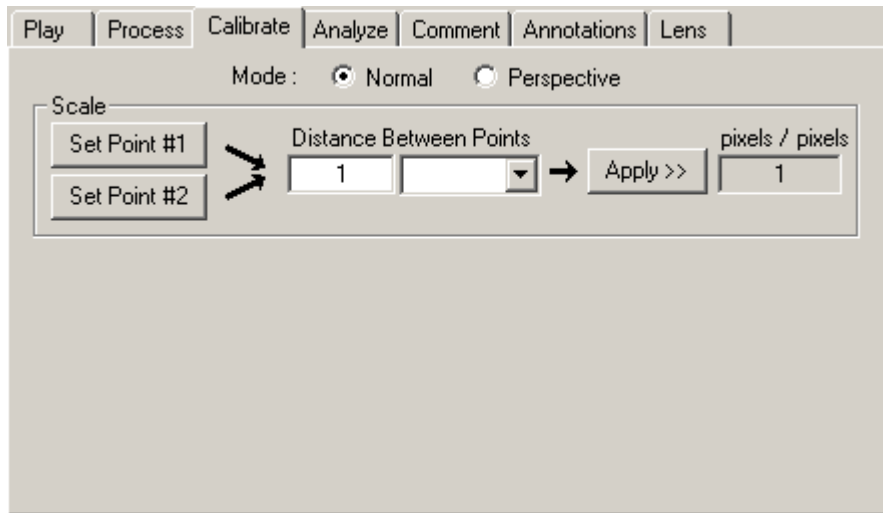
The Image Calibration Tab	105
Overview of Calibration	106
Calibrating the Scale	106
Calibrating the Coordinate System (Control Pro version only)	107
Perspective Calibration (Control Pro version only)	109
Saving and Loading Calibration Settings (Control Pro version only)	110
Displaying Calibration Marker (Control Pro version only)	112



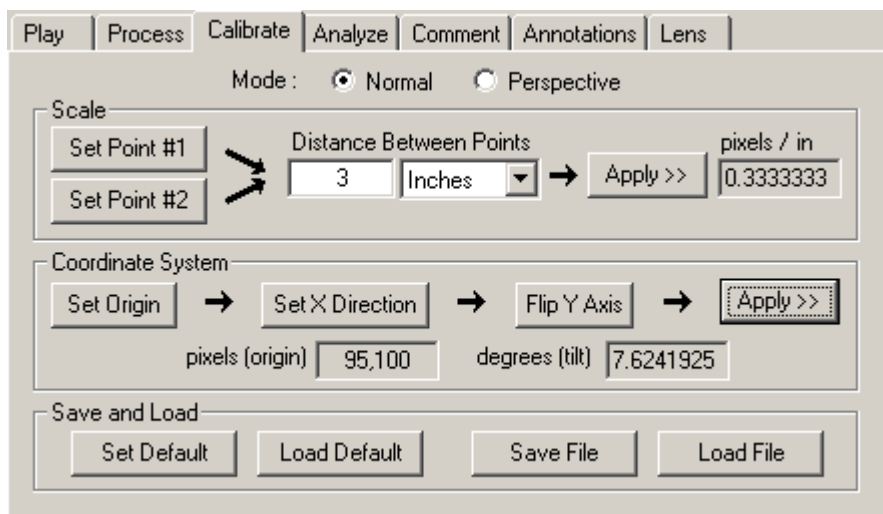
Image Calibration

The Image Calibration Tab

The image calibration tab is the second tab found in the Working View, named “Calibrate”. The version of the Calibrate tab for the Control version of the *i-SPEED* Software Suite is shown below. Only Normal calibrations are allowed for the Control version.



The Control Pro version of the *i-SPEED* Software Suite includes a more feature-laden version of the tab and also allows for the use of Perspective calibrations.



The various components of the Calibrate tab are described in the following sections.

Overview of Calibration

Calibrating an image serves the following functions:

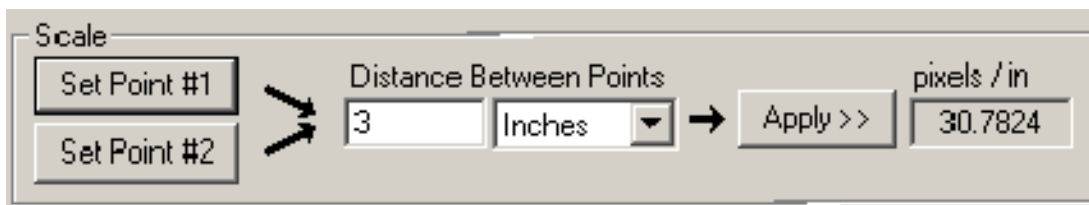
- Converts and scales the recorded video image to real-world dimensions (e.g. inches, meters, etc.)
- Rotates the coordinate frame to remove any unwanted tilt introduced during the recording process from the analysis process
- Establishes an origin (0,0) and X,Y coordinate plane for motion analysis (direction of motion).

Normal mode 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 in the Analyze tab.

Normal calibrations are only valid when the motion occurs in a plane perpendicular to the direction of the camera (i.e. objects moving across the screen in the video, not towards or away from the camera). Perspective calibration allows for motion to occur in a plane that is inclined relative to the camera.

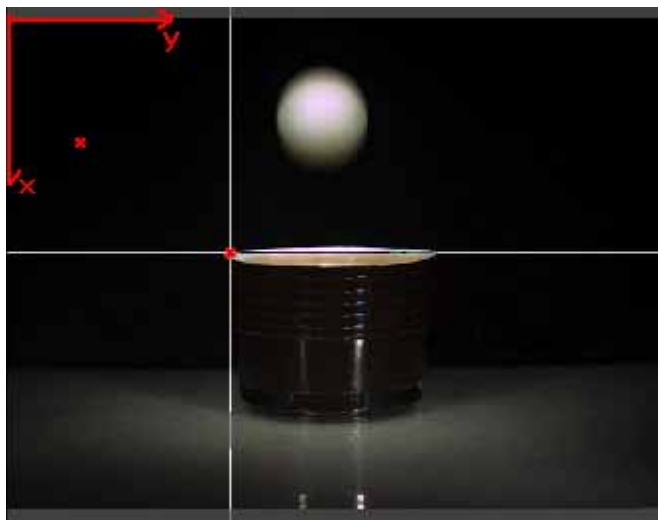
Calibrating the Scale

The process of calibrating the scale is outlined in the top box on the Control and Control Pro tabs.



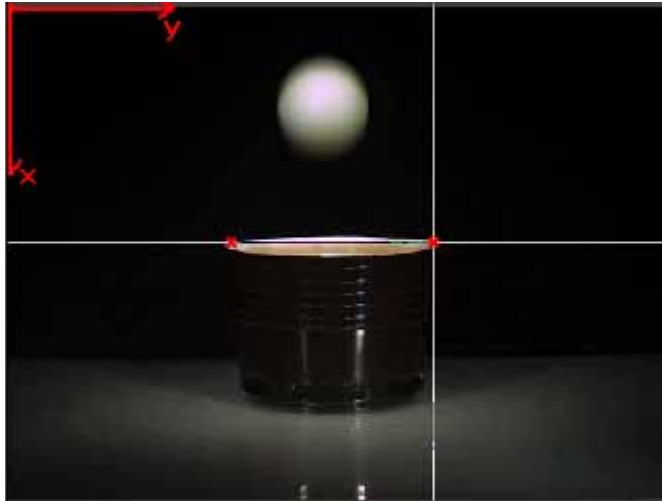
To set the calibration scale:

- 1 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.



- 2 Click on SET POINT #1.

- 3 Within the video image, left-click on the other end of the known object.



- 4 In the Calibration dialog, click on **SET POINT #2**.
- 5 Type the distance between the points and choose the unit of measure from the drag-down list (e.g. inches, meters, etc.).

Distance Between Points

3 Inches

- 6 Click on **APPLY** button to set the scale factor.
- 7 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.

Calibrating the Coordinate System (Control Pro version only)

Coordinate System

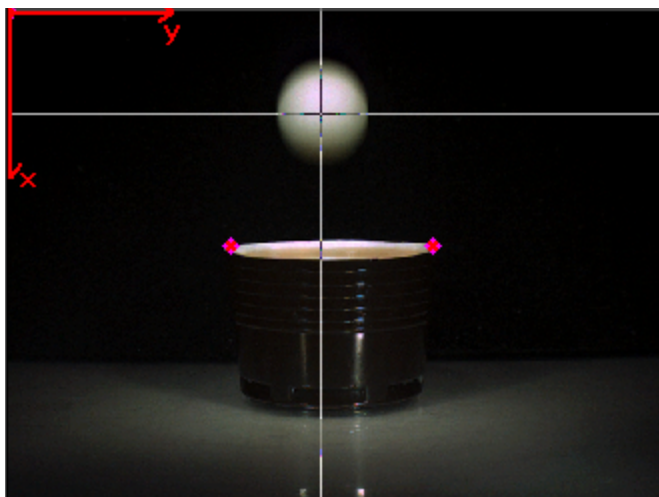
Set Origin → Set X Direction → Flip Y Axis → Apply >>

pixels (origin) 0,0 degrees (tilt) 0

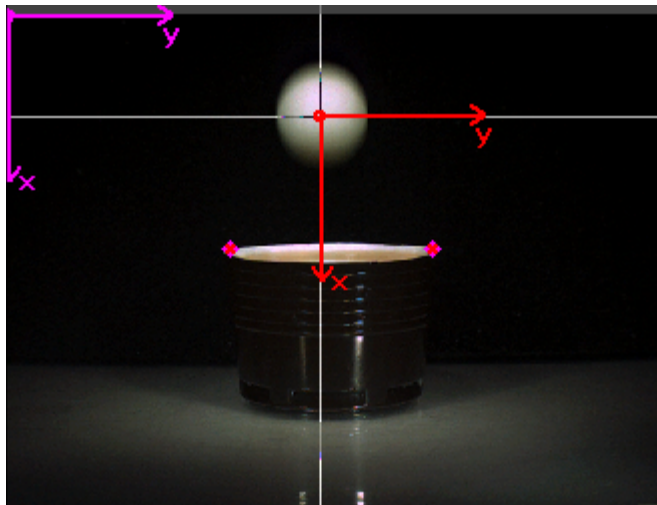
The coordinate system is defined to include the origin (0,0 point) and the X,Y axes. The coordinate system is used in the motion analysis of video.

To calibrate the origin and axes of the coordinate system:

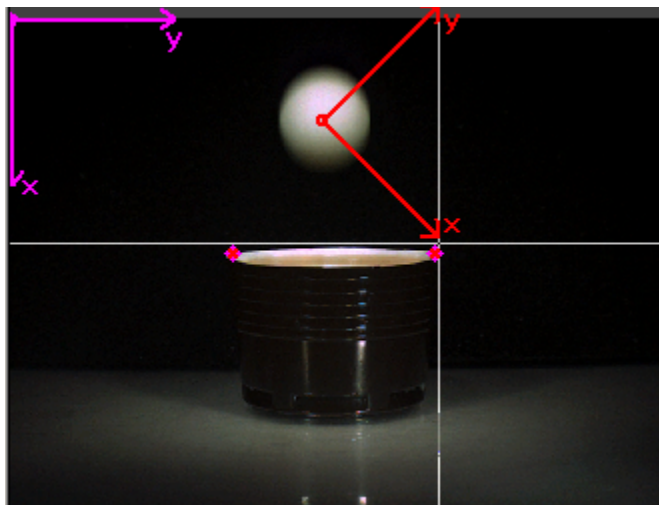
- 1 Choose a point in the image that will serve as the origin of your coordinate system. Left-click on one end of the object, using the reticle as a guide.



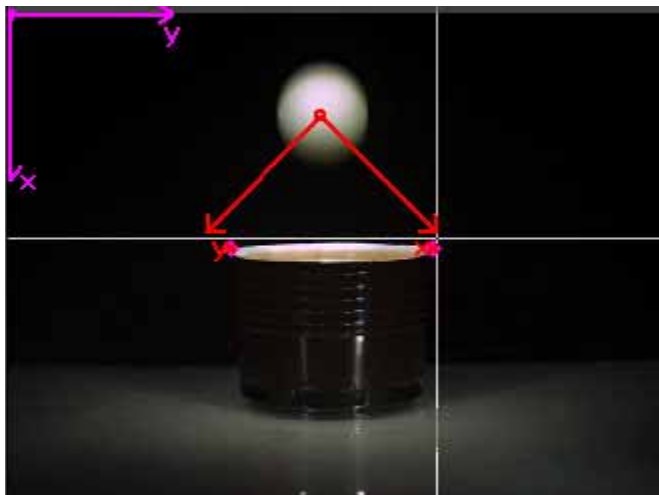
- 2 On the Calibrate tab, click on **SET ORIGIN**. The coordinate system marker moves such that its 0,0 position is on the selected point. Note that the moved marker is shown in red and the original marker position is shown in purple.



- 3 Determine the appropriate positive X-axis direction, and left-click anywhere in the image in that direction. The coordinate X,Y markers will rotate to align the X direction with the new reticle position.
- 4 On the Calibrate tab, click on **SET X-DIRECTION**.
- 5 In the image, the coordinate markers will automatically rotate to align the X axis between the origin and the current point.



- 6 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 AXIS** button in the Calibrate tab.



- 7 Click on **APPLY** to set the calibration. The origin location and the tilt degrees are shown in the text boxes on the right side of the Calibrate tab.

Perspective Calibration (Control Pro version only)

To use a perspective calibration instead of a normal calibration, click on the Perspective option for Mode: at the top of the calibration tab.

The screenshot shows the 'Calibrate' tab in the software. The 'Mode' is set to 'Perspective'. There are four 'Set Point' buttons, each followed by 'X Coord.' and 'Y Coord.' text boxes. The coordinates entered are: Set Point #1 (0.0, 0.0), Set Point #2 (50.0, 0.0), Set Point #3 (0.0, 50.0), and Set Point #4 (50.0, 50.0). An arrow points from the Set Point #2 button to the 'Units' dropdown menu. The 'Units' dropdown is currently empty. An 'Apply >>' button is to the right of the units dropdown. Below the calibration section is a 'Save and Load' section with four buttons: 'Set Default', 'Load Default', 'Save File', and 'Load File'.

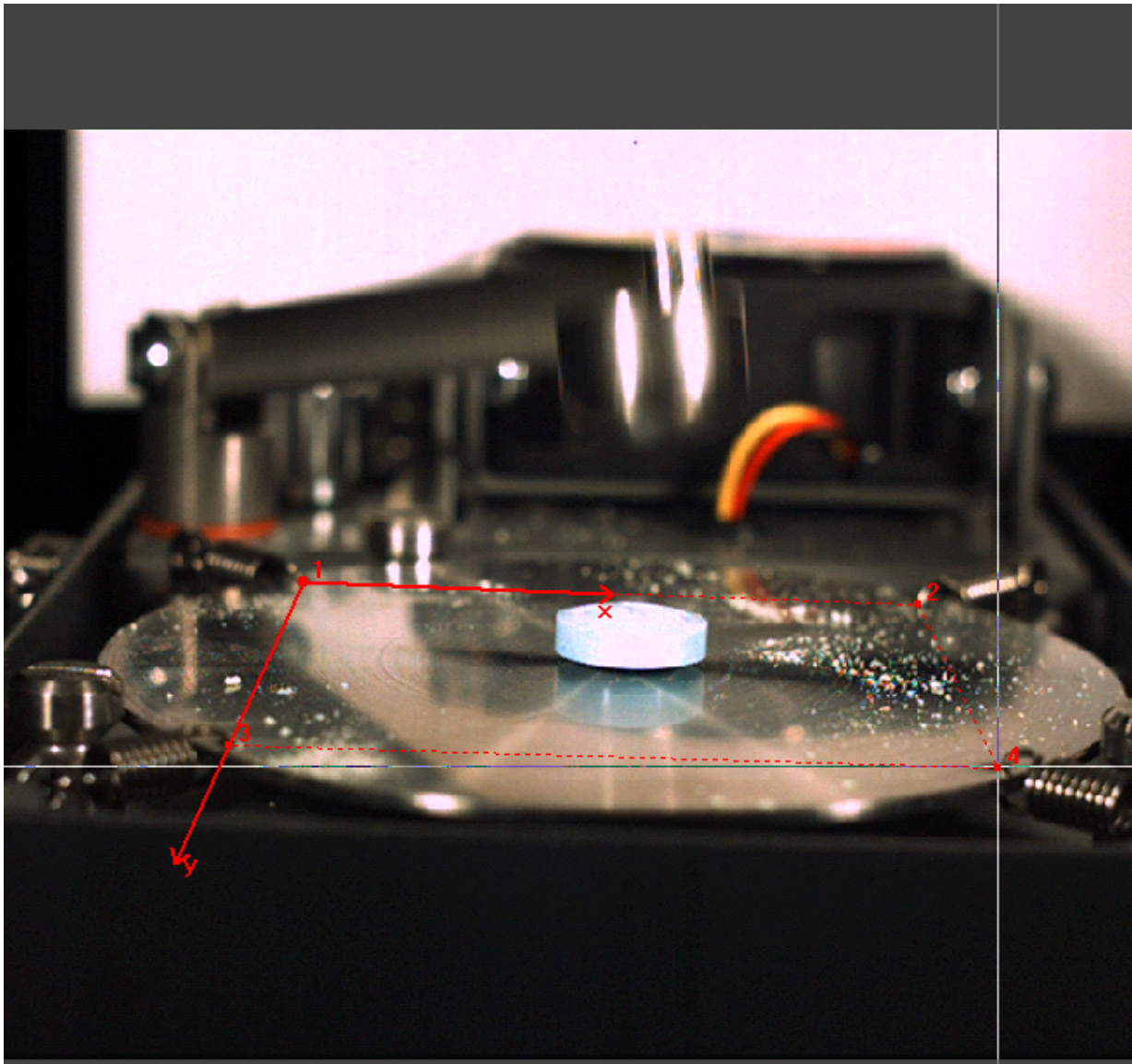
Perspective calibration allows you to define a plane of motion that is moving towards the camera, away from the camera, tilted upward or downward, or a combination of those. Four points with known locations are required. These four points are not required to form a rectangle or square, however, they must all lie in the same plane. All items that you wish to measure must also lie in this same plane in order for the calibration to be accurate.

It is often helpful to place a rectangular object of known dimensions in the field of view. The four corners of this object can then serve as the four points in the image used to define a perspective calibration. Decide which corner of the object should represent the origin. Let the coordinates of that point be 0,0. The coordinates of the other three points are then known from knowing the width and height of the rectangular object. For instance, if the object is 50 inches by 50 inches, then the four points could be at coordinates: (0,0), (50,0), (0,50), and (50,50).

To define a perspective calibration:

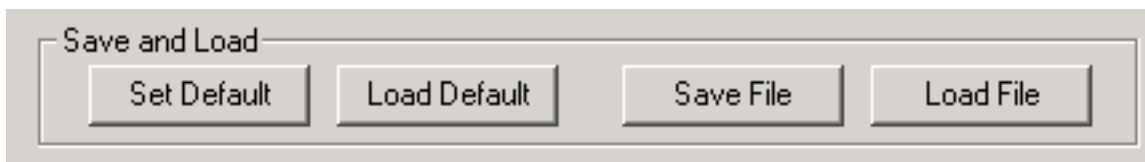
- 1 Place the reticle in the image on the first point used to define the calibration.
- 2 Click on Set Point #1 in the Calibration tab.
- 3 Enter the X and Y coordinates of point #1 in real world coordinates.
- 4 Repeat steps 1-3 for points 2, 3, and 4.
- 5 Select the units of the X and Y coordinates that were entered.
- 6 Click on the Apply button.

Once all four points have been set and all four X, Y coordinates have been entered, the coordinate frame should be drawn in the video image. If the coordinate frame is not drawn as expected, verify that the point locations and/or X, Y coordinates were entered in the proper order.



Saving and Loading Calibration Settings (Control Pro version only)

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 all future measurements, click on the **SET DEFAULT** button in the Calibrate tab.



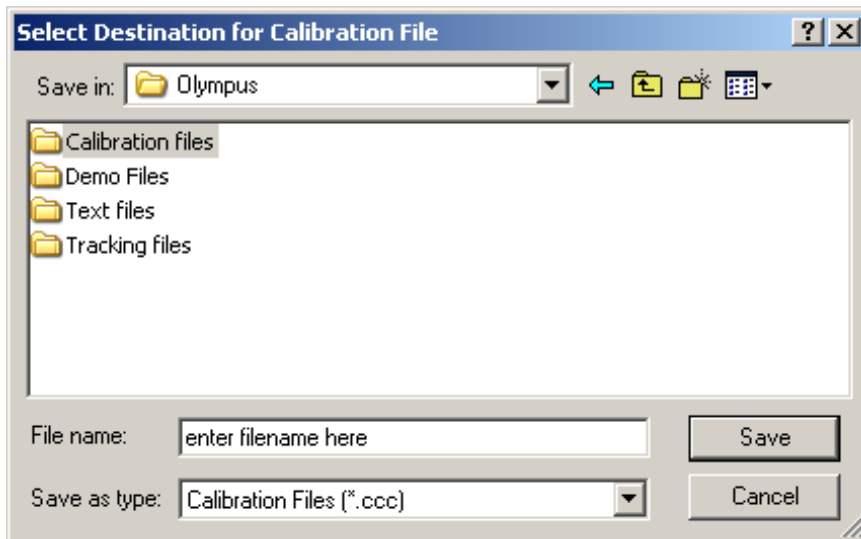
To re-load the default calibration settings (e.g. after experimenting or if you wish to change the analysis positions), click on the **LOAD DEFAULT** button. The default calibration settings will apply.

You may wish to have different calibration settings for different recordings, rather than only one default set.

To save the current calibration values to disk at any time, click on **SAVE FILE** button in the Calibrate tab.

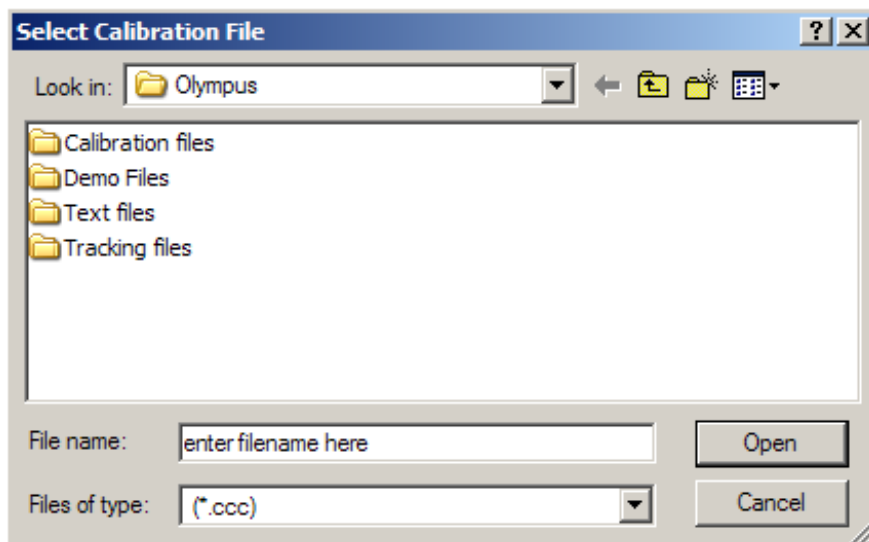
The Select Destination for Calibration File dialog box appears:

Enter the filename and click on the **SAVE** button. Calibration files are saved as *.CCC file.



Calibration files can be applied to any image at any time. Only one file can be applied to an image at any time. To load a previously stored calibration onto an image, click on the **LOAD FILE** button in the Calibrate tab.

The Select Calibration File dialog window appears.

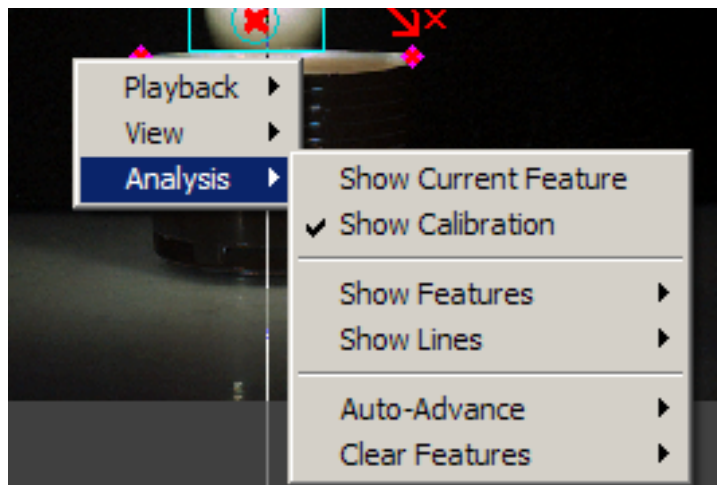


Select the calibration file you wish to apply to the image and click on **OPEN** button.

Displaying Calibration Marker (Control Pro version only)

The calibration marker can be toggled on and off the video in the Working View at any time -- for example, during image processing, during analysis or during normal viewing.

The visibility of the calibration marker is controlled via the right-click contextual menu. To enable or disable the visibility of the calibration marker, right click anywhere within the video, select Analysis, then Show/Hide Calibration.



Analyzing Motion

Overview of Motion Analysis	114
Control and Control Pro Versions	116
Manually tracking features	117
Automatically tracking features (Control Pro Version)	120
Manually repairing automatically tracked data	126
Displaying position, distance and velocity	127
Exporting Motion Analysis	127
Saving and Loading Tracked Points (Control Pro only)	130



Analyzing Motion

Overview of Motion Analysis

Motion analysis is performed in the Working View. The process of analyzing motion contains the following steps:

- Image processing
- Point-by-point or automatic feature tracking
- Analysis and calculations
- Graphing

Manual vs. Automatic Tracking

“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.

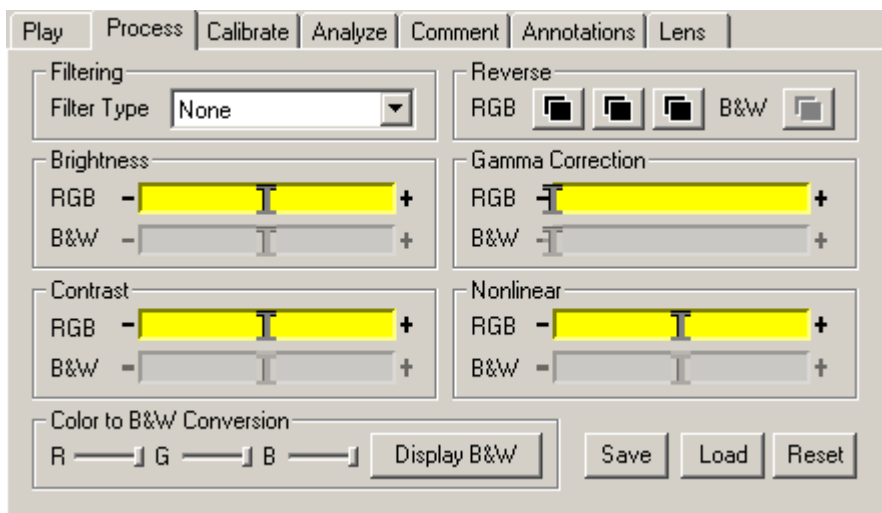
There are two general methods of tracking:

- 1 **“Automatic Tracking”** (often shortened to Auto-Tracking) requests that the user select the feature to be tracked in the initial frame only. The *i-SPEED* software then steps through the video image, frame by frame, and automatically finds the selected feature. When it finds a match from the originally selected feature in subsequent frames, it highlights the location of the feature per frame and stores the positions in the database. Automatic tracking is the most effective and expeditious solution for most applications.
- 2 **“Manual Tracking”** requires the user to manually step through the video one frame at a time, using the mouse to select the location of the feature in each frame. The manual tracking method is preferable for low-quality images or very irregular feature paths not suitable for auto tracking.

Image Processing

To optimize the success of tracking an image, users must generally first perform some form of image processing.

To optimize the image via image processing, click on the Process tab in the working view.



The Process tab contains features and controls for modifying, enhancing, sharpening and processing an image. These functions help optimize images for tracking by highlighting the features to be tracked and suppressing the effects of the background. The goal for image processing is to improve the ability of the *i-SPEED* software's auto-tracking algorithms to find the features on each frame.

It should be noted that the tracking algorithm looks for correlation of pixel patterns. So, features with high contrast-to-noise ratios are always desirable. By modifying the image using the functions of the Process tab, you are improving the likelihood of achieving a high correlation factor between a pattern of pixels and the desired initial feature. The image processing settings are used during the tracking process.

The Process tab provides the following features:

- Filtering (smoothing, sharpening, edge detection)
- Brightness
- Contrast
- Gamma Correction
- Nonlinear palette
- Conversion from color to monochrome
- Individual RGB channel palette settings
- Reversal of color images
- Reversal of monochrome images

Calibration

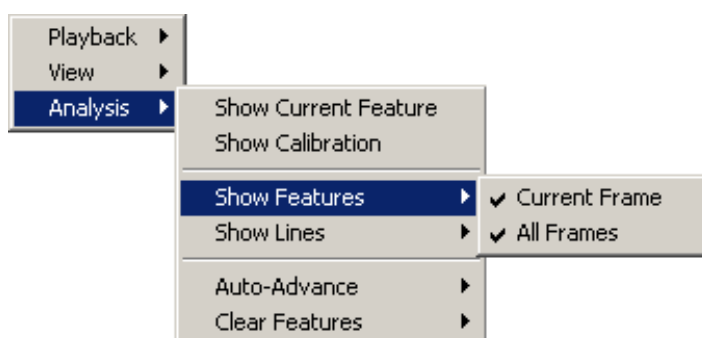
Images are expressed in pixels, as presented from the *i-SPEED* camera. In order to convert your images from pixels to units of inches, meters, millimeters, etc., you must calibrate the image. The *i-SPEED* software provides calibration tools for the following functions:

- Linear scaling
- Coordinate system
- Origin location
- Perspective calibration

The calibration functions are described in detail in Section 14 of this User Manual.

Context Menu Shortcuts

The *i-SPEED* software contains contextual menu shortcuts to common operations. To access the contextual menus for motion analysis, right-click within the working view image. The following menu appears:



The ability to toggle features on/off, view lines, and clear the image of tracking point indicators are available via the context menu.

Control and Control Pro Versions

The Control version of the *i-SPEED* software allows you to calibrate, process and manually click on features with your mouse within each video frame. The X,Y position of each click is recorded. The database can then be exported to Excel or a text file with the frame number and time position.

The Control Pro version *i-SPEED* software adds improved calibration, image processing and graphing features and allow automatic tracking of user-defined features. These versions also export tracked data to an Excel spreadsheet or text file in the same fashion as with the manual tracking.

The following matrix shows the features included in the three versions.

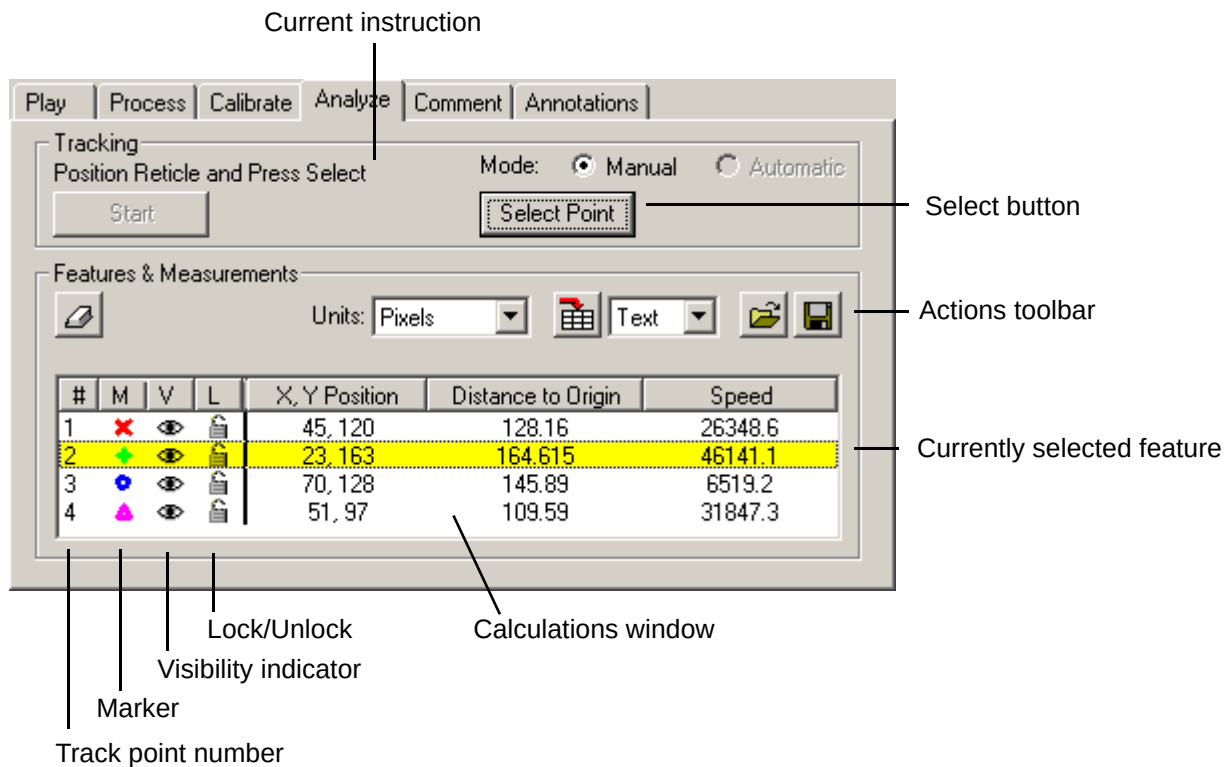
		Control	
Tracking	64-point Manual Tracking	✓	✓
	64-feature Automatic Tracking		✓
	Ability to add/remove number of features		✓
	Measure relative to first feature		✓
	Tracking of rotating targets		✓
Image Processing	Brightness, Contrast, Gamma Controls	✓	✓
	Non-linear image scaling	✓	✓
	Color to monochrome conversion, reversal	✓	✓
	Image filtering		✓
	Saving/Loading configurable settings		✓
Calibration	Standard 2-D calibration	✓	✓
	Enhanced/configurable 2-D calibration		✓
	Perspective calibration		✓
Display and Graphing	Real Time velocity, distance, position	✓	✓
	On-screen graphing		✓
	Melding of user data and analysis graphs		✓
	Data smoothing in on-screen graph		✓
Exporting	Export to Excel directly	✓	✓
	Export to other programs (via file)	✓	✓

Manually tracking features

Manual tracking requires the user to manually step through an image sequence (avi movie or sequentially numbered series of tiff, bitmap or jpeg images) one frame at a time, using the mouse to select the location of the feature in each frame. The manual tracking method is preferable for low-quality images or very irregular feature paths not suitable for auto tracking.

The Manual Tracking Tab

The manual tracking tab has the following components:



Current instruction

The text in this location changes to instruct the user as to the next procedural action. This guide facilitates the process.

Select Point button

Pressing this button registers the X,Y position of the reticle into the database for the currently selected feature.

Currently selected feature

The currently selected feature (point) is highlighted in yellow. If you are using the Deluxe version of the *i-SPEED* software, you can hold down the CTRL or Shift buttons to select and deselect multiple features at the same time for editing (adding or removing) this window.

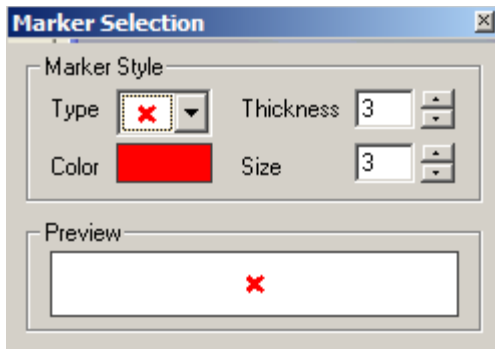
Track point number (#)

The feature number. Hold down the CTRL or Shift buttons to select and deselect multiple features at the same time.

Marker (M)

The marker assigned to each feature. Double clicking on the marker will bring up the feature editor window.

In the feature editor window, users can select the type and color of each marker, the thickness of the lines and the size of the marker. Use this tool to combine similar features (e.g. elbow, wrist and shoulder) of an object or to improve visibility of the marker against the background.



Visibility Indicator (V)

Click on this icon to show/hide the denoted marker on the image. This tool is valuable when tracking multiple points or objects that cross each other. Hiding markers helps understand motion.

Lock/Unlock (L)

Click on this icon to lock or unlock the selected feature. 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.

The Calculations Window

The position, distance moved and speed (magnitude of the velocity) of the object are displayed in this window. These items are not editable by the user.

Actions Toolbar

This toolbar contains icons for common user actions during manual tracking.



The functions include:

- Clear Tracked Points for Selected Features

Clicking on this button erases all the tracked points for the currently selected feature (highlighted in yellow).

Units

The units of measure for displaying the calculations in the calculations window. Units include pixels, inches, feet, meters, millimeters, and centimeters. Units do not need to be the units of calibration – for example, calibrate the image in inches, display calculations in feet or meters.

Export to Text

Clicking on this button causes the current database of tracked points to be exported to either Microsoft Excel or a text file, as selected in the drag-down box. Microsoft Excel must be loaded on the computer. Each row of the export file corresponds to a frame of video, with the time and frame number in the first two fields followed by a series of X,Y coordinates for each feature.

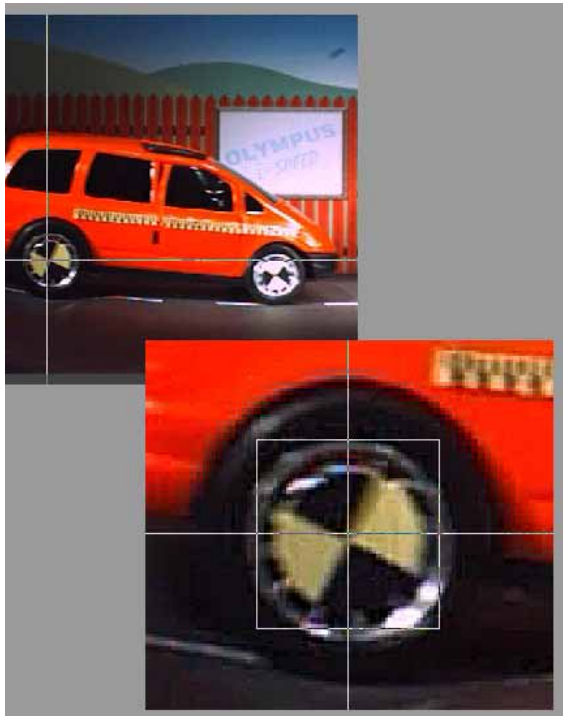
Load Track Results from File, Save Track Results to File

Clicking on these buttons causes the *i-SPEED* software to store the tracked points with the video. When the video is opened again, the tracked points will automatically appear overlaid on the video. You can also save tracked points and open the file on another video for comparison of motion between files. This is an ideal technique for comparing current motion with a pre-defined master motion.

Manual Tracking Procedure

The process for manually tracking a feature through an image sequence is as follows:

- 1 Click on the Start button.
- 2 Select **MANUAL** mode
- 3 If you are using the Control Pro version of the *i-SPEED* software, click on the Add or Remove features buttons in the toolbar until you have the desired number of feature trackers. If you are using the Control version of the *i-SPEED* software, click on the Lock/Unlock icon for each feature you wish to use.
- 4 Navigate through the recording video to the desired frame, using either the playback controls.
- 5 Highlight the feature of interest.
- 6 In the image, place the crosshairs (reticle) on the feature of interest. Use the zoom feature to zoom in on the feature for greater accuracy.



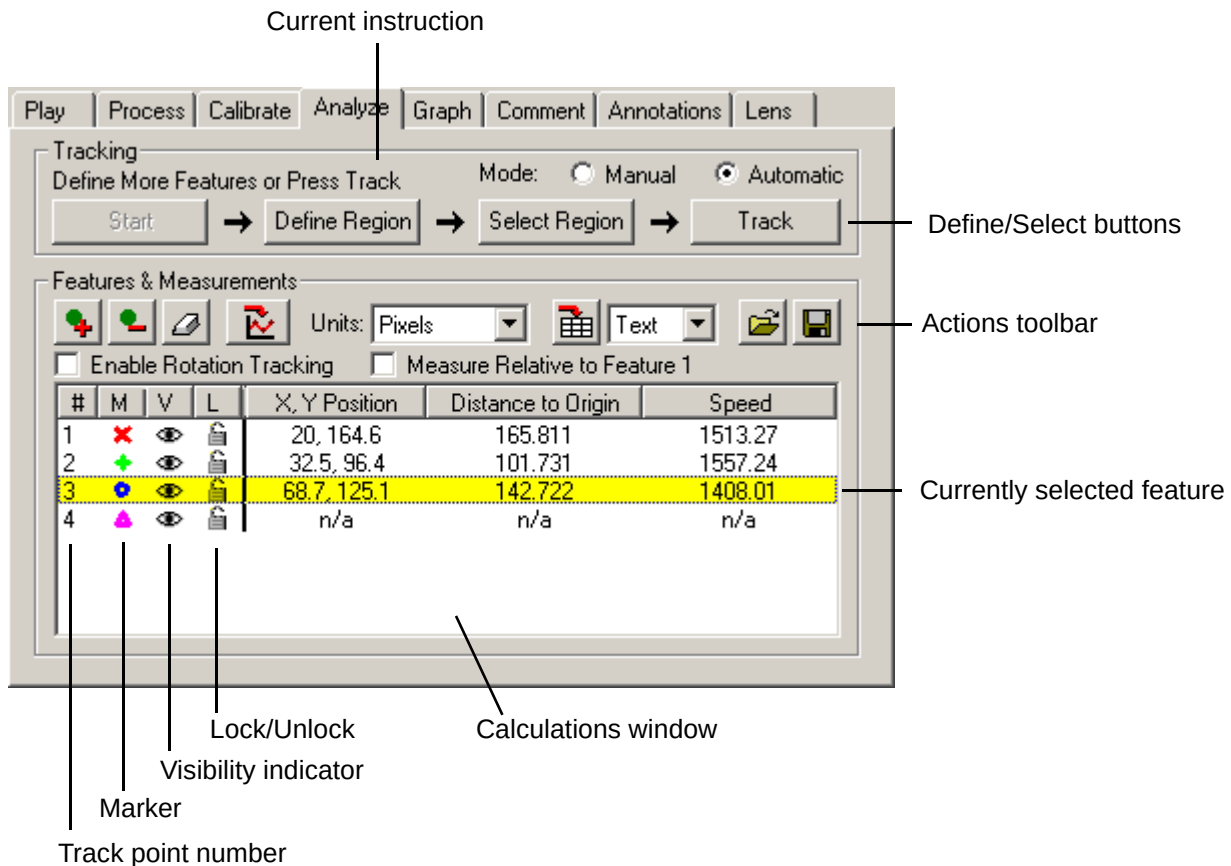
- 7 Click on the **SELECT POINT** button. or hold down the CTRL-SHIFT keys and click with the mouse.
- 8 *i-SPEED* software places the active feature marker on the selected location for this frame. The blue circle  denotes the marker(s) associated with the current frame.
- 9 Repeat steps 5,6, and 7 for the each unlocked feature in the list. The *i-SPEED* software will automatically advance to the subsequent feature if the auto-advance feature is enabled. To enable/disable this feature, right-click within the image, select Analysis, then Auto-Advance Feature on/off.
- 10 Advance to the next frame and repeat steps 5,6 and 7. The *i-SPEED* software will automatically advance to the next video frame if the auto-advance feature is enabled. To enable/disable this feature, right-click within the image, select Analysis, then Auto-Advance Frame on/off.

Automatically tracking features (Control Pro Version)

Automatic Tracking uses a modified template tracking algorithm to track patterns through a video sequence. A tracking template is a group of pixels within the image. Tracking templates are also referred to as “features” or “regions” of an image. The *i-SPEED* software automatically steps through the video image, frame by frame, to find a pattern to the user-selected tracking template. When the correlation tracking algorithm finds a match, it highlights the location of the feature and continues to the next frame. If no adequate match is found or the video reaches the end, the *i-SPEED* software 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. Automatic tracking is the most effective and accurate tracking technique for most applications.

The Automatic Tracking Tab

The automatic tracking tab has the following components:



Current instruction

The text in this location changes to instruct the user as to the next procedural action. This guide facilitates the process.

Define/Select buttons

This sequence of buttons, separated by arrows, is used to define a region around the feature, select the region and then track the selected regions.

Currently selected feature

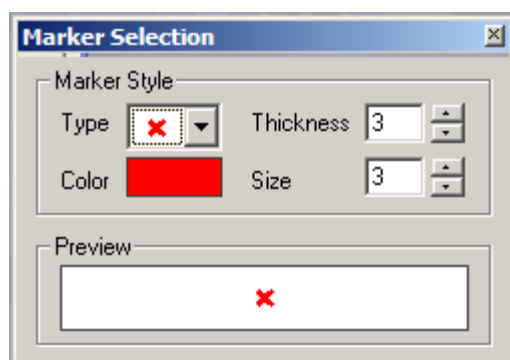
The currently selected feature is highlighted in yellow. If you are using the Deluxe version of the *i-SPEED* software, you can hold down the CTRL or Shift buttons to select and deselect multiple features at the same time for editing (adding or removing) this window.

Track point number (#)

The feature number. Hold down the CTRL or Shift buttons to select and deselect multiple features at the same time.

Marker (M)

The marker assigned to each feature. Double clicking on the marker will bring up the feature editor window



In the feature editor window, users can select the type and color of each marker, the thickness of the lines and the size of the marker. Use this tool to combine similar features (e.g. elbow, wrist and shoulder) of an object or to improve visibility of the marker against the background.

Auto-Track Feature Indicator

This icon shows you which features are set to auto-track and which are set to manually track. If the bow-tie target  is visible for the feature, then this feature will be automatically tracked when the user presses the Track button. If the bow-tie target it is not visible, then this feature will not be automatically tracked.

To select or features to include in the auto-tracking process, click on the Set Feature to Auto Track button  in the Actions Toolbar.

Visibility Indicator (V)

Click on this icon to show/hide the denoted marker on the image. This tool is valuable when tracking multiple points or objects that cross each other. Hiding markers helps understand motion.

Lock/Unlock (L)

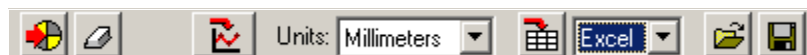
Click on this icon to lock or unlock the selected feature. When a feature is locked, any of the tracked points for this feature cannot be modified. The feature will also be skipped in any auto-advance cycle.

The Calculations Window

The position, distance moved and speed (magnitude of the velocity) of the object are displayed in this window. These items are not editable by the user.

Actions Toolbar

This toolbar contains icons for common user actions during manual tracking.



The functions include:

Set Feature to Auto Track

Clicking on the button causes the currently selected feature (highlighted in yellow) to become an auto-track feature. All features that are designated as auto-track features will be included in the auto-track routine when the user presses the Track button. In the Control Pro version of the *i-SPEED* software, clicking on this button toggles the auto-track selection on/off. There are no auto-track capabilities in the Control version.

Clear Tracked Points for Selected Features

Clicking on this button erases all the tracked points for the currently selected feature (highlighted in yellow).

Update Graph

Clicking on this button updates the graph with the most current track points.

Units

The units of measure for displaying the calculations in the calculations window. Units include pixels, inches, feet, meters, millimeters, and centimeters. Units do not need to be the units of calibration – for example, calibrate the image in inches, display calculations in feet or meters.

Export to Text :

Clicking on this button causes the current database of tracked points to be exported to either Microsoft Excel or a text file, as selected in the drag-down box. Microsoft Excel must be loaded on the computer. Each row of the export file corresponds to a frame of video, with the time and frame number in the first two fields followed by a series of X,Y coordinates for each feature.

Load Track Results from File, Save Track Results to File :

Clicking on these buttons causes the *i-SPEED* software to store the tracked points with the video. When the video is opened again, the tracked points will automatically appear overlaid on the video. You can also save tracked points and open the file on another video for comparison of motion between files. This is an ideal technique for comparing current motion with a pre-defined master motion.

Measure Relative to Feature 1

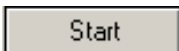
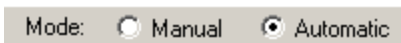
Checking this box causes the *i-SPEED* software to calculate all feature positions relative to the position of Feature 1 for every frame. The coordinates of Feature 1 will always be 0,0 and all the coordinates of all other features will be computed using the distance to the Feature 1 point. If the Feature 1 point is not defined for a given frame, then the relative distance will be listed as “n/a”, not available. This feature is only available in the Control Pro version.

Enable Rotation Tracking

Checking this box causes the *i-SPEED* software to do additional calculations to account for the possibility that the target being tracked is rotating. Enable this feature if your target rotates more than a few degrees during the course of the video. Due to the additional computation time required when this option is selected, it is only recommended to enable this feature when needed. This feature is only available in the Control Pro version.

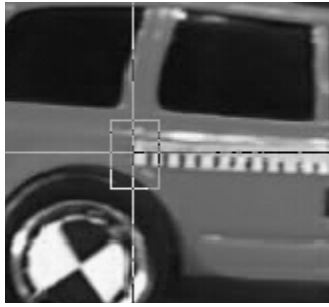
Automatic Tracking Procedure

The process for manually tracking a feature through an image sequence is as follows:

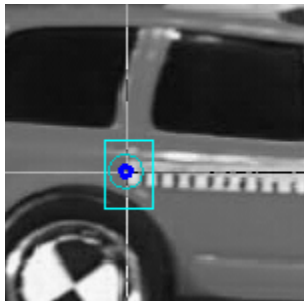
- 1 Click on the Start button .
- 2 Select **Automatic** mode .
- 3 If you are using the Control Pro version of the *i-SPEED* software, click on the Add or Remove features buttons in the toolbar until you have the desired number of feature trackers
- 4 Highlight each feature that you wish to auto-track and click on the Set Feature to Auto Track  button.
- 5 Navigate through the recording video to the desired frame, using either the playback controls or the contextual menu shortcuts.
- 6 Highlight the feature of interest (highlighted features have a yellow background)

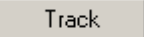
1				n/a	n/a	n/a
2				n/a	n/a	n/a
3				290.1	-110.8	310.545
4				n/a	n/a	n/a

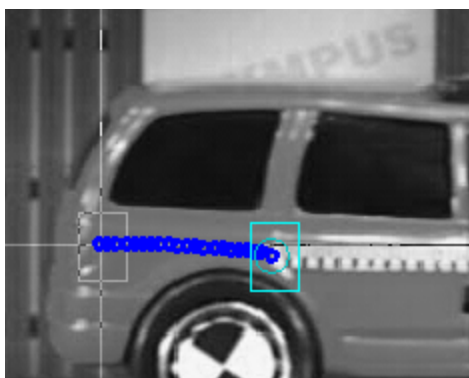
- 7 Click on the Define Region button. .
- 8 Using the mouse, draw a box around the feature to auto-track. This is the “tracking template”.



- 9 Click on the **SELECT REGION** button  or hold down the CTRL-SHIFT keys and click with the mouse.
- 10 *i-SPEED* software places the active feature marker on the selected location for this frame. The blue circle  denotes the marker(s) associated with the current frame. The blue box denotes that the initial template location.



- 11 Repeat steps 6-9 for the each unlocked, auto-track designated feature in the list. The *i-SPEED* software will automatically advance to the subsequent feature if the auto-advance feature is enabled. To enable/disable this feature, right-click within the image, select Analysis, then Auto-Advance Feature on/off.
- 12 Click on the Track button . The *i-SPEED* software will track all auto-track designated objects.
- 13 While tracking, the Track button will change to a Stop button
- 14 . Clicking on this Stop button will stop the tracking at its current location. Otherwise, *i-SPEED* software will continue to track until it can no longer find a good template match or it reaches the end of the video sequence.
- 15 When complete, the image will show all the tracked points.



Restarting auto-tracking after stop

If the automatic tracking process stops due to a natural template loss, you may continue to track a point manually or automatically. To continue tracking this object manually, select **MANUAL** mode **Mode:** ☒ Manual and follow the instructions for manual tracking of objects.

To continue tracking this feature automatically, you must reset your tracking template at the frame where the feature was lost.

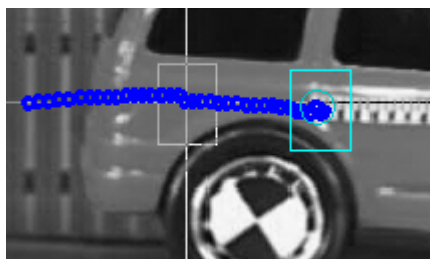
- 1 Using the playback controls, navigate through the recording video to the last frame containing a successful track (e.g. the frame just prior to the stoppage).
- 2 Highlight the feature of interest (highlighted features have a yellow background)

1	✗	👁	📄	n/a	n/a	n/a
2	+	👁	📄	n/a	n/a	n/a
3	⊗	👁	📄	290.1, -110.8	310.545	n/a
4	▲	👁	📄	n/a	n/a	n/a

- 3 Click on the Define Region button. **Define Region**
- 4 Using the mouse, draw a box around the feature to auto-track. This is the new “tracking template”.



- 5 Click on the **SELECT REGION** button **Select Region** or hold down the CTRL-SHIFT keys and click with the mouse.
- 6 Click on the Track Button **Track**.
- 7 The displayed data will appear as though it was one continuous feature track sequence instead of a restarted series of auto-track.

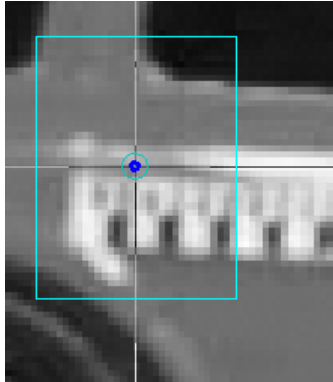


Creating optimum tracking templates

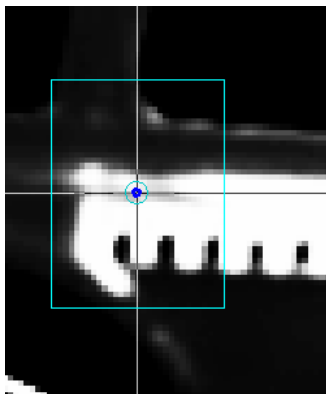
The *i-SPEED* software tracking algorithms use all image processing settings in the calculation of the correlation ratio between the current frame the original tracking template. Therefore, the potential success at tracking objects (features) is based heavily on the quality of processed image presented to the algorithm.

The following are suggestions for optimizing the tracking template:

- D Display color images as Black/White images unless the feature to be tracked is color dependent. The algorithms convert images to 8-bit monochrome automatically.
- D Make tracking templates asymmetric in both X and Y directions. This will increase the probability of only one solution to the pattern match.



- D Use the image processing brightness, contrast and nonlinear controls to strengthen the white portions of the tracking template while darkening the background.



- D Find features that are not changing drastically from frame to frame. The *i-SPEED* software looks for high correlation from frame to frame. Features that are rotating quickly or changing from frame to frame (e.g. going in/out of shadows) are more likely to fail.

Manually repairing automatically tracked data

At any time, you can repair or replace tracked data points. Since only one tracked point per feature can exist per frame, all changes to the tracking data automatically replaces previous data.

Therefore, you can use a modified manual tracking routine to repair incorrect data, as follows:

- 1 Select **MANUAL** mode Mode: ☒ Manual

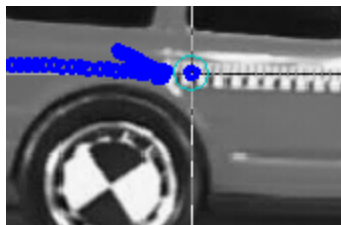
- 2 Highlight the feature of interest.

1	✗	👁	🔒	n/a	n/a	n/a
2	+	👁	🔒	n/a	n/a	n/a
3	⊕	👁	🔒	290.1, -110.8	310.545	n/a
4	▲	👁	🔒	n/a	n/a	n/a

- 3 Using the Lock/Unlock feature unlock the feature of interest and lock all other features.

1	✗	👁	🔒	n/a	n/a	n/a
2	+	👁	🔒	376.2, -72.81	383.199	n/a
3	⊕	👁	🔒	376.2, -72.81	383.199	21.4697
4	▲	👁	🔒	376.2, -72.81	383.199	n/a

- 4 Navigate through the recording video to the desired frame, using either the playback controls.
- 5 In the image, place the crosshairs (reticle) on the feature of interest. Use the zoom feature to zoom in on the feature for greater accuracy, if necessary.

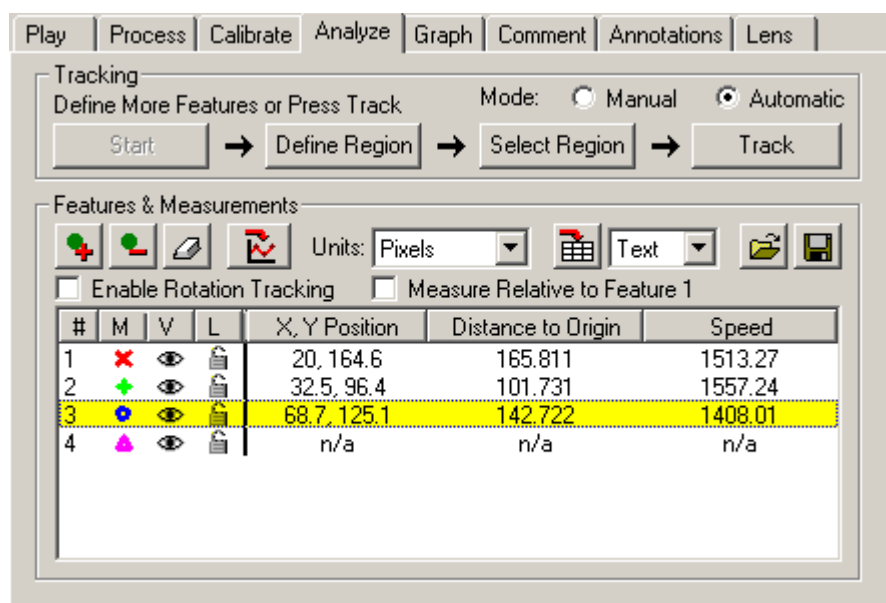


- 6 Click on the Select Point button. Select Point

- 7 Repeat this process for each track point that you wish to repair. At any time, you may switch to automatic tracking.

Displaying position, distance and velocity

Location, distance and velocity are displayed in real time in the calculations window of the Analysis tab.



X,Y Position

Location is presented from the user-defined origin, as set in the Calibrate tab. In the absence of user calibration, the location is presented from the 0,0 point – the upper left corner – of the sensor.

Distance to Origin

The distance from the current point to the user-defined origin, in user-selected units. In the absence of user calibration, the location is presented from the 0,0 point – the upper left corner – of the sensor.

Speed

The distance that the point has moved from the previous frame to the current frame, in user-selected units, divided by the time between frames. The distance moved is always a positive number.

Exporting Motion Analysis

Tracked point data may be exported for more detailed motion analysis and calculations with other scientific programs. There are two options for exporting within *i-SPEED* software – Export to Excel and Export to Text.

Export to Excel

To export data to an Excel spreadsheet, set the export destination to Excel from the drag down menu box on the Action Toolbar, and click the Export button.  Excel .

Microsoft Excel will be launched automatically and a new workgroup created. In the first worksheet of the workgroup, the tracked points will be exported. The worksheet looks like the following:

Microsoft Excel - Book1

File Edit View Insert Format Tools Data Window Help

The following is the organization of the worksheet:

Row 1: Title

Row 7: Sub-title "Test Data"

Row 9: Date of worksheet creation

Row 10: Time of worksheet creation

Row 11: Filename of video image

Row 13: Sub-title "Calibration"

Row 15: Scale calibration

Row 16: Tilt calibration

Row 17: Export units

Row 21: Sub-title "Tracking Data"

Row 23: Column headings

Row 25 start of tracking data

Tracking data is presented such that each row of the worksheet corresponds to a frame of video.

Column A: Frame number

Column B: Frame time

Columns C, D: X,Y position of Feature 1

Columns E, F: X,Y position of Feature 2

Columns G, H: X,Y position of Feature 3

Columns I, J: X,Y position of Feature 4

More columns are automatically added for more features.

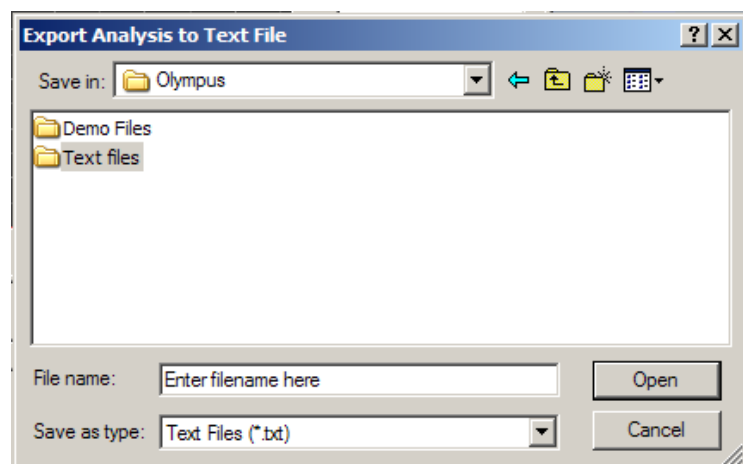
Note that the maximum number of rows allowed by Microsoft Excel is 65,560. If your video sequence has more than 65,550 frames, you cannot export to Excel (an error message will be generated). In this case, you must export to text and parse the length of the file.

Exporting to a text file

To export data to a comma-delimited text file that can be used by all known scientific analysis software packages (Matlab, Mathcad, etc.), set the export destination to Text from the drag down menu box on the Action Toolbar, and click the Export button.



You will be prompted for a save destination for the text file:



Type in the filename and location. The file will be created at the prescribed destination.

The format of the text file is as follows:

```
Enter filename here.txt - Notepad
File Edit Format View Help
# Date       : 2003-08-27
# Time       : 00:54:23.972000
# File Name  : C:\Olympus\Demo Files\carcrash1k.avi
#
# Calibration : 30.782400 Pixels / Inch
# Tilt       : -25.816597
# Units      : Millimeters
#
#
# Frame Time      Point 1      Point 2      Point 3      Point 4
#      x          y          x          y          x          y          x          y
191, 1.910000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -2.146908e+002, -1.056955e+002, 0.000000e+000, 0.
000000e+000
192, 1.920000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -2.102340e+002, -1.035394e+002, 0.000000e+000, 0.
000000e+000
193, 1.930000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -2.102340e+002, -1.035394e+002, 0.000000e+000, 0.
000000e+000
194, 1.940000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -2.054179e+002, -1.021261e+002, 0.000000e+000, 0.
000000e+000
195, 1.950000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -2.054179e+002, -1.021261e+002, 0.000000e+000, 0.
000000e+000
196, 1.960000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -2.017040e+002, -1.003294e+002, 0.000000e+000, 0.
000000e+000
197, 1.970000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -2.017040e+002, -1.003294e+002, 0.000000e+000, 0.
000000e+000
198, 1.980000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -1.972472e+002, -9.817334e+001, 0.000000e+000, 0.
000000e+000
199, 1.990000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -1.972472e+002, -9.817334e+001, 0.000000e+000, 0.
000000e+000
200, 2.000000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -1.927905e+002, -9.601727e+001, 0.000000e+000, 0.
000000e+000
201, 2.010000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -1.927905e+002, -9.601727e+001, 0.000000e+000, 0.
000000e+000
202, 2.020000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -1.883337e+002, -9.386121e+001, 0.000000e+000, 0.
000000e+000
203, 2.030000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -1.883337e+002, -9.386121e+001, 0.000000e+000, 0.
000000e+000
204, 2.040000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -1.838770e+002, -9.170515e+001, 0.000000e+000, 0.
000000e+000
205, 2.050000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -1.838770e+002, -9.170515e+001, 0.000000e+000, 0.
000000e+000
206, 2.060000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -1.805224e+002, -8.916563e+001, 0.000000e+000, 0.
000000e+000
207, 2.070000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -1.805224e+002, -8.916563e+001, 0.000000e+000, 0.
000000e+000
208, 2.080000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -1.771678e+002, -8.662611e+001, 0.000000e+000, 0.
000000e+000
209, 2.090000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -1.771678e+002, -8.662611e+001, 0.000000e+000, 0.
000000e+000
210, 2.100000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -1.734538e+002, -8.482939e+001, 0.000000e+000, 0.
000000e+000
211, 2.110000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -1.734538e+002, -8.482939e+001, 0.000000e+000, 0.
000000e+000
212, 2.120000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -1.697399e+002, -8.303267e+001, 0.000000e+000, 0.
000000e+000
213, 2.130000e+002, 0.000000e+000, 0.000000e+000, 0.000000e+000, 0.000000e+000, -1.697399e+002, -8.303267e+001, 0.000000e+000, 0.
000000e+000
```

Line 1: Creation data
Line 2: Creation time
Line 3: Origin filename
Line 5: Scale calibration
Line 6: Tilt calibration
Line 7: Export units
Line 10: Sub-title row
Line 11: Sub-title row
Line 12: Tracking data.

Like the Excel output, the text file includes (from left to right) frame number, frame time, X,Y position for each tracked point (4 minimum).

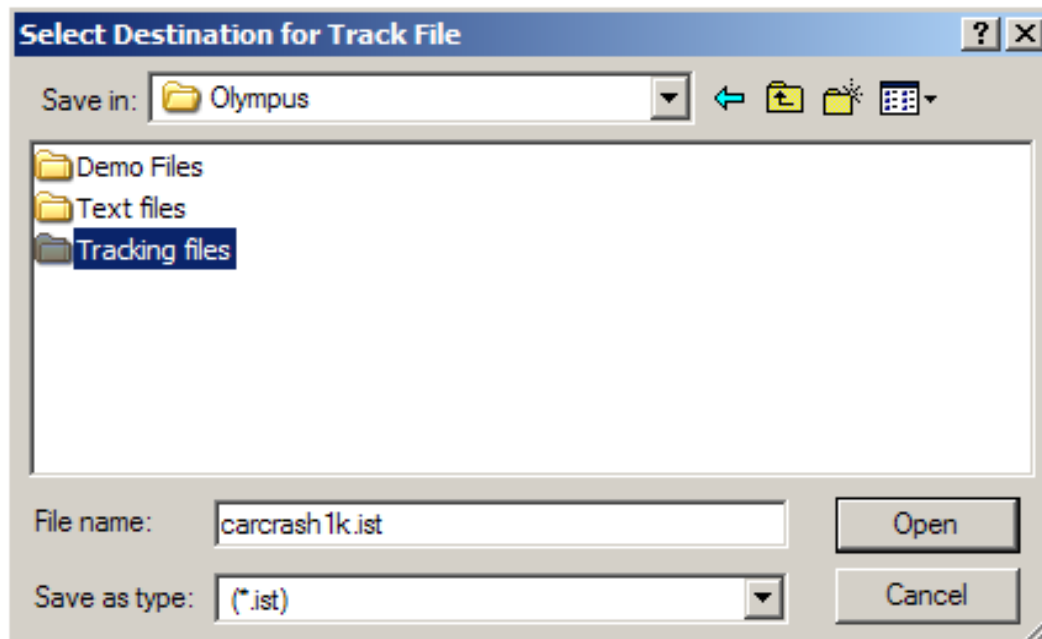
Saving and Loading Tracked Points (Control Pro only)

Tracked points are automatically saved in a special binary file named filename.ist, where 'filename' is the name provided by the user during saving.

However, as an additional feature of *i-SPEED* software Control Pro version, users can save and load tracked points in separate IST files. By using the Save/Load feature, tracked points from one analysis can be overlaid onto another image for comparison and for computation of deviations or errors. This very powerful feature helps understand part motion beyond what is available with standard analysis and exporting.

To save tracked points:

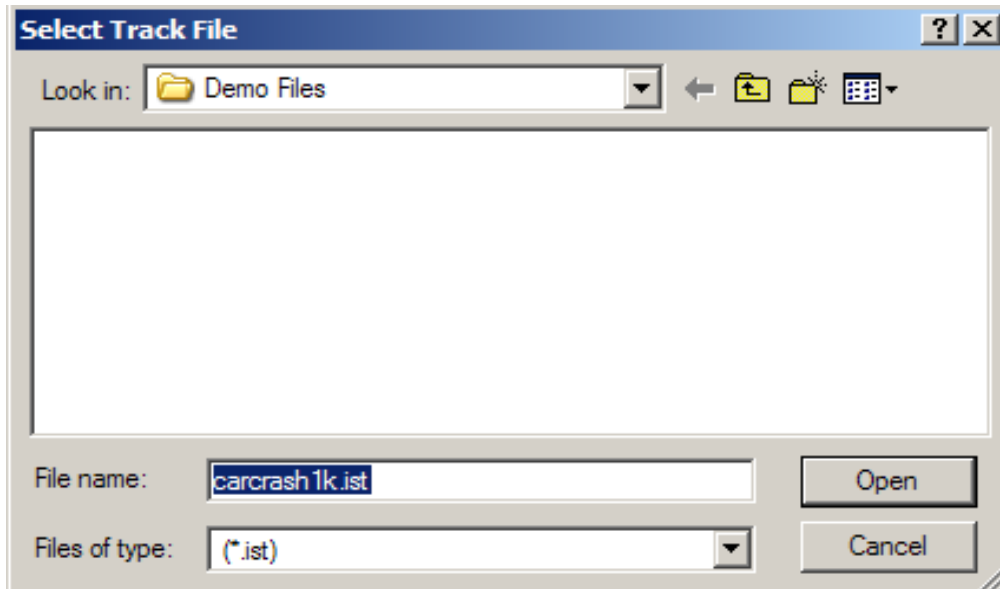
- 1 Complete the analysis per the above-described procedures.
- 2 Click on the Save Track Results to File button in the Action Toolbar (Advanced and Deluxe only)
- 3 You will be prompted for a destination and file name for the new IST file.



- 4 Type in the file name and destination.

To load previously saved tracked points:

- 1 Open a video sequence
- 2 Click on the Load Track Results from File button 
- 3 Select the file to load



- 4 Click on the Open button.

16

Graphing User Data and Analysis (Control Pro only)

The Graph Panel	133
The Graphing Tab	134
Zooming and Panning a Graph	136
Changing the Displayed Channels	137
Changing the Y Axis	138
Scaling the Visible Data	139
Changing the Line Colors	139
Single Stepping through a Graph	140
Data Filtering	141

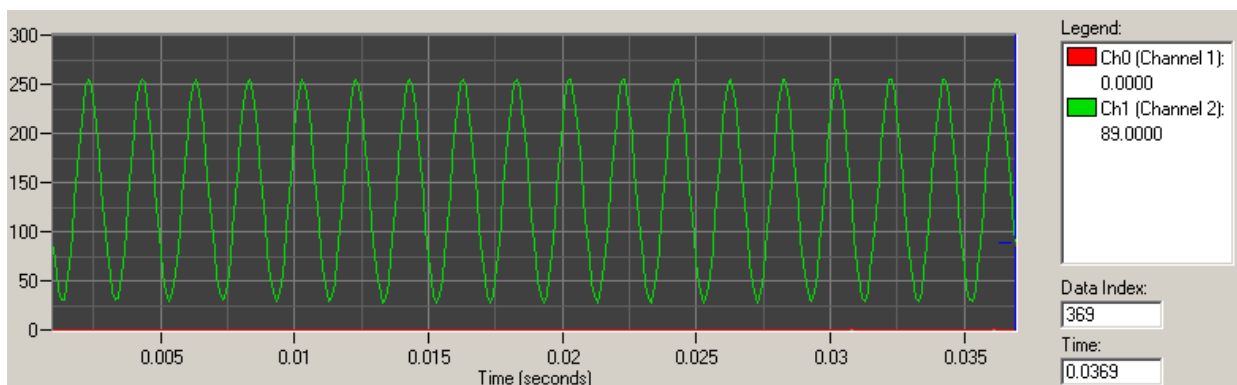
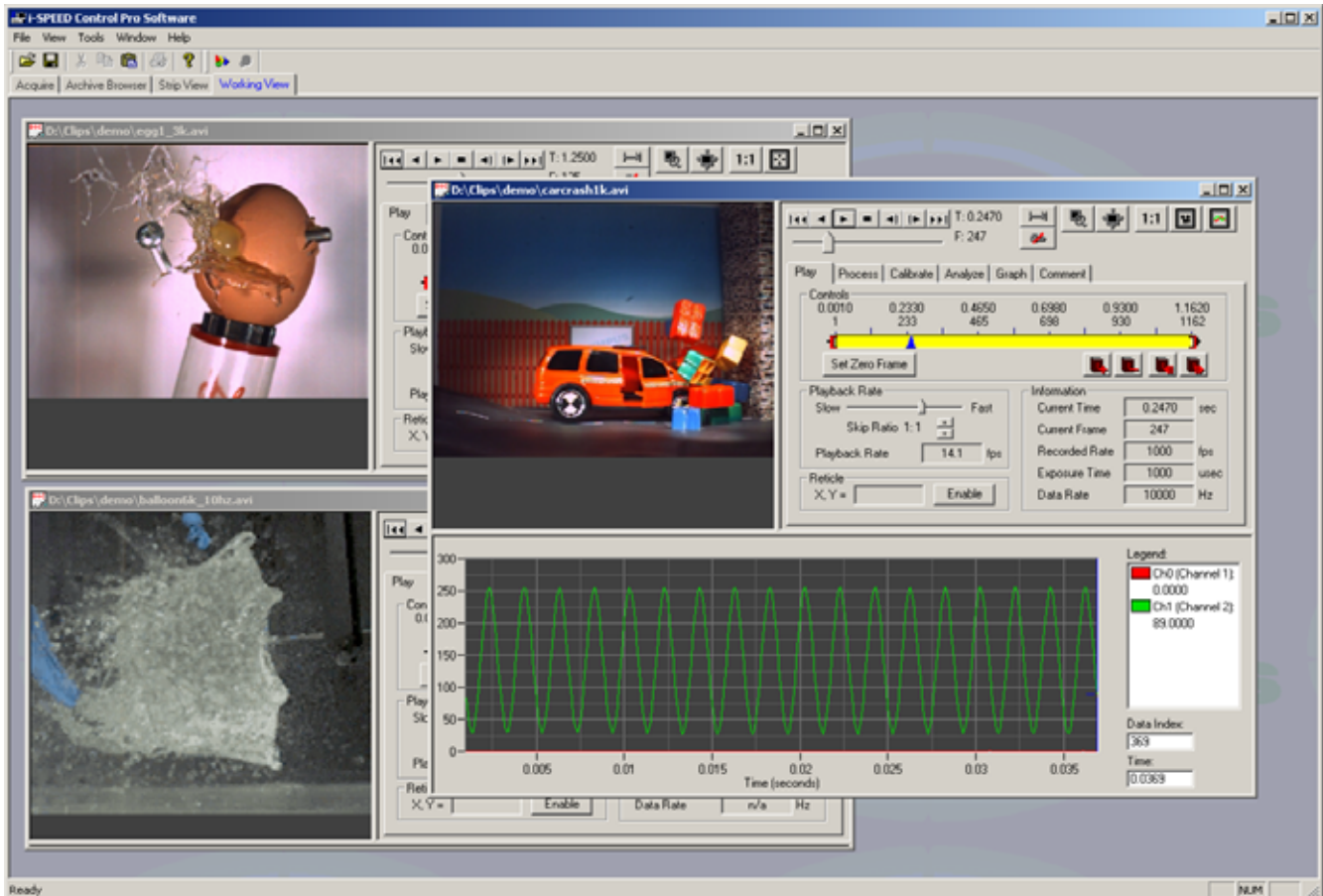


Graphing User Data and Analysis (Control Pro only)

The Graph Panel

The graph panel is available with the Control Pro version of the software only. The graph shows both user data from sensors and motion analysis data.

The graph panel is part of the Working View. It is located below the video panel and the control panel. It is only visible when either user data is present or if motion analysis has been performed on the image from within the Analyze tab.



On the right side of the graph panel are the following features:

Legend	Shows the various graph lines and color assignments
Data index	The number of the data point that is currently highlighted by the vertical blue line
Data time	The time of the data point that is currently highlighted by the vertical blue line.

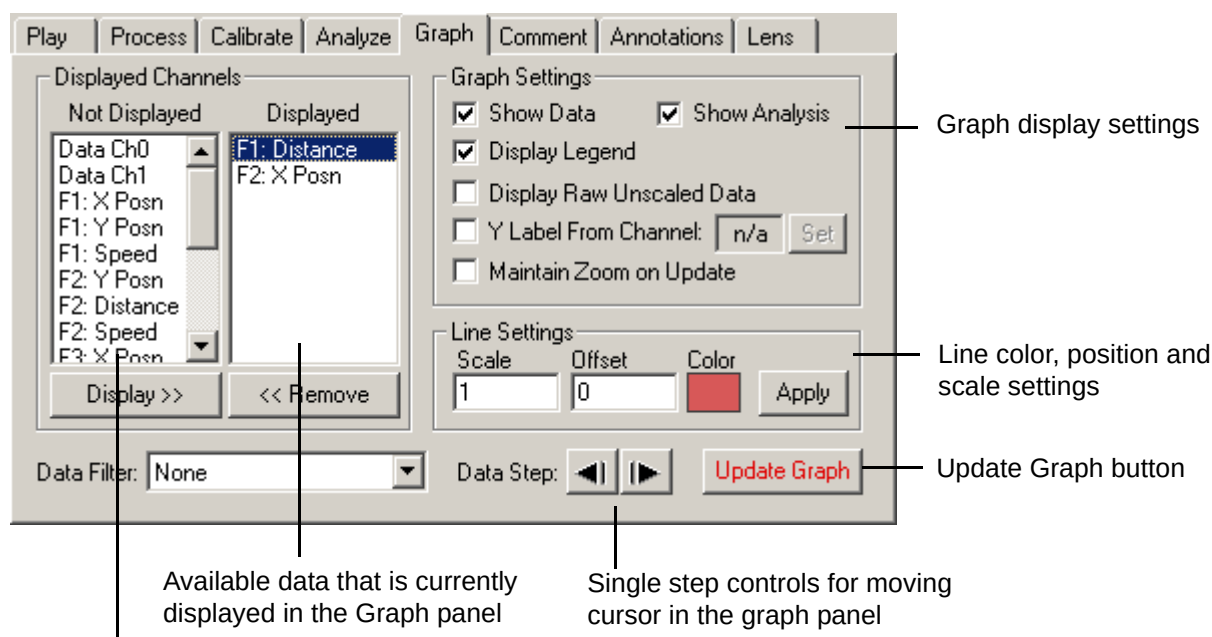
The Graphing Tab

The graphing tab is the fifth tab (left to right) in the Working View. It is only visible in the Control Pro version of the *i-SPEED* software.

In order to use the graphing tab, either (1) User Data acquired from external sensors at the same time as the video must be present or (2) you must have analyzed motion within your image using the Analyze tab. Until either of these conditions exist, the graph panel of the Working View will be hidden.

The graphing tab sets what is displayed in the graph panel and how it is displayed (colors, line width, etc.). The step controls for the graph are also located in the graphing tab.

The key components of the graphing tab are as follows:



Available data that is not currently displayed in the Graph panel

The features of the Graphing tab are as follows:

Not Displayed Channels

Listed in this box are the data channels (either user data or analysis data) that are available for display, but are not currently displayed.

Displayed Channels

Listed in this box are the data channels (either user data or analysis data) that are currently displayed.

Display>> and <<Remove buttons

Use these buttons to select and remove channels of data to be displayed in the Graph Panel of the Working View window.

Show Data checkbox

If highlighted, then user data acquired with the video is displayed in the Channels window at left, and is available for display on the Graph Panel.

Show Analysis checkbox

If highlighted, then motion analysis data is displayed in the Channels window at left, and is available for display on the Graph Panel.

Display Legend checkbox

If selected, displays the legend in the Graph Panel. If not selected, then the legend is hidden and the graph is extended to the full length of the window.

Display Raw Unscaled Data checkbox

If selected, displays the data without any scaling factors (e.g. raw volts) or offsets.

Y Label from Channel checkbox

The Y axis of the Graph Panel is automatically set to the maximum of all selected channels. This auto-scaling allows the full visibility of graphs, but also causes some graphing to be lower resolution. If this feature is selected, the user has the opportunity to override the auto-scaling and set the Y axis scale and Y axis label to any of the displayed channels.

Maintain Zoom on Update checkbox

If selected, the current zoom region is preserved even during graph updates. If not selected, the action of updating the graph results in the reset of zoom window to full size.

Line Settings

Set the visibility, offset and scale of the lines in the graph.

Data Step buttons

Single step forward and backward to see actual data values in the legend. The Display Legend checkbox must be selected for this feature to be of value.

Update Graph button

The graph is NOT redrawn every time a user input is registered. To apply your changes to the graph, click on the Update Graph button.

Data Filter

A smoothing filter can be applied to all graphed data. To apply a smoothing filter, selected the desired level of smoothing from the drop down list. The smoothed data is graphed on top of the original un-smoothed data. Both the smoothed and un-smoothed data values will be displayed in the graph legend.

Zooming and Panning a Graph

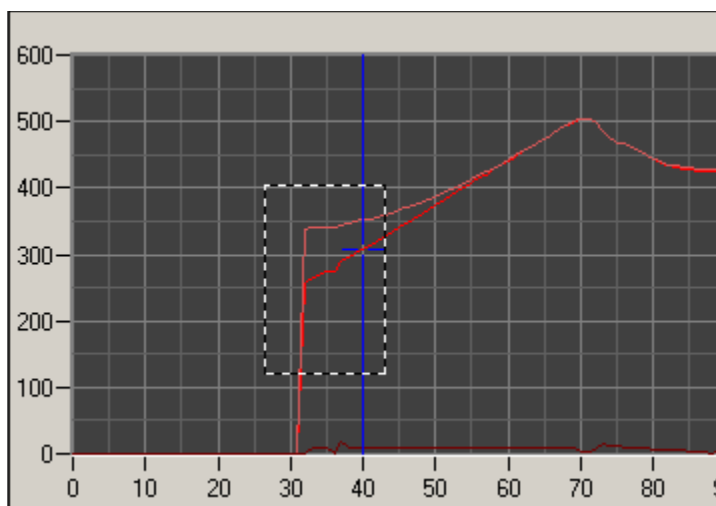
The graph also supports panning and zooming.

Panning

To pan the graph, set the mouse mode to Pan by clicking on the Pan button () in the control panel. The cursor will change to a 4-way arrow. The panning works identically like in the image window.

Zooming

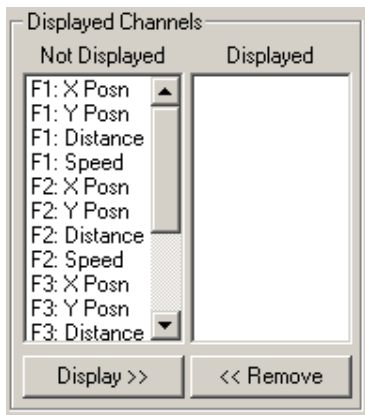
To zoom in on a region in the graph, set the mouse mode to Zoom by clicking on the Zoom button () on the control panel. The cursor should change to a dotted box with a pointer next to it. Click the left mouse button on the graph and drag the mouse to define a zoom region.



To zoom back out, double click in the graph window when in pan or zoom mode.

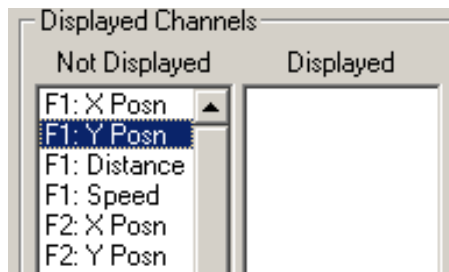
Changing the Displayed Channels

All the available channels for display are initially listed in the Not Displayed box.



To display a channel:

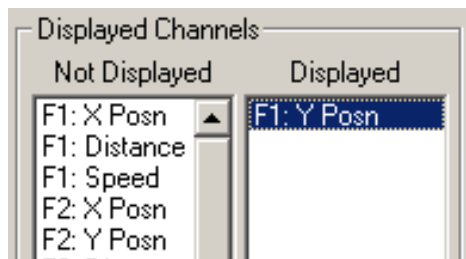
- 1 Select the channel for display



- 2 Click on the Display >> button

Display >>

The channel will be displayed on the Graph Panel.



To remove a channel from the Displayed list:

- 1 Select that channel.

- 2 Click on the << Remove button

<< Remove

The channels are listed by feature number or data input number. The code for determining the features is as follows:

F = "Feature"

D = "Data Input"

1,2,3, = numerical value of that feature or input channel.

X Posn = X axis position

Y Posn = Y axis position

Speed = Relative Speed

Distance = Distance moved since first tracked frame

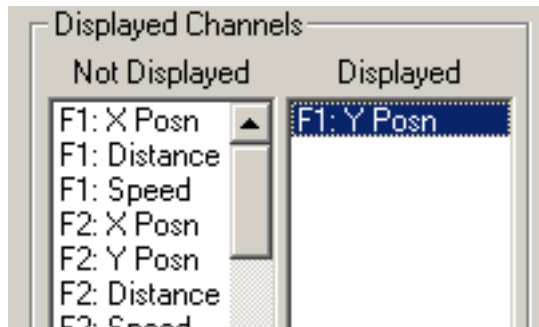
So, the code for "Feature 1 Speed" is "F1: Speed", for Feature 2 Speed is F2: Speed, for Data input channel 3 is D3.

Changing the Y Axis

The Y axis of the Graph Panel is automatically set to the maximum of all selected channels. This auto-scaling allows the full visibility of graphs, but also causes some graphing to be lower resolution. If this feature is selected, the user has the opportunity to override the auto-scaling and set the Y axis scale and Y axis label to any of the displayed channels.

To change the Y-axis scale and label:

- 1 In the Graphing Tab, select the feature from the Displayed Channels box.
- 2 Check the checkbox next to Y Label from Channel



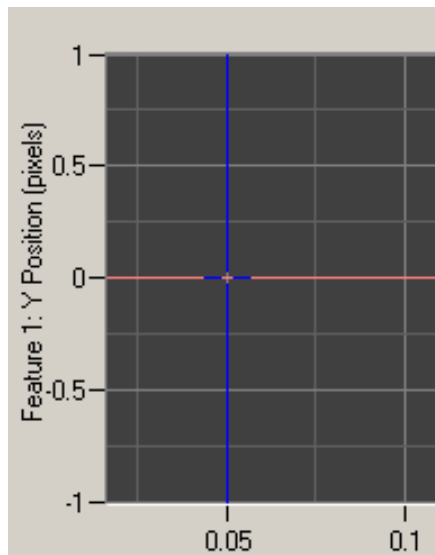
- 3 The channel name will appear in the box on the right



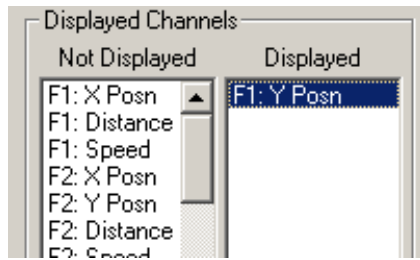
- 4 Click on the Set button.

- 5 Click on the Update Graph button. Update Graph

The graph in the Graph Panel will rescale using the Y axis values from that channel. In addition, a label will be added that indicates the Y-axis description. The X-axis is automatically determined by the *i-SPEED* PC Software as either frame number or data index.



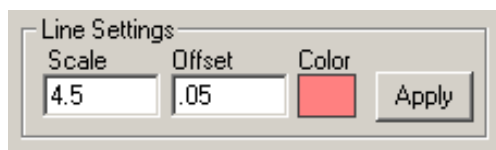
Scaling the Visible Data



Data can also be scaled using a standard $y=mx+b$ linear representation, where m is the scale factor and b is the offset. Each channel can be scaled independently of the other channels. Note that this is a scaling of the visibility of data; the actual data is not changed when saved.

To scale a channel of data:

- 1 In the Graphing Tab, select the feature from the Displayed Channels box.



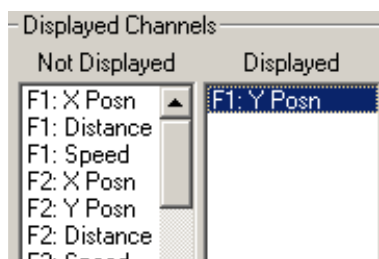
- 2 Change the Scale and Offset from within the Line Settings group.
- 3 Click on the Apply button.
- 4 Click on the Update Graph button. 

Changing the Line Colors

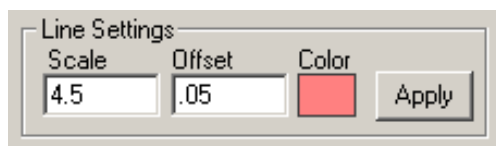
You may also change the colors of the graph from within the Graphing tab.

To change the color of the line:

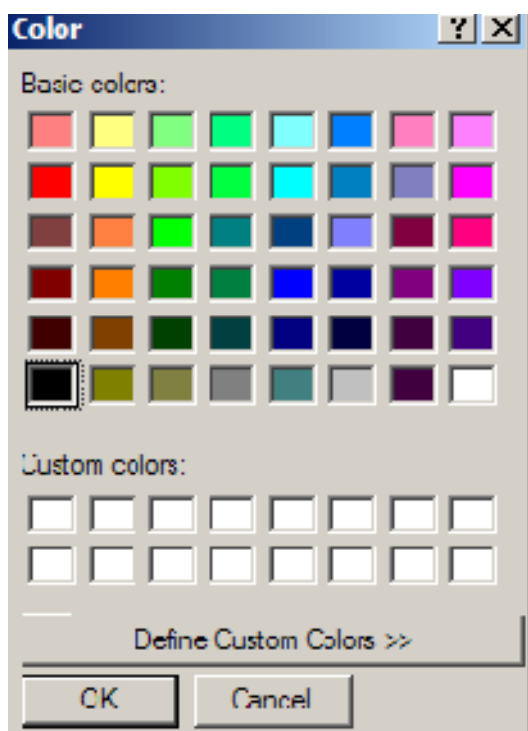
- 1 In the Graphing Tab, select the feature from the Displayed Channels box.



- 2 Click on the color swatch (rectangle). The standard Windows color selector dialog window appears.



- 3 Select the new color for the line.

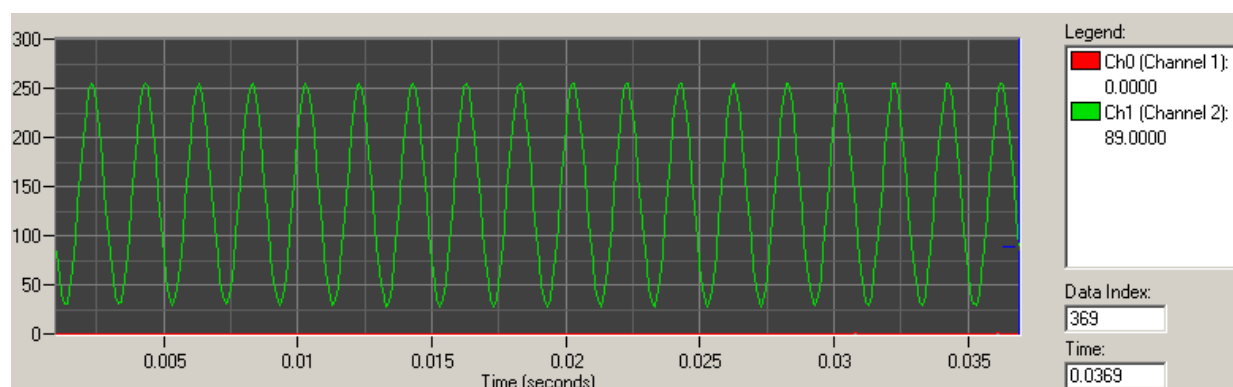


- 4 Click on the OK button to register that Click on the Apply button.

- 5 Click on the Update Graph button 

Single Stepping through a Graph

The single step forward and single step backwards buttons allow you to step through the data one data point at a time. The data index shows the current position.



Note that, most often, external input data is acquired at a different rate than video. Therefore, one video frame may include many of data points within its time period. The data index is a multiple of the frame rate. For example, data might be acquired at 100kHz and video acquired at 1000 fps, so there are 100 data points per video frame.

To step through the data, use the Data Step buttons.



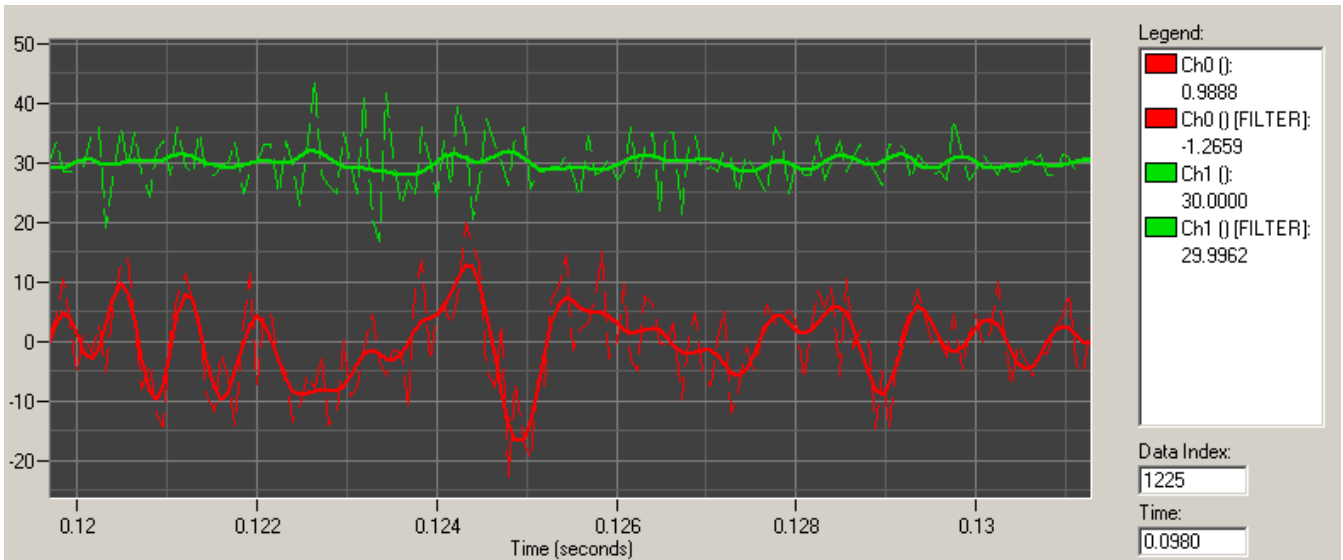
. The on-screen cursor (blue) will track the progress through the graph.

Data Filtering

Graphed data can sometimes exhibit noise, especially when graphing velocity or acceleration. Applying a data filter can help to smooth noisy data. To apply a smoothing data filter, select a desired level of smoothing from the Data Filter drop-down box. The various options are relative smoothing values. There is no absolute scale. For greater smoothing, select a higher percentage, for less smoothing, select a lower percentage until you obtain the desired results. The data filter selection is applied to all graph lines.



When a data filter is selected, each graph line is graphed twice. The dashed graph is the original un-filtered data. The solid bold graph is the filtered data. The legend will indicate "FILTER" for the filtered values.



Saving and Reloading your Work

Overview	143
i-SPEED Software File Formats	143
Setting the Frame Rate in Saved AVI Files	146
Saving Analyses, Calibrations, Comments and Bookmarks	146
Saving from the Strip View	148
Saving from the Working View	151
Loading Video and User Data into i-SPEED Software	153
Moving and Deleting i-SPEED Files on your Computer	155
Saving and Loading in Bayer Format	156



Saving and Reloading your Work

Overview

One of the most important aspects of the *i-SPEED* software is the ability to save and load all the components of your work. The following information may be saved (and later reloaded):

- Video
- User Data
- Motion Analysis
- Image Processing Settings (Control Pro version only)
- User Comments (Control Pro version only)
- Calibration information (Control Pro version only)
- Test configuration information

The *i-SPEED* software uses a video-centric file naming convention. That is, you name the video file during the save procedure and all the other files are saved with the same filename, but different suffix. During the Save As... process, you are asked for one filename. All the various pieces of your test are named this filename with a different 3-letter suffix (e.g. filename.avi, filename.isz, filename.uda, etc.)

Image processing settings, calibration information and analyses can be saved and reloaded independently through their respective tabs. For more information on saving and reloading saved settings, consult the image processing, image calibration and motion analysis sections of this user guide.

When copying or moving files, it is very important to move all files of the same name. Critical information or user-added content may not appear if all files are not moved together.

The *i-SPEED* software will automatically load all files with the same filename in the same directory. You can also load image processing, image calibration and analysis files separately.

i-SPEED Software File Formats

The *i-SPEED* software creates the following file formats, based on what you have used in your measurement.

AVI	Standard Microsoft Windows Video format. <i>i-SPEED</i> software can save video into AVI file format.
HSV	Video file format saved to compact flash (CF) card from the <i>i-SPEED</i> camera.
BMP	Standard bitmap file format. <i>i-SPEED</i> software can save video as a series of sequential BMP images.
TIF	Standard tag image file format. <i>i-SPEED</i> software can save video as a series of sequential TIFF images.
JPG	Standard jpeg compressed file format. <i>i-SPEED</i> software can save video as a series of sequential JPG images.
ISC	<i>i-SPEED</i> software configuration file. Contains all the configuration information about your measurement so that when you load a video file back up, <i>i-SPEED</i> software knows the frame rate, shutter speed, trigger frame and other aspects of the original recording
ISD	<i>i-SPEED</i> software data file. The software creates tab-delimited text files that contain all the user data and associated settings from a measurement.
ISZ	<i>i-SPEED</i> software Comments and GPS/IRG data file. This binary file (un-editable) contains the user comments. User comments can be updated by using the Save Comments... menu command.
XLS	Standard Microsoft Excel file. <i>i-SPEED</i> software analysis can be exported to Excel and saved in this format.
LUT	<i>i-SPEED</i> software image processing look-up table settings. Contains settings for modifying an image using <i>i-SPEED</i> software image processing tools. Look-up table settings are stored separately from other files and can be applied at any time to an image through the Process tab.
CCC	<i>i-SPEED</i> software calibration file. Contains the calibration settings (e.g. origin location, X,Y coordinate system, tilt angle, etc.) about an image. Calibration files are stored separately from other files and can be applied at any time to an image through the Calibrate tab.

IST	<i>i-SPEED</i> software analysis file. Contains the tracked points (location, color, etc.) from a motion analysis tracking procedure. Analysis files are stored separately from other files and can be applied at any time to an image through the Analyze tab.
TXT	Standard Windows text file. Created when analysis is exported to Text.
IBD	<i>i-SPEED</i> software basic data file. Created when user data is captured and saved in the Basic version of <i>i-SPEED</i> software. Data in this file will be loaded and displayed over the video frames in the Control version and displayed in a separate data strip in the Control Pro version.
UDA	<i>i-SPEED</i> camera native configuration and data file. This file is generated by the <i>i-SPEED</i> Camera when storing captured events onto a compact flash (CF) card. It contains record settings and user data. These files will automatically be read and displayed by <i>i-SPEED</i> software.
LENS	<i>i-SPEED</i> software lens distortion coefficients file. This file is generated by the Lens Distortion Correct window in the Control Pro version of software.

Video file types

Video may be saved as either one continuous movie in the standard Microsoft Windows video (.AVI) format or as a sequence of individual image files. The *i-SPEED* software allows you to save individual frames as bitmap (BMP), TIFF (TIF) or JPEG (JPG) formats. For example, you can save one 2000 frame video sequence to disk as one AVI movie or as 2000 sequential, individual BMP images.

You can also load files in one format and resave them in another format.

If you elect to save a video as a sequence of image files, *i-SPEED* software will append an underscore and a frame number to the file name you select. Therefore, you should avoid using filenames that end in numbers or contain underscores and numbers. To avoid confusion, *i-SPEED* software will display a confirmation dialog containing the pattern of image filenames that will be saved. Please check the resulting pattern to see if it matches your desired naming/numbering scheme.

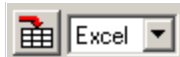
If, during the save process, you select an image file that is already a part of a sequence, *i-SPEED* software will prompt you asking if you wish to overwrite the existing sequence. If you select **OK**, *i-SPEED* software will delete the entire selected sequence of image files, and then save the new sequence of images. Use caution when over-writing a sequence of image files, ALL image files matching the pattern selected will be deleted. Pay close attention to the pattern displayed in the confirmation dialog when over-writing an existing sequence.

Data file types

User data is saved in a universal ASCII text format for easy loading by third-party software packages for data analysis.

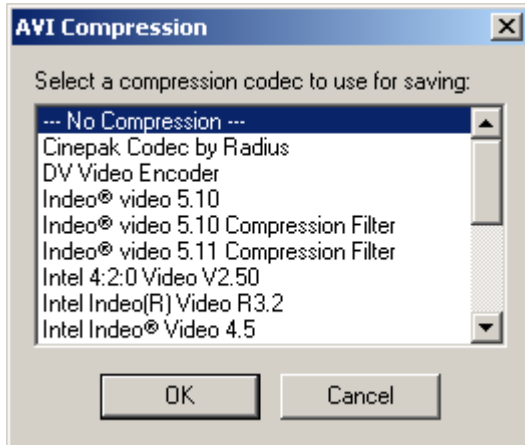
Saving vs. Exporting

The *i-SPEED* software provides the ability to export motion analysis results to either Excel or a text file (see the section on Motion Analysis). The process of Exporting is different than saving – it opens a separate software package (in this case Excel or WordPad) and populates that software with data. In Excel, the data is not saved until the software is closed or the user clicks on the Save As... menu item.

To export motion analysis data, set the export destination to Excel or to Text from the drag down menu box on the Action Toolbar in the Analyze tab (Working View), and click the Export button. .

Applying Compression Codecs to AVI Video Files

If you have elected to save a video to an AVI file, *i-SPEED* software will automatically present you with the video compression dialog window shown at right. This window provides you with the opportunity to apply a compression codec to the AVI movie. Compression codecs are used to compress the file (make it smaller in size). Most codecs are lossy, and will degrade the image quality. You will not be able to recover the original quality images from a compressed AVI.

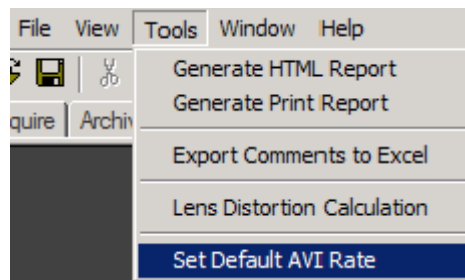


The settings for the Video Compression window are as follows:

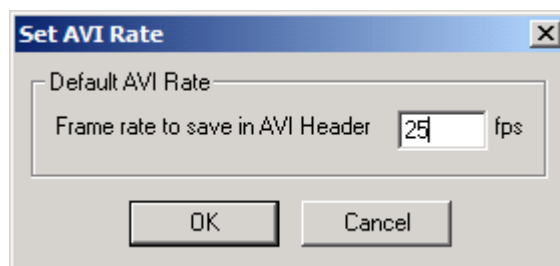
Compressor	The compression codec that you wish to apply. The various codecs listed in this dialog are provided by your operating system. <i>i-SPEED</i> software searches your operating system for the loaded codecs and displays them in a single list box. The default value is no compression. It is highly recommended that you save using the "No compression" option.
Compression Quality	Some codecs allow you to balance the quality vs. size. If the selected codec allows this feature, adjust the quality value.
Key Frame	Some codecs allow you to set the key frame increment. If the selected codec uses key frames in its algorithm, set the increment between key frames.
Data Rate	Some codecs allow you to set the data sample rate. If the selected codec uses data rates in its algorithm, set the rate here.
Configure	If the selected codec requires additional configuration settings, click on this button to adjust them.

Setting the Frame Rate in Saved AVI Files

Every AVI file contains a frame rate value in the header of the file that controls the playback rate in conventional media players such as Windows Media Player. By default, AVI files will be saved with a playback frame rate of 25 fps. To change the default rate, click on **Tools - Set Default AVI Rate**.



Enter the desired frame rate in the dialog that appears.



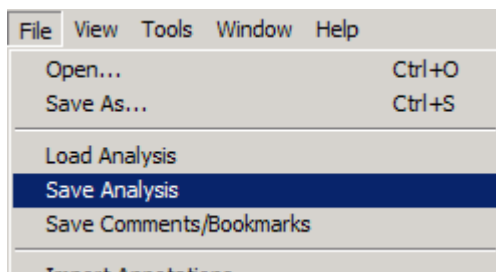
This rate will be used for all subsequent AVI files that are saved. The rate is stored so that it retains the same value when the software is run again.

Saving Analyses, Calibrations, Comments and Bookmarks

One of the features of *i-SPEED* software is the ability to save and load important information about your measurement and motion analysis. This information is invaluable for a later understanding of the measurement. It is also invaluable for apply the results of one test to another for comparison.

Saving and Loading.IST Analysis Files (Control Pro version only)

You can save your analysis files separately. Analysis files are saved using the File  Save Analysis menu item. Analysis files can be loaded using the File ' Load Analysis menu item.

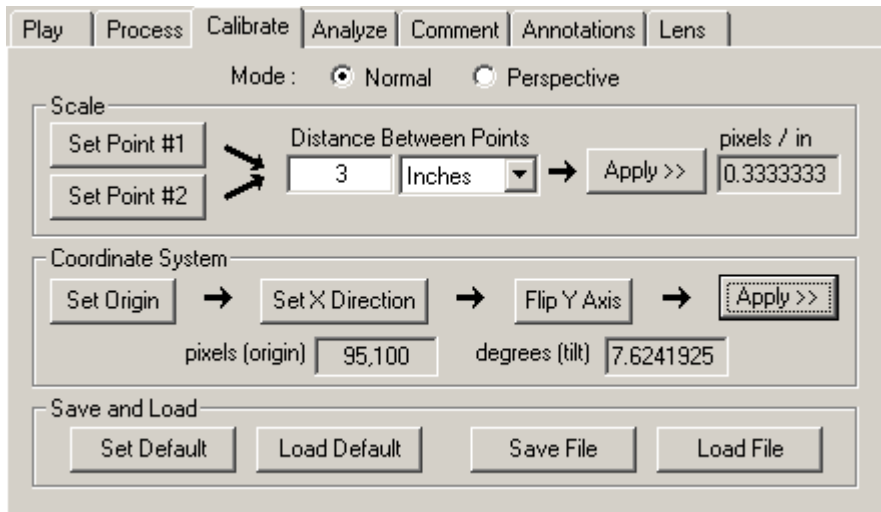


Analysis files contain tracked point information. The ability to save tracked point information for later overlay on another image is valuable for comparing current results with previous results. This ability to compare results is invaluable for applications where current measurements are used to determine a deviation from a perfect motion.

Analysis files are saved in an *i-SPEED* software.IST format. This file format is compressed and readable only by *i-SPEED* software.IST files cannot be edited.

Saving and Loading.CCC Calibration Files (Control Pro version only)

You can save your image calibration files separately. Calibration files are saved using the Save File button on the Calibrate tab in the Working View. Likewise, Calibration files can be loaded by using the adjacent Load File button.

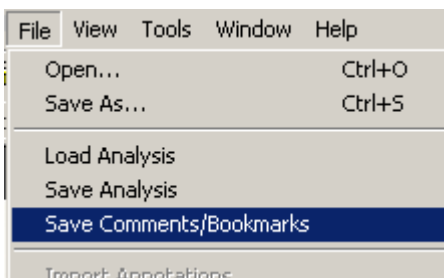


Calibration files contain information relating to the origin (0,0) and orientation of the X,Y calibration system. The ability to save calibration information for later overlay on another image is valuable for simplifying repetitive tests. For example, if you have the camera placed in the same location for a test that you are performing repetitively, you can very quickly apply the same calibration file to the image for analysis. This step saves the time and effort associated with manually setting the origin and X,Y axes.

Calibration files are saved in an *i-SPEED* software.CCC format. This file format is compressed and readable only by *i-SPEED* software.CCC files cannot be edited.

Saving Comments/Bookmarks

You can save your comments and bookmarks into the .ISZ file at any time by clicking on the File ' Save Comments/Bookmarks menu item.

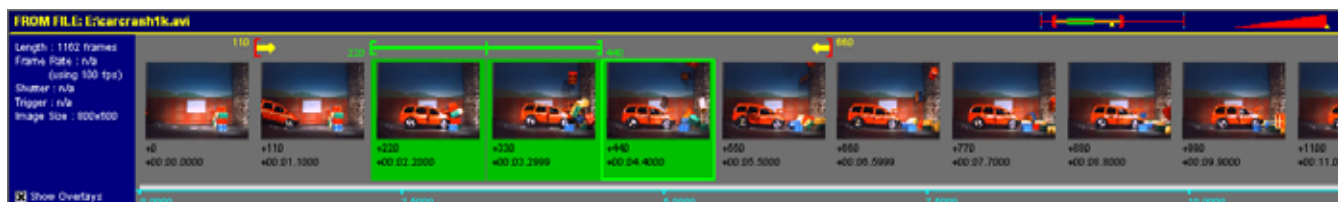


Comments and Bookmarks are saved in the .ISZ binary file. This file format is compressed and readable only by *i-SPEED* software. .ISZ files cannot be edited.

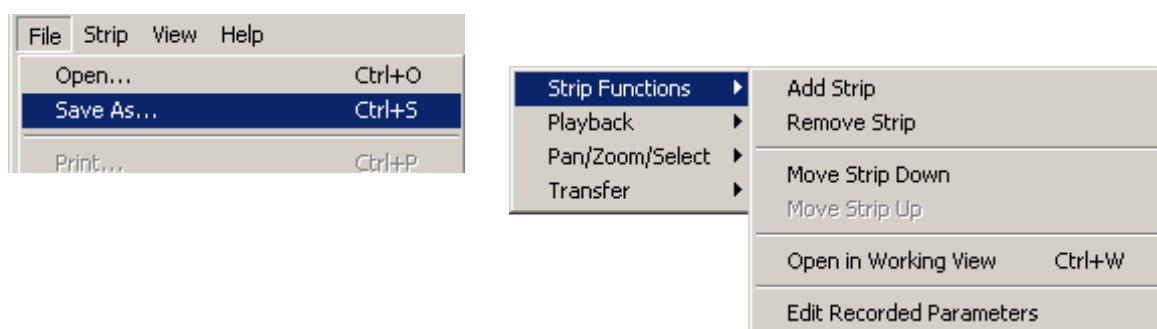
Saving from the Strip View

You can save directly from within Strip view.

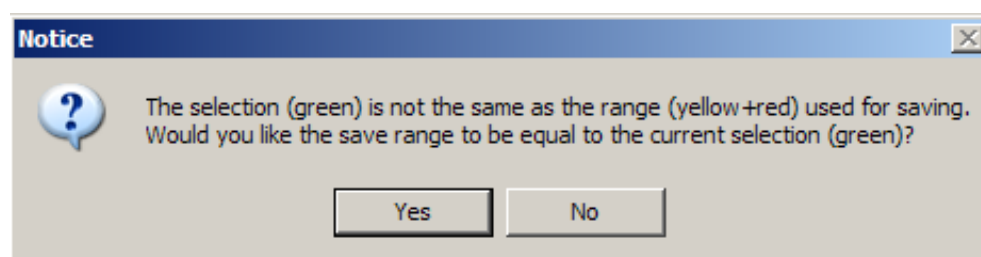
- 1 Set the range you wish to save. The range is the set of frames that are within the yellow and red end markers. The range may be modified in the Strip View by dragging the yellow and red end markers above the video frames or in the Working View by dragging the red end markers in the Play tab controls. The range may also be set to the current selection (shown in green) by using the context menu, or hitting the "Space" bar.



- 2 From the menu bar, select File ' Save As...(as shown below left). Alternatively, you can select this function through the right-click contextual menu using the Strip Functions ' Save As... shortcut.

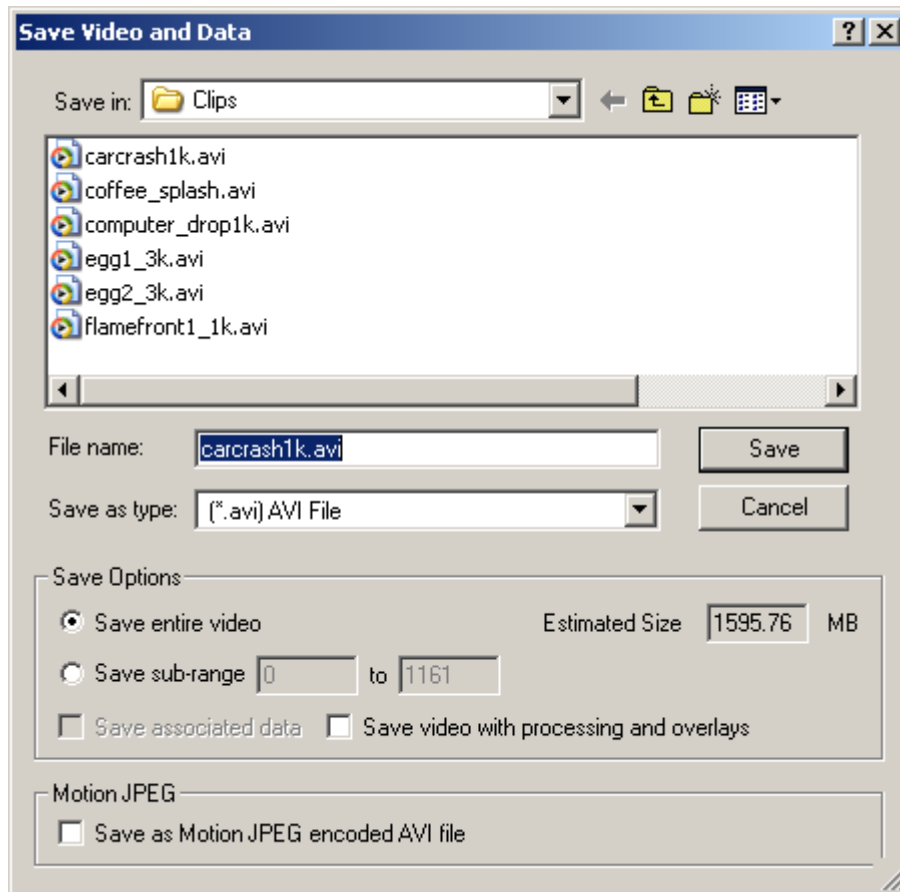


- 3 If the green highlighted current frame selection is not the same as the range set in step 1, *i-SPEED* software will ask you whether you wish to override the range that had been previously set with the green highlighted selection. The notice that appears is as follows:



By clicking the Yes button, the Range is set to the current selection (as if the Space bar had been hit). By clicking the No button, the original Range is preserved.

4 The following Save Video and Data dialog will appear:

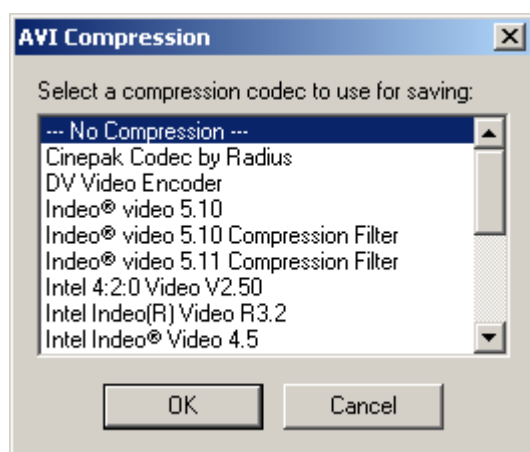


The settings for this Save As... window are as follows:

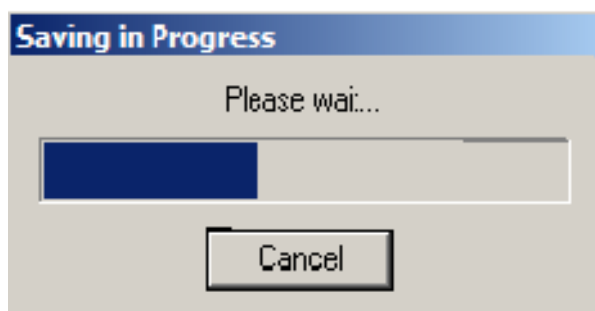
File Name	The Microsoft Windows compatible file name and associated folder location on the hard drive or network.
File Type	Select the desired file type from the drag down list. The options are AVI (Microsoft video) or a sequence of individual frames, each frame being saved in the BMP (bitmap), TIF (tag image file format) or JPG (JPEG) format.
Save entire video	Save the entire collection of frames from the current video clip.
Save sub-range M to N	Save a range of the frames, designated by frame numbers. The range can be set using the Range selection in Strip View or the end markers in Working View. You may also type in the range in the white boxes.
Estimated Size	Shows the estimated file size based on <i>i-SPEED</i> saving conventions.
Save associated data	Saves the associated data as filename.ISD. To save associated data with the video, select the SAVE ASSOCIATED DATA checkbox on the bottom of the Save As screen prior to saving. If the box is grayed, then <i>i-SPEED</i> PC Software has determined that there is no data available to save.

5 Click on the Save button.

- 6 If you have selected to save in the AVI movie format, the *i-SPEED* software will ask if you desire to apply a compression codec as it saves your file.



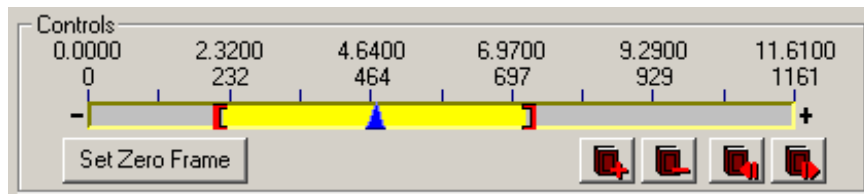
- 7 Apply a codec per the above described guidelines and click OK.
- 8 The save process begins. The progress indicator appears.



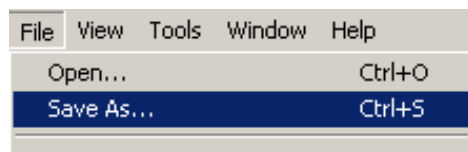
Saving from the Working View

You can save directly from within Strip view.

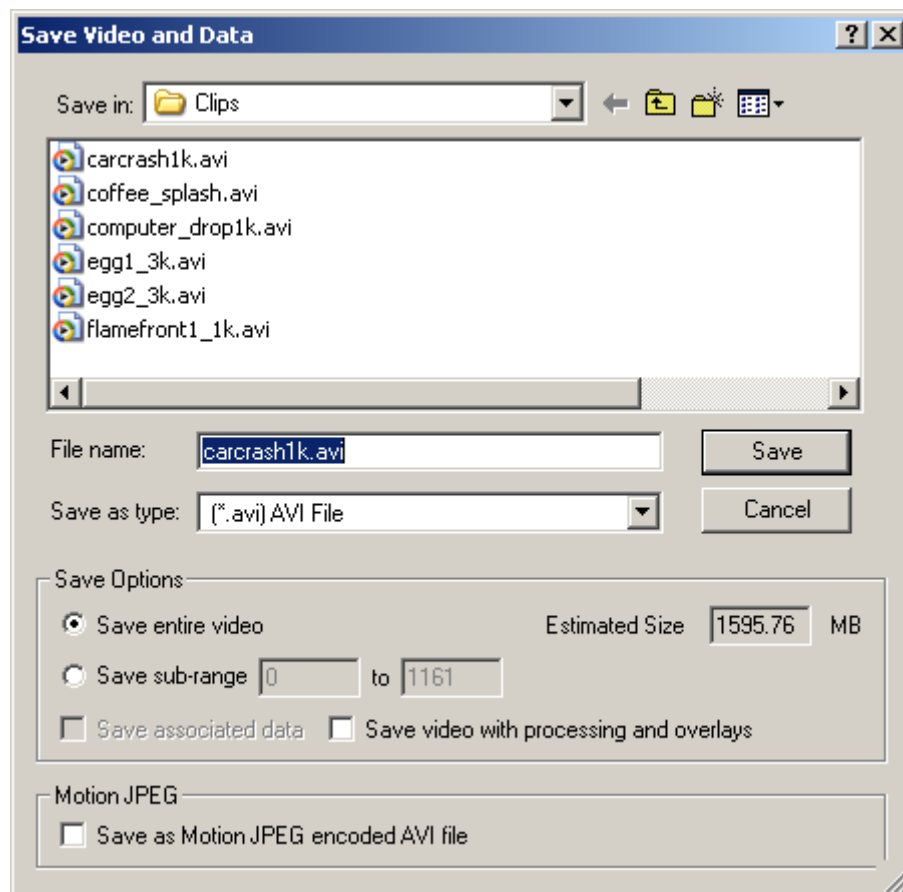
- 1 Set the range you wish to save. The range is the set of frames that are within the yellow and red end markers. The range may be modified by dragging the red end markers in the Play tab controls.



- 2 From the menu bar, select File ' Save As...(as shown below).



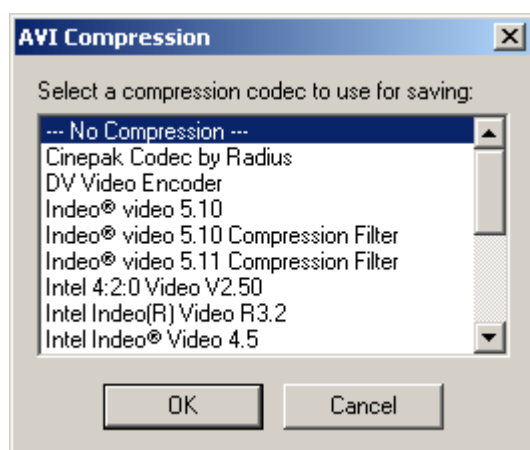
- 3 The following Save Video and Data dialog will appear:



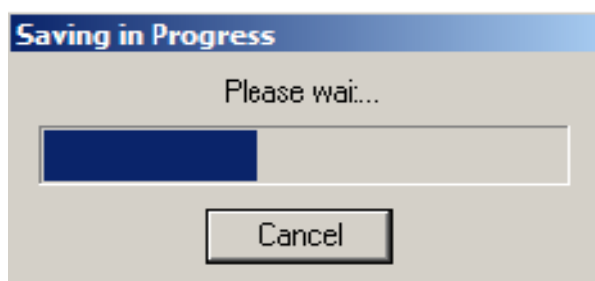
The settings for this Save As... window are as follows:

File Name	The Microsoft Windows compatible file name and associated folder location on the hard drive or network.
File Type	Select the desired file type from the drag down list. The options are AVI (Microsoft video) or a sequence of individual frames, each frame being saved in the BMP (bitmap), TIF (tag image file format) or JPG (JPEG) format.
Save entire video	Save the entire collection of frames from the current video clip.
Save sub-range M to N	Save a range of the frames, designated by frame numbers. The range can be set using the Range selection in Strip View or the end markers in Working View. You may also type in the range in the white boxes.
Estimated Size	Shows the estimated file size based on <i>i-SPEED</i> saving conventions.
Save associated data	Saves the associated data as filename.ISD. To save associated data with the video, select the SAVE ASSOCIATED DATA checkbox on the bottom of the Save As screen prior to saving. If the box is grayed, then <i>i-SPEED</i> software has determined that there is no data available to save.

- 4 Click on the Save button.
- 5 If you have selected to save in the AVI movie format, the *i-SPEED* software will ask if you desire to apply a compression codec as it saves your file.



- 6 Apply a codec per the above described guidelines and click OK.
- 7 The save process begins. The progress indicator appears.



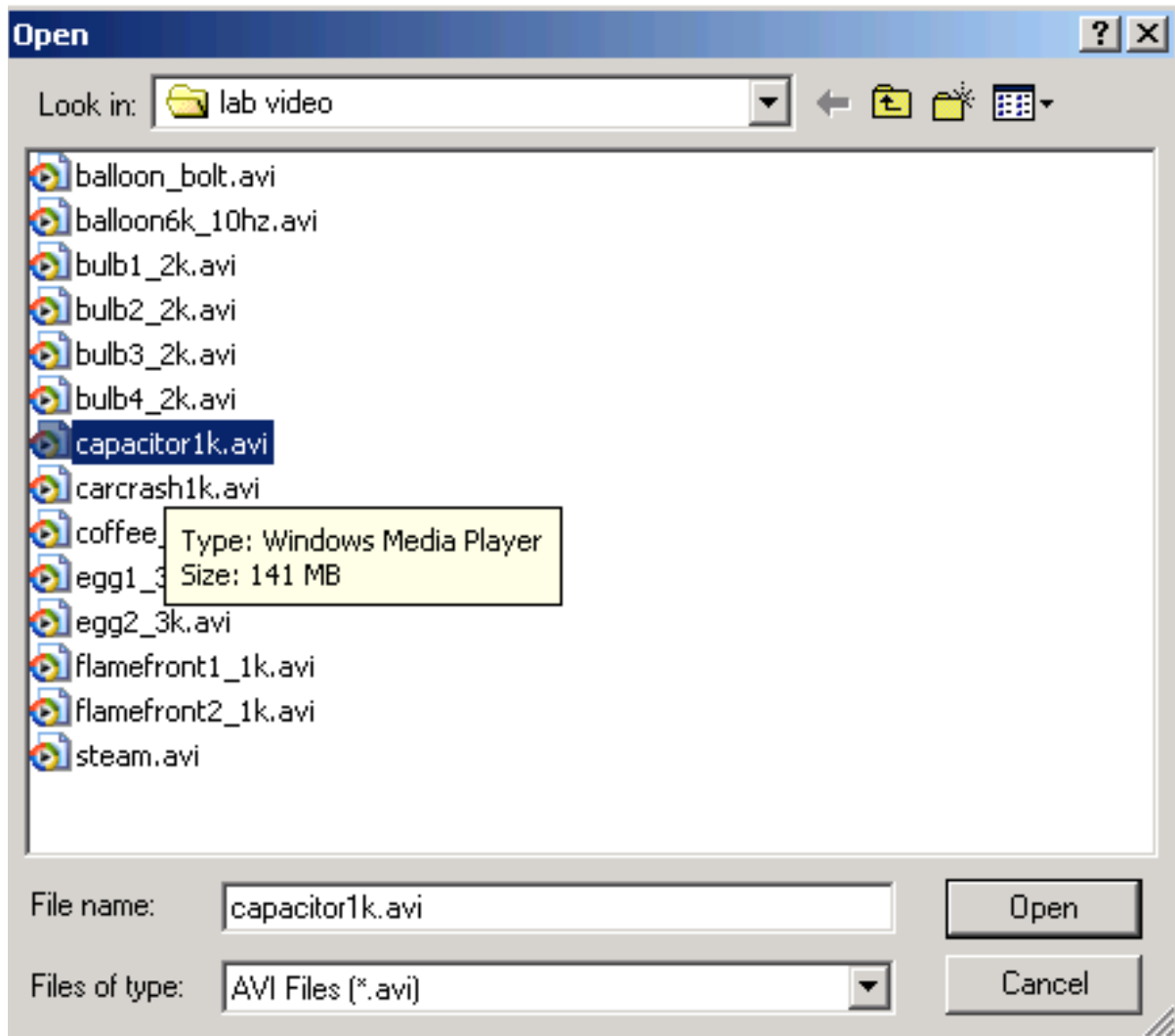
Loading Video and User Data into *i-SPEED* Software

There are two methods of reloading previously saved work files – the standard Open window and the Archive Browser window.

Loading through the Open File menu

To load a previously saved video:

- 1 Select File ' Open from the menu.
- 2 The Open dialog appears:

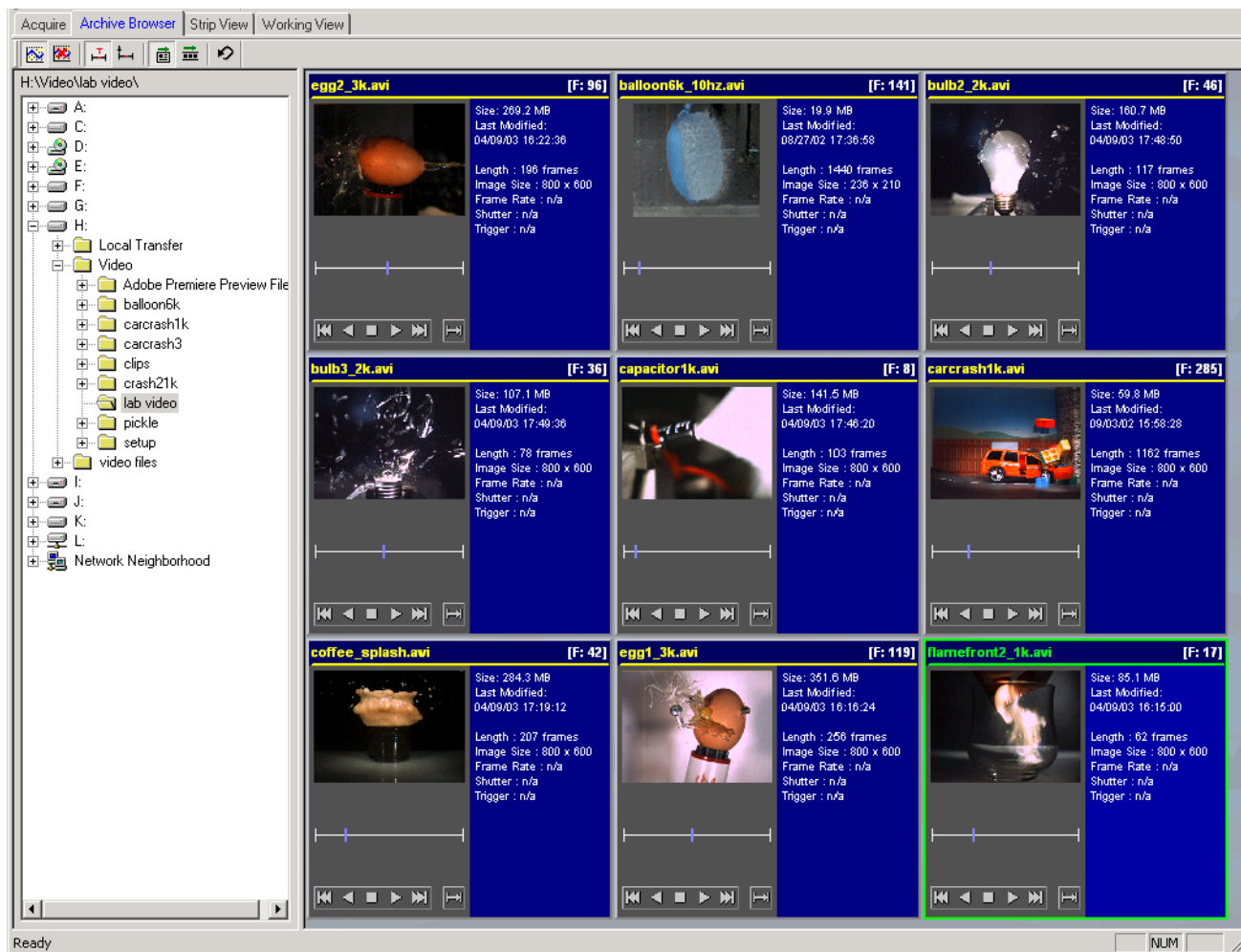


- 3 Either type in or select the filename of the file to load. For loading a sequence of image files, you can click on any image in the sequence and *i-SPEED* software will load the complete sequence of image files that match the same pattern
- 4 Click on the Open button.

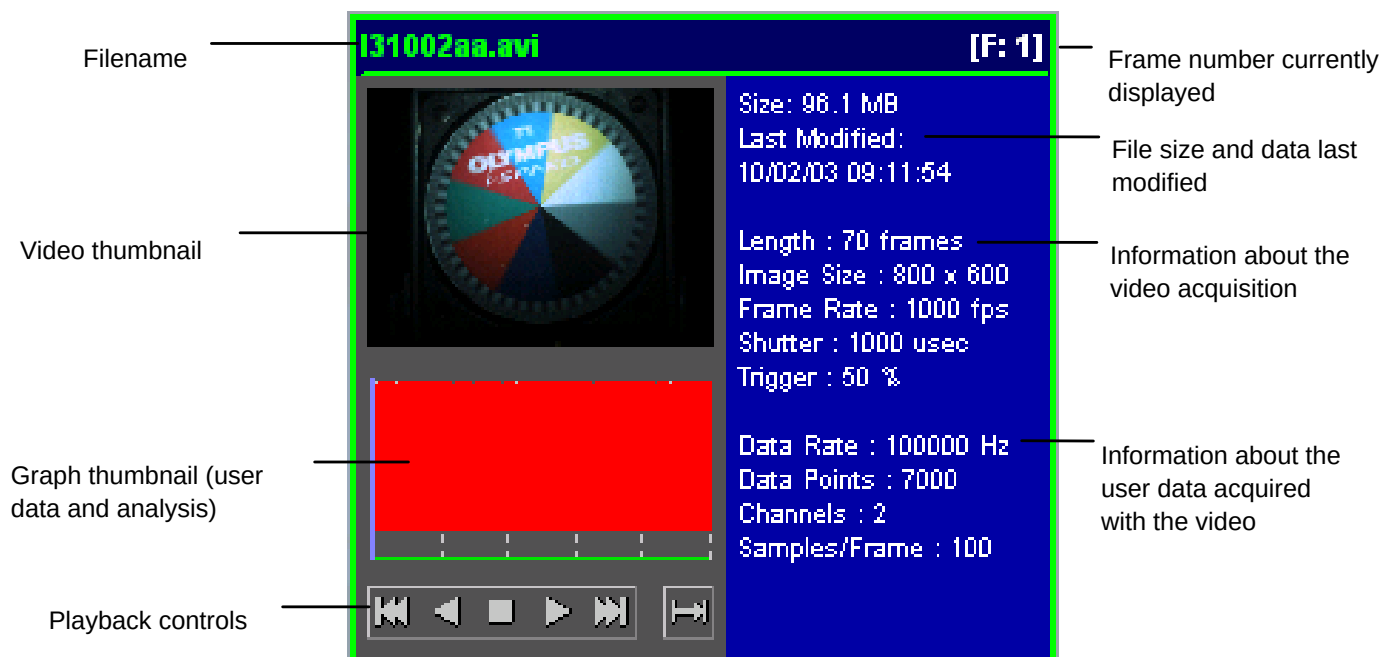
If video (in an AVI or an image sequence) and associated data were originally saved together, then they will share the same filename. Only the video filenames are shown in the Open dialog. The *i-SPEED* software will always look for associated data files; if found, data files are automatically opened with the video file.

Opening through the Archive Browser Window

The Archive Browser provides a very convenient mode of reviewing all your work before opening it. The Archive Browser presents a complete Windows Explorer panel along the left side of the screen and a thumbnail mosaic of the video acquisitions in the main desktop window.



The Archive Browser displays all the files within the currently selected folder, based on video name. Each pane of the Archive Browser contains the following information:



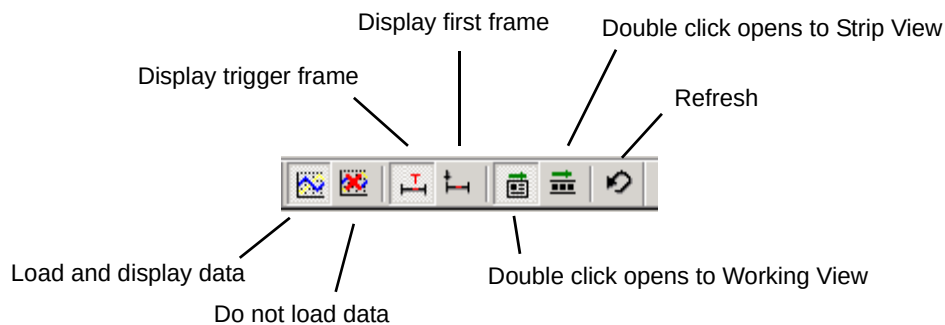
To select a file to open with the Archive Browser:

- 1 Explore your hard drive to the folder of interest.
- 2 Use the playback controls to browse the thumbnail view of the file or alternatively use the contextual (right click) menu to control playback of the video and data.



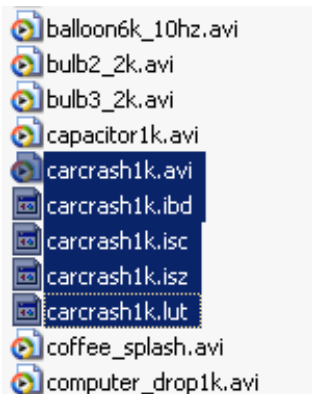
- 3 Double click within the image to move the video and data directly to the Strip view or right click within the image to access the contextual menu. Select Open in Strip View or Open in Working View.

The appearance of and the speed at which the Archive Browser downloads refreshes information can be adjusted by using the icon bar at the top of the Archive Browser window:



Moving and Deleting *i-SPEED* Files on your Computer

When moving files created with the *i-SPEED* software, you must move all files of the same filename to preserve the full measurement. Depending on how the measurement was saved, there may be many files. All the files must be selected and moved together.



Likewise, if deleting files off a hard drive to save space, it is recommended to remove all files with the same filename. Files that are orphaned from an AVI (e.g. they do not have the same filename as an AVI file) are not useable in the *i-SPEED* Software.

Critical information or user-added content may not appear if the associated support files are not in the same folder as the video file(s).

Saving and Loading in Bayer Format

What is Bayer?

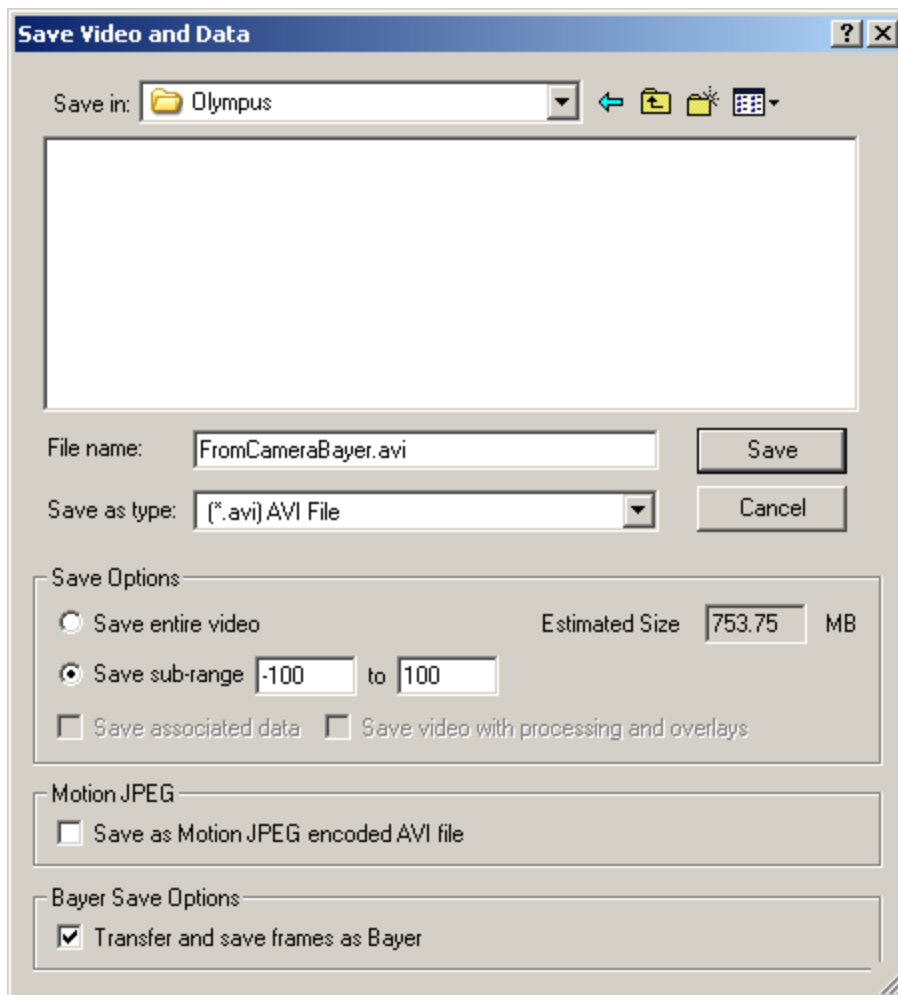
When using the *i-SPEED* Color Camera, the *i-SPEED* PC software is capable of saving and loading videos in raw Bayer format.

Bayer format is an 8-bit per pixel image format that stores an array of red, green, and blue pixels in a special arrangement. Bayer formatted images can be converted back to 24-bit color images using special Bayer conversion functions. The advantage of storing in Bayer format is the reduced size of the resulting files (1/3 the size of color) and the ability to change the gains used in converting from Bayer format to color. The disadvantage is the increased processing time required for converting and displaying the Bayer images in color during playback.

Due to the specialized nature of the Bayer format, you cannot save Bayer images to a compressed format (JPEG, MJPEG, or AVI with a codec). The resulting images will not be rendered correctly in color if compression has been applied.

Saving in Bayer Format from a Recording

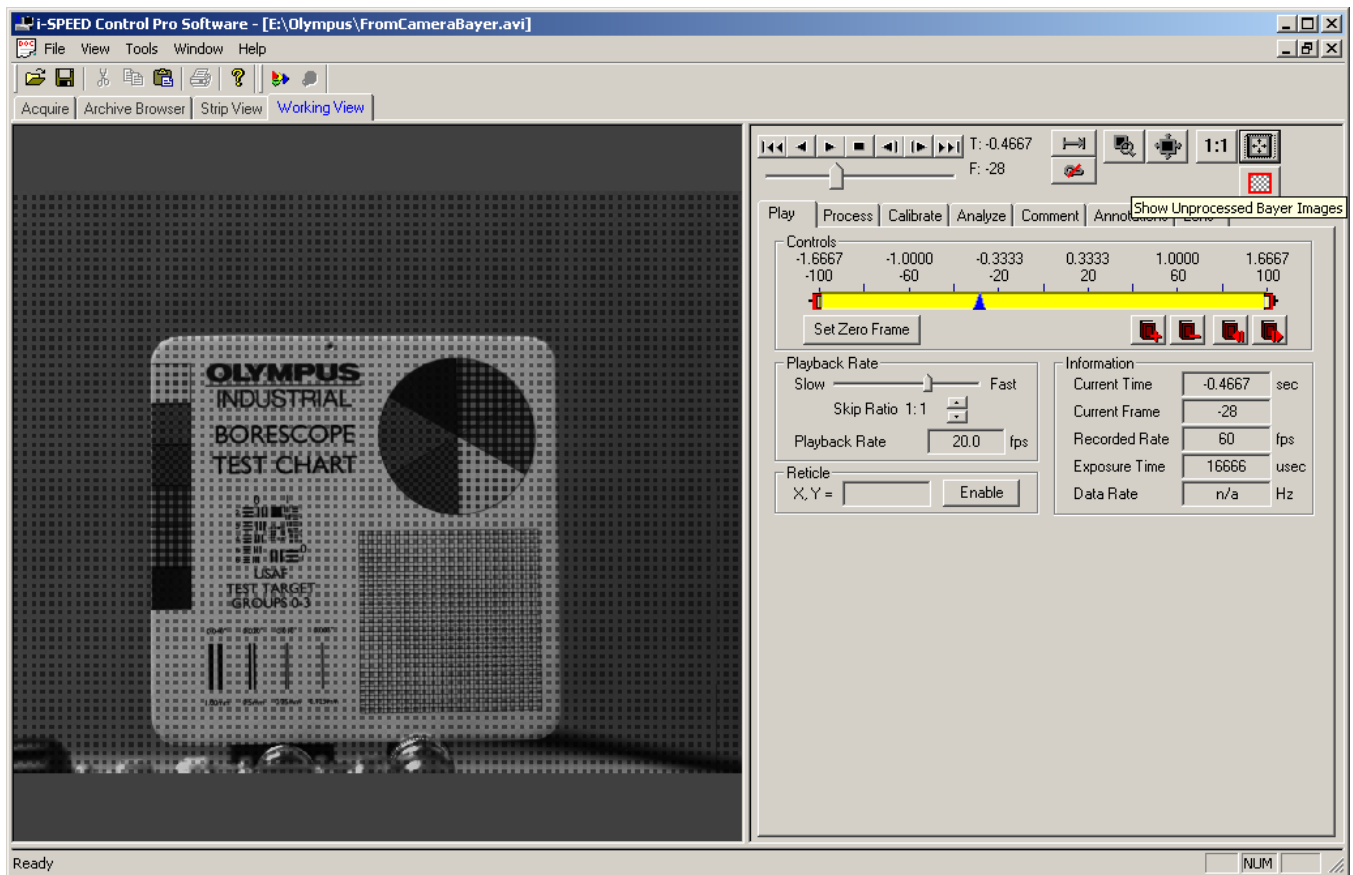
When saving a recording from a color *i-SPEED* camera, the Save As. dialog will have an additional option at the bottom for saving in Bayer.



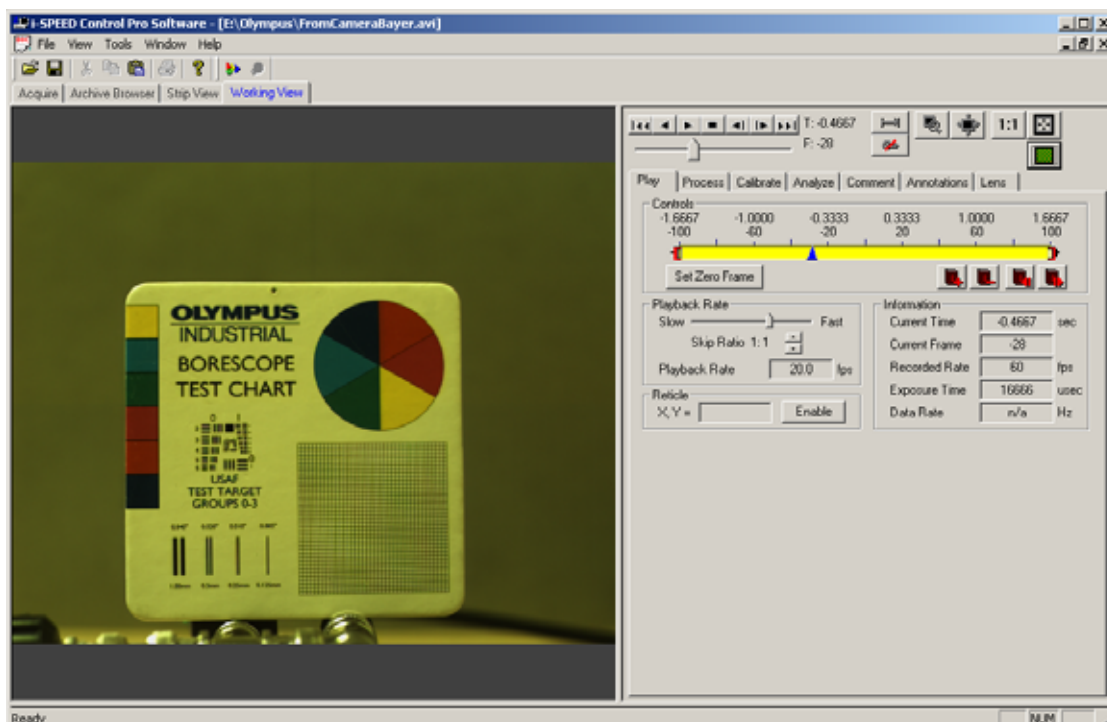
Please note, when a video is saved in Bayer format, all images are re-transferred directly from the camera. Any frames that have already been transferred to the transfer cache will be ignored, since they are not in Bayer format.

Reloading a File Saved in Bayer Format

Once a file has been saved in Bayer format, when it is reloaded, the configuration file (.ISC) will inform the *i-SPEED* PC Software that the video is in Bayer format. All thumbnails in the Strip View will be shown in Bayer format (to reduce processor load). Images in the Working View may be viewed in Bayer or in color format by clicking on the “Show Unprocessed Bayer Images” button in the control panel section, as shown below:

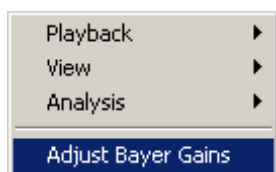


When displaying processed Bayer images in the Working View, the title bar will display the message: “Please Wait: Converting Bayer.” for every frame. The speed of the conversion will depend on the speed of your processor. Each frame of the video is converted from Bayer format on-the-fly as needed. To display the image in Bayer format again, click on the “Show Unprocessed Bayer Images” button again.

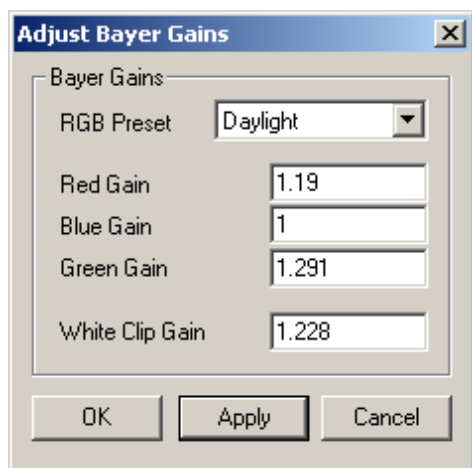


Adjusting Bayer Gains

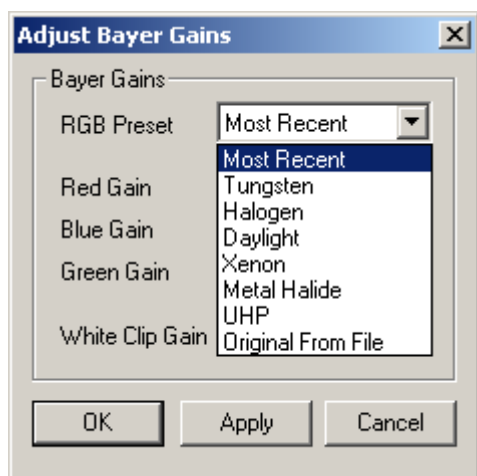
When the video was saved in Bayer format, the current set of white balance gains from the camera was also stored in the configuration file. These gains may be viewed using the context-menu in the Working View window.



The gain values may be adjusted in the dialog that appears.



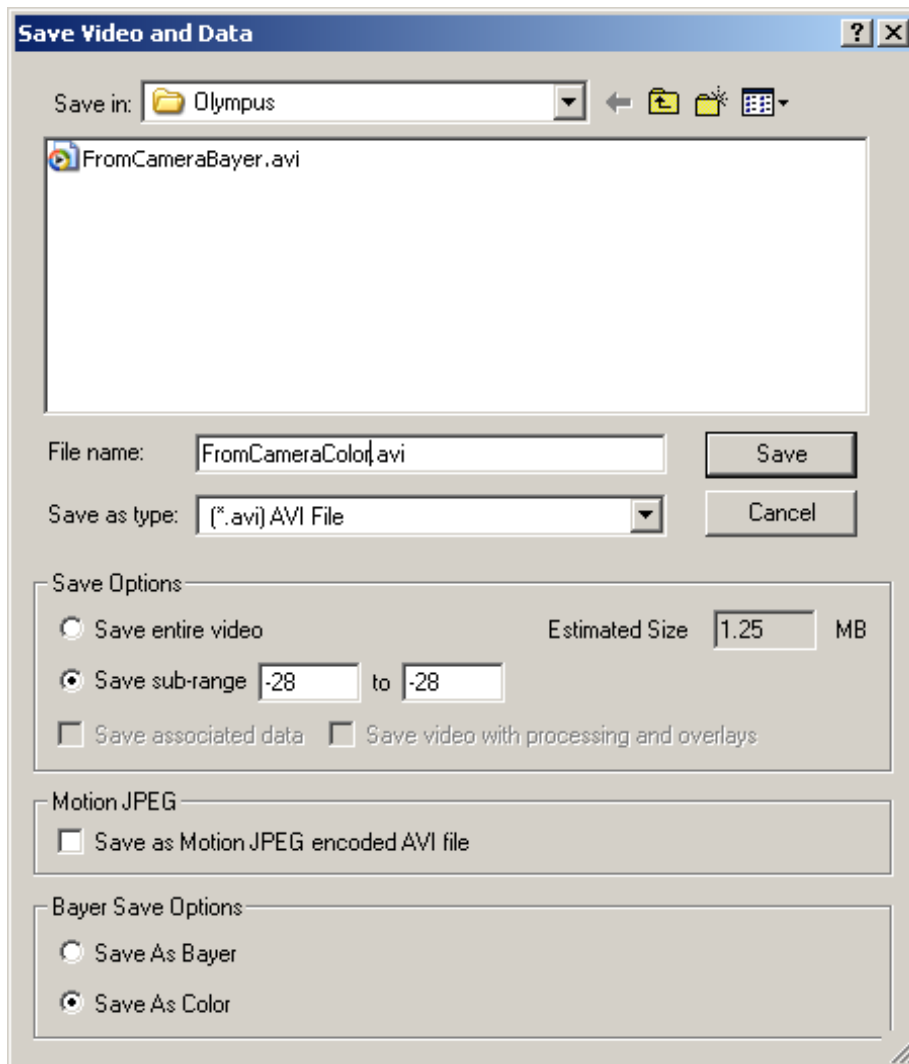
New values may be entered directly or one of the RGB Presets may be selected.



The RGB Presets are the same options as the White Balance options on the camera with the exception of two entries. The "Most Recent" selection will restore the gains to the values when the dialog was first opened. The "Original From File" will restore the gains to the values when the video was first opened.

Resaving Videos in Bayer or Color

A file that has been loaded in Bayer format may be re-saved in Bayer format or in color. The save dialog will have a different set of the Bayer Save Options displayed at the bottom.



If the video is re-saved in Bayer format after modifying the gains, the new gains will be stored with the newly saved video.

Please note, once a video is saved in color, it may not be saved in Bayer. The Bayer to color transformation is an irreversible operation. Do not delete the original Bayer formatted video if you wish to perform the color conversion again.

Data acquisition add-on module

Introduction	161
Differential Sensors	162
Single-Ended Grounded Sensors (Non-Referenced or NRSE)	162
Single-Ended Floating Sensors (Referenced or RSE)	162
Installing the Data Acquisition module	163
Configuring the Data Acquisition Software	164



Data acquisition add-on module

Introduction

The data acquisition module provides more flexibility as to configuring the input channels. Channels are configured based on the type of sensor that is hooked up the input channel and to the calibration information provided with that sensor. This professional data acquisition system provides a complete flexibility to the user for acquiring professional data with video.

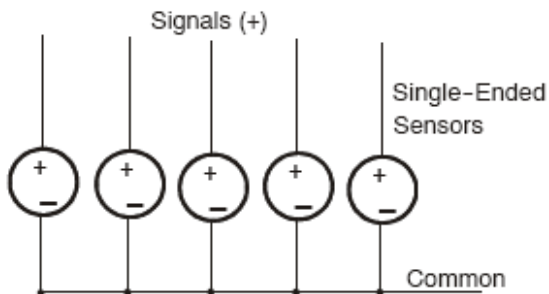
There is no live display of data when using the external data source.

Sensor Types

First, it is important to understand the different types of sensors and gauges that can be connected to the external data box.

Sensors have different characteristics that must be considered when connecting to the *i-SPEED* software 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.



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.

i-SPEED software is designed to work with all these sensor types. The operator must simply instruct the software as to which sensor type is being connected and the software automatically makes all the proper adjustments and switch settings. For example, if you are using a Referenced Single Ended sensor, the *i-SPEED* software 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, *i-SPEED* software knows which terminals to assign to the sensor and makes the appropriate switch changes to measure the difference between + and – leads.

Differential sensors are always recommended for better signal integrity. Single ended sensors are recommended only under controlled conditions, the most important of which is that you need more channels than are currently available. If your signal environment is the least bit noisy, your cable lengths exceed 3 meters (10 ft), or your signal level is less than 1V P-P, then it is highly recommended that you use Differential sensor types with two leads.

In the following sections, each type of sensor is summarized.

Differential Sensors

In this configuration, the Differential sensor has two leads – one positive (+) and one negative (-). Most commercial data acquisition systems are designed in a Differential configuration, especially if significant signal conditioning is required.

The negative lead of the sensor may be tied to earth or building ground and is therefore already connected to a common ground point with respect to the board (assuming that the computer is plugged into the same power system). This is termed “Grounded” or “Ground Sourced”. In this configuration, the little rocker switch under the BNC jack on your external data box should be placed in the “GS” position.

The negative lead of the sensor may not be tied to earth or building ground and is therefore “floating” with respect to the amplifier. Therefore, to reduce the effects of signal drift relative to the board ground, you must tie the ground reference of the floating signal to your board's analog input ground through a bias resistor. In essence, you are “biasing” the drift toward ground. Technically, you should bias both the signal lead and the negative lead, but little improvement is gained by adding a bias resistor to the positive lead. You can add this bias automatically by sliding the little rocker switch under the BNC jack on your external data box to the “FS” position.

Single-Ended Grounded Sensors (Non-Referenced or NRSE)

Single-Ended sensors have one wire that carries the signal (+) and one common wire. Typically, single ended sensors are used in specialized applications such as crash testing where many additional sensors are required and the test environment is very well controlled. If you are using single ended sensors, you may tie the common wires of the sensors together.

On a Grounded Single-Ended sensor, the common lead of the sensor is also tied to earth or building ground and is therefore already connected to a common ground point with respect to the board (assuming that the computer is plugged into the same power system). However, since the differential amplifier needs both a positive (+) and negative (-) input, the common lead must be tied to a point on the External Box called the “AISENSE” – an internal ground sensing point.

When using Single-Ended Grounded sensors, the common lead gets tied to AISENSE at the BNC Breakout Box. All other connections and switches are handled automatically by the *i-SPEED* software.

Single-Ended Floating Sensors (Referenced or RSE)

Single-Ended sensors have one wire that carries the signal (+) and one common wire. Typically, single ended sensors are used in specialized applications such as crash testing where many additional sensors are required and the test environment is very well controlled. If you are using single ended sensors, you may tie the common wires of the sensors together.

On a Floating Single-Ended sensor, the common lead of the sensor is not tied to earth or building ground and is therefore floating relative to the ground of the amplifier. Therefore, to reduce the effects of signal drift relative to the board ground, you must “reference” the floating signal to the amplifier analog input ground through a bias resistor. In essence, you are “biasing” the drift toward ground. Technically, you should bias both the signal lead and the negative lead, but little improvement is gained by adding a bias resistor to the positive lead.

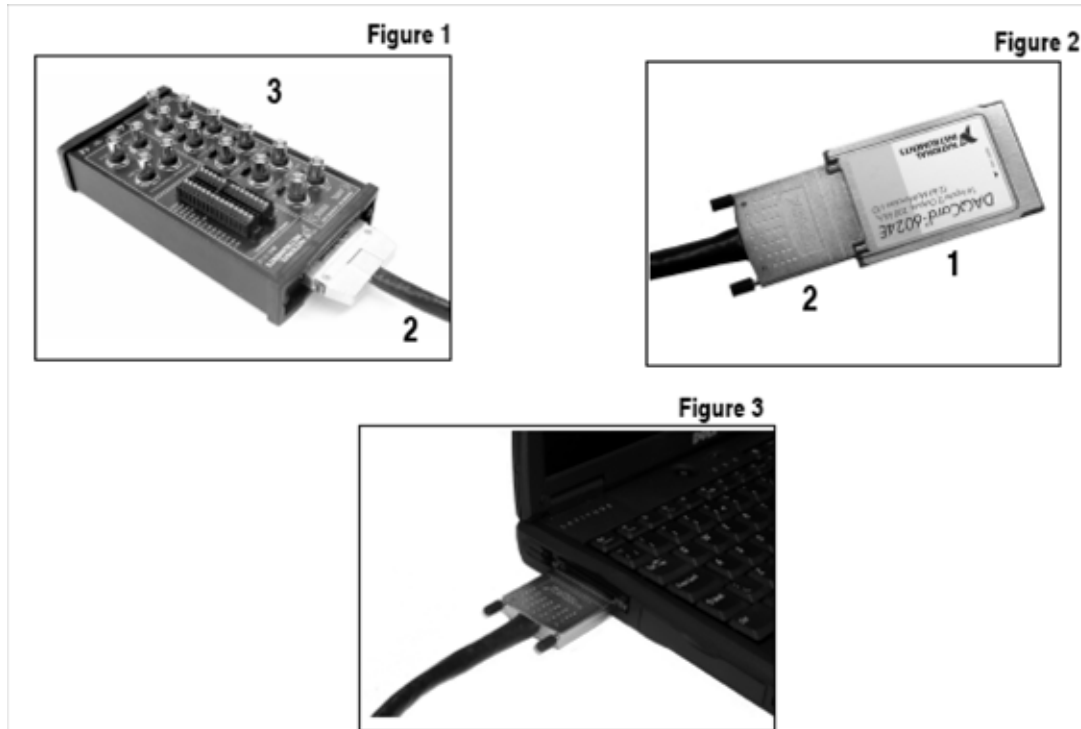
You must add the bias resistor yourself, even if you are using the BNC Breakout Box (Single-Ended sensors do not use the negative lead of the BNC jack). For sources with low impedance, no bias resistor is needed and you may simply connect the common lead(s) to the AIGND terminal on your External data box directly.

For sources with large impedance, however, you must put a bias resistor in-line to de-couple the noise from the amplifier. Place a bias resistor of minimum 100x the equivalent source impedance between the negative terminal (common) of the sensor and the AIGND terminal on your External data box.

Installing the Data Acquisition module

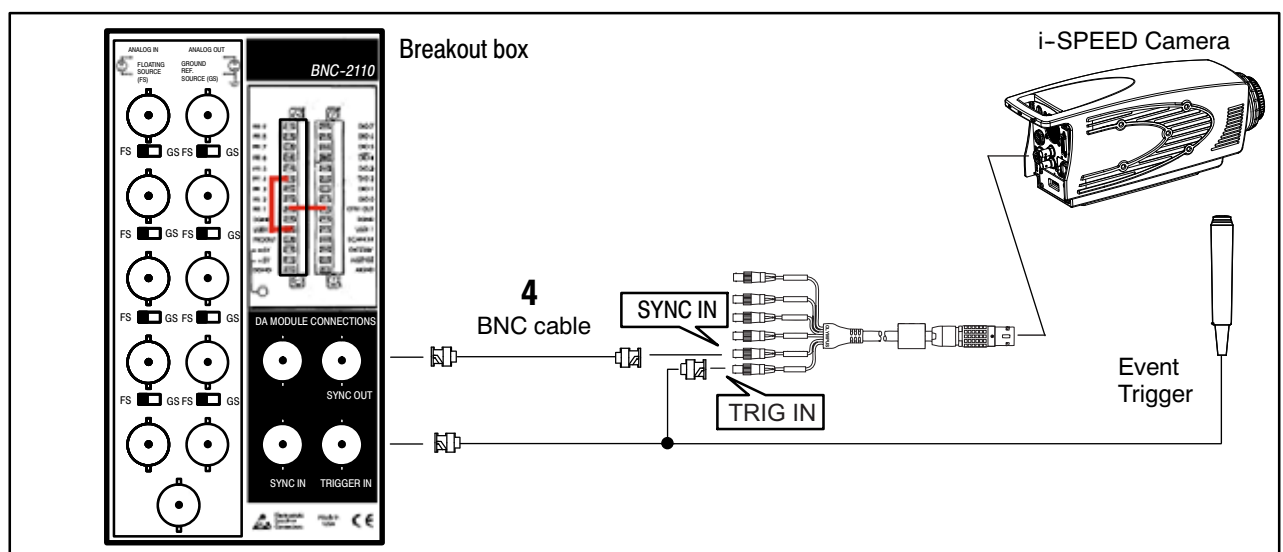
Hardware installation

- 1 Connect the 1m data cable (2) to the breakout box (3) - Figure 1.
- 2 Connect the other end of the 1m data cable (2) to the DAQ card and secure - Figure 2.
- 3 Insert the data cable with DAQ card into the PCMCIA port in the PC or laptop - Figure 3.



- 4 Connect the BNC cable (4) to the breakout box input labelled 'SYNC OUT' and to the i-SPEED camera connector labelled 'SYNC IN'. Connect the event trigger to the breakout box input labelled 'TRIGGER IN' and to the i-SPEED camera connector labelled 'TRIGGER IN'.

NOTE: If connecting multiple cameras, the BNC connector must be connected to each camera 'SYNC IN' connector. The event trigger must also be connected to each camera 'TRIGGER IN' connector in addition to the breakout box.



Device driver installation

- 1 Insert the "NIDAQ" driver CD from National Instruments (5). 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. The NI-DAQ Installation screen appears, follow the on-screen instructions.
- 2 Reboot the system when driver installation is complete.

Configuring the Data Acquisition Software

To set up your external data acquisition software:

- 1 Connect your external data box to the computer.
- 2 Select the Data tab.
- 3 Select the External DAQ source.

For each channel of data, perform the following steps:

Data Acquisition Settings

DAQ Configuration

DAQ hardware being used: BNC Breakout Box(es)

Analog Inputs

On	Channel	Input Mode	Label	Units
☒	2	RSE	Vref	V

Lower Limit: 0 Upper Limit: 10 Factor (units/volt): 1 Offset (units): 0 Plot Color: [Yellow] Set Update

Chan	Input M...	Lowe...	Uppe...	Label	Factor	Offset	Units
0	DIFF	-5.00	5.00	Pressu	1.0000	0.00	psi
1	NRSE	-10.00	10.00	Speed	1.0000	0.00	m/s
2	RSE	0.00	10.00	Vref	1.0000	0.00	V

Set As Default OK

- 4 Select the channel number that you will be connecting your sensor. Start with Channel 0 and proceed incrementally upward. If a channel is not available (e.g. in use), the software will not allow you to input any input parameters. Skip all unusable channels.
- 5 Connect your sensor to the data box.
- 6 Select the type of sensor input from the software.
- 7 Select the sensor parameters (gain, offset, label, etc.)
- 8 Click on update button.

The input parameters are defined as follows:

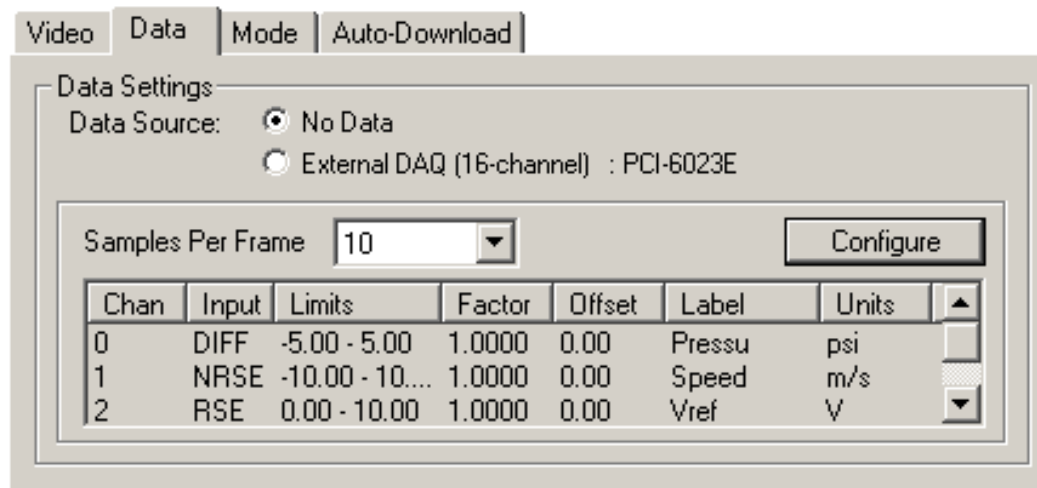
Channel	<i>i-SPEED</i> automatically determines and displays which channels are available based on which type of sensors you have already configured. Always start with Channel 0 and check the box to enable that channel.
Input Mode	The type of sensor you are connecting to that channel. The three options here are DIFF, RSE and NRSE.
Label	A short label for the analog input channel.
Units	A short field for placing units in the graphs.
Lower Limit	The lower limit, in volts, that you expect to see from your sensor. <i>i-SPEED</i> adjusts the dynamic range of the input from Lower Limit to Upper Limit based on the user inputs.
Upper Limit	The upper limit, in volts, that you expect to see from your sensor. <i>i-SPEED</i> adjusts the dynamic range of the input from Lower Limit to Upper Limit based on the user inputs.
Factor	The scale factor to be applied by the graphing and saving routine 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
Plot color button	The color of the line to be used in multiple-line graphs. Select this button to bring up the color palette.

Choosing the Data Sample Rate

The maximum data sample rate is 200,000 data points/second. You can acquire data at a much faster rate than you can acquire video. To set the data sample rate:

- 1 Select the Data tab.
- 2 Select the samples per frame rate from the drop-down list.

The total data sample rate is the product of the number of channels times the sample rate per channel. For example, if you have 4 channels active and wish to acquire 10,000 samples per second per channel, the total sample rate is $4 \times 10,000 = 40,000$ samples/second. Likewise, if you have 8 channels active, the maximum rate per channel is $50,000/8 = 6,250$ samples/second.



IRIG Settings (FS Models Only)

Introduction	167
Setting the Camera to IRIG Mode	167
Configuring IRIG Settings for Recording	167
Performing a Recording with IRIG Synchronization	169
Displaying IRIG Time during Playback	169



IRIG Settings (FS Models Only)

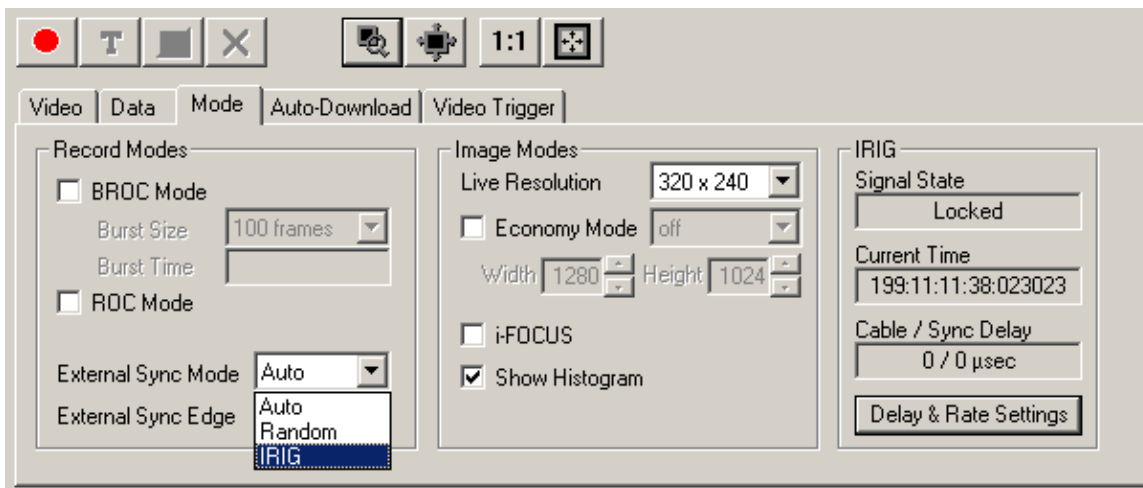
Introduction

The i-SPEED FS model cameras support synchronization with an incoming IRIG (Inter-Range Instrumentation Group) timing signal from a time generator. IRIG time generators generate timing signals that can be used to accurately synchronize multiple hardware devices deployed across large distances.

The i-SPEED FS model is capable of “locking” its internal clock to an external IRIG timing signal. The i-SPEED FS camera can decode the timing signal and display a time stamp for every recorded frame. For more information regarding the IRIG capabilities of the i-SPEED FS model cameras, please refer to the hardware manual that came with your camera.

Setting the Camera to IRIG Mode

In order for your i-SPEED FS camera to lock to an IRIG signal, you must set the external synchronization mode of the camera. In the *Mode* tab of the Acquire Window, select the IRIG option from the *External Sync Mode* drop-down box:



Once you have set the *External Sync Mode*, you can begin to review and adjust your IRIG settings on the far right of the *Mode* panel.

Configuring IRIG Settings for Recording

Signal State

The Signal State field indicates one of the four “states” of the incoming IRIG signal, as it is seen by the camera. The four possible states are:

- 1 **Locked:** The IRIG signal is present, and the camera is using the signal to generate IRIG times.
- 2 **Warning:** The IRIG signal has been lost, but the camera is calculating IRIG values internally. This is also known as “free-running”.
- 3 **Error:** The IRIG signal has been lost, no IRIG times are available.
- 4 **Uninitialized:** The camera has not received an IRIG signal.

Current Time

As long as a valid time code signal has been received, the Current Time field displays the universal (current) time received by the camera. This field updates in real time whenever an IRIG signal is being received.

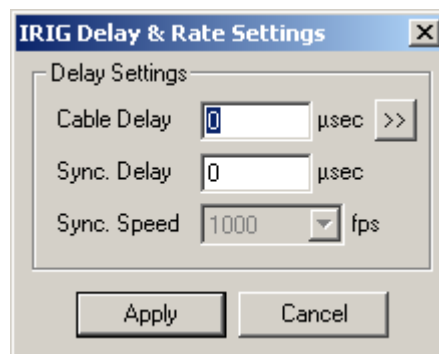
Cable/Sync Delay

There may be a need to compensate for or impose additional delays in your system. There are two variables to compensate or impose delays. The Cable/Sync Delay field indicates the current value of the Cable Delay and the Sync Delay. The cable delay compensates for transmission delays along lengthy cables. The sync delay introduces an additional delay between the incoming timing signal and when the camera acquires frames.

The Cable/Sync Delay field can be adjusted by clicking on the the **Delay & Rate Settings** button.



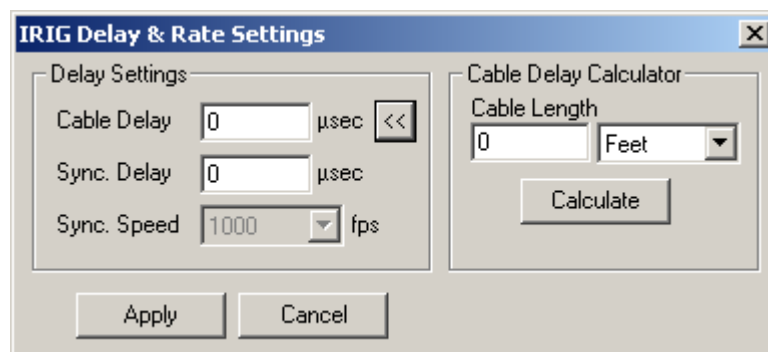
When you click the Delay & Rate Settings button, the following menu appears:



Cable Delay

The Cable Delay refers to the amount of delay caused by the transmission of the signal along the wire between the timing generator and the camera. The cable delay is specified in units of microseconds (μsec). It has a minimum value of "0" and a maximum value of "65,000."

By clicking the small expansion (>>) button located to the right of the Cable Delay field, the IRIG Delay & Rate Settings menu expands to show a simple Cable Delay Calculator:



The calculator allows you to specify the exact length of your cables and calculate your signal delay for your given length of cable.

Input your cable length in the allotted field and select the appropriate units of measure. Click the “Calculate” button to calculate your cable delay.

Note: The calculator uses a estimated delay rate of 4 nanoseconds/meter.

Sync Delay

The next field below the Cable Delay field is the Sync Delay field.

A Sync Delay can be specified in units of microseconds (μsec). This value imposes a delay between the incoming timing signal and when the camera acquires frames.

The maximum sync delay value varies depending on the Sync Speed setting. If the value input is greater than the maximum allowed value for the current camera configuration, the value will be set to the maximum allowed value for the current configuration. The minimum value is “0”.

Sync Speed

The Sync Speed field allows you to adjust the rate at which frames are captured during the recording.

The set of available speeds is a reduced set of the frames rates normally available to the camera. Click on the drop-down box to see the list of available synchronization speeds. The current speed is indicated in the thumbnail view of the camera on the left side of the Acquire Window.

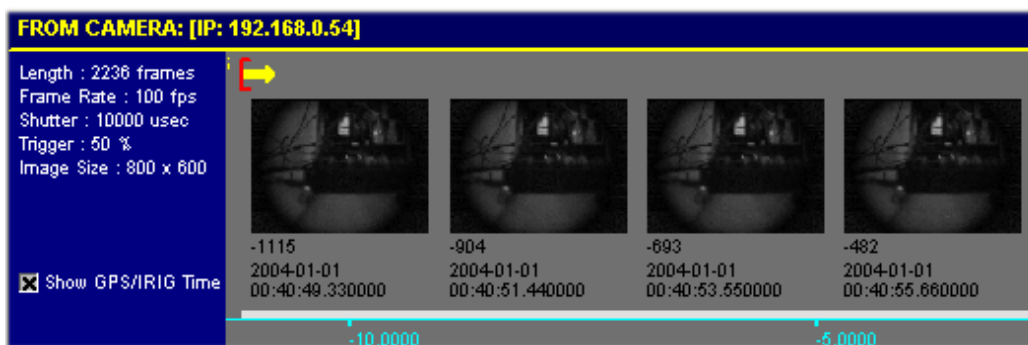
Performing a Recording with IRIG Synchronization

Once the External Sync Mode and the various delay and rate settings have been set to desired values, the recording is performed in the same manner as a standard recording. The Signal State should be observed to verify that the IRIG signal is not lost during recording.

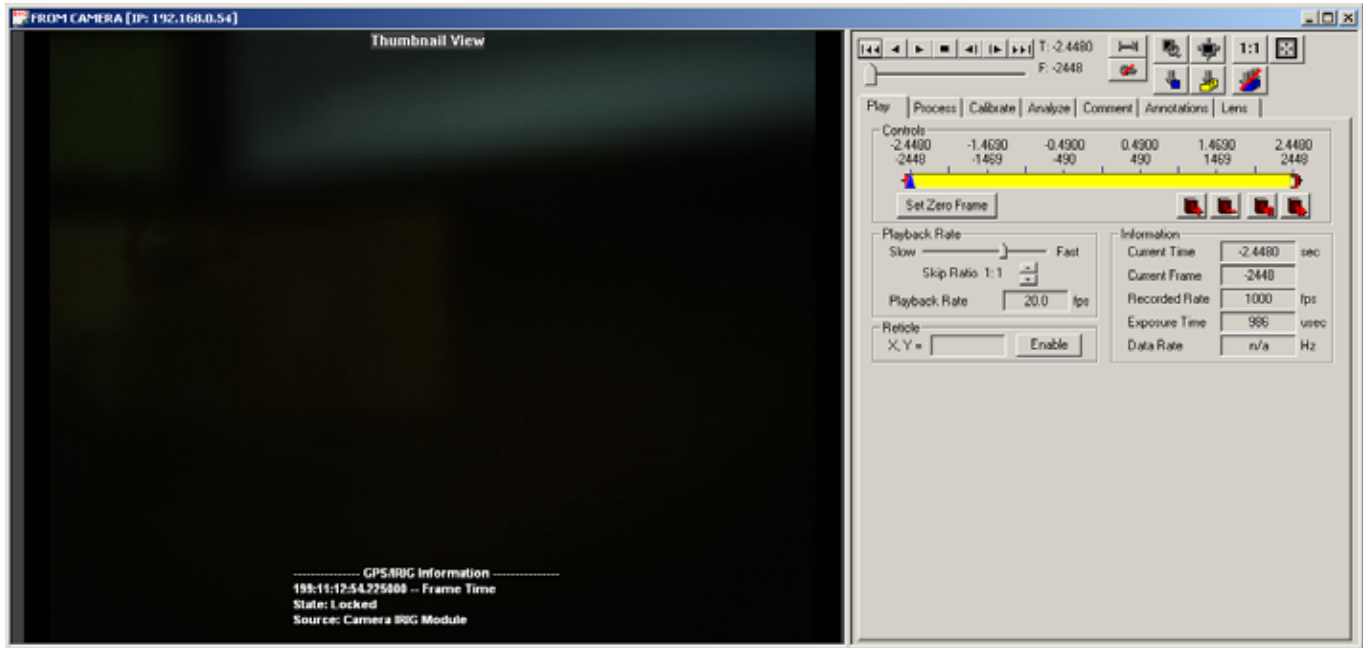
Displaying IRIG Time during Playback

After a recording has completed, the time stamps are automatically displayed in both Strip View and Working View windows.

In Strip View, the time is displayed under the individual frames when the “Show GPS/IRIG Time” checkbox is checked:



In Working View, the time is displayed automatically in the bottom center of your Working View window as shown below:



In both the Strip View and Working View, the following information is displayed:

Frame Time

The IRIG time stamp of the currently displayed frame, in the following format:

“Day of Year-Hour-Minute-Second-Fraction of Second”

Signal State

The Signal State will be one of the four states (Locked, Uninitialized, Warning and Error) of the IRIG signal, as detected by the camera, when the currently displayed frame was captured.

The Working View also displays one additional line of information:

Source

The source of the displayed time is displayed here. For the i-SPEED FS model camera, the source is always listed as “Camera IRIG Module”.

If loading a previously recorded file from an i-SPEED 1 or i-SPEED 2 camera with the external GPS/IRIG module option, additional information may be displayed in the Strip View and Working View. For more information regarding the external GPS/IRIG module, please refer to your i-SPEED 1 or i-SPEED 2 User Guide.

Lens Distortion Correction

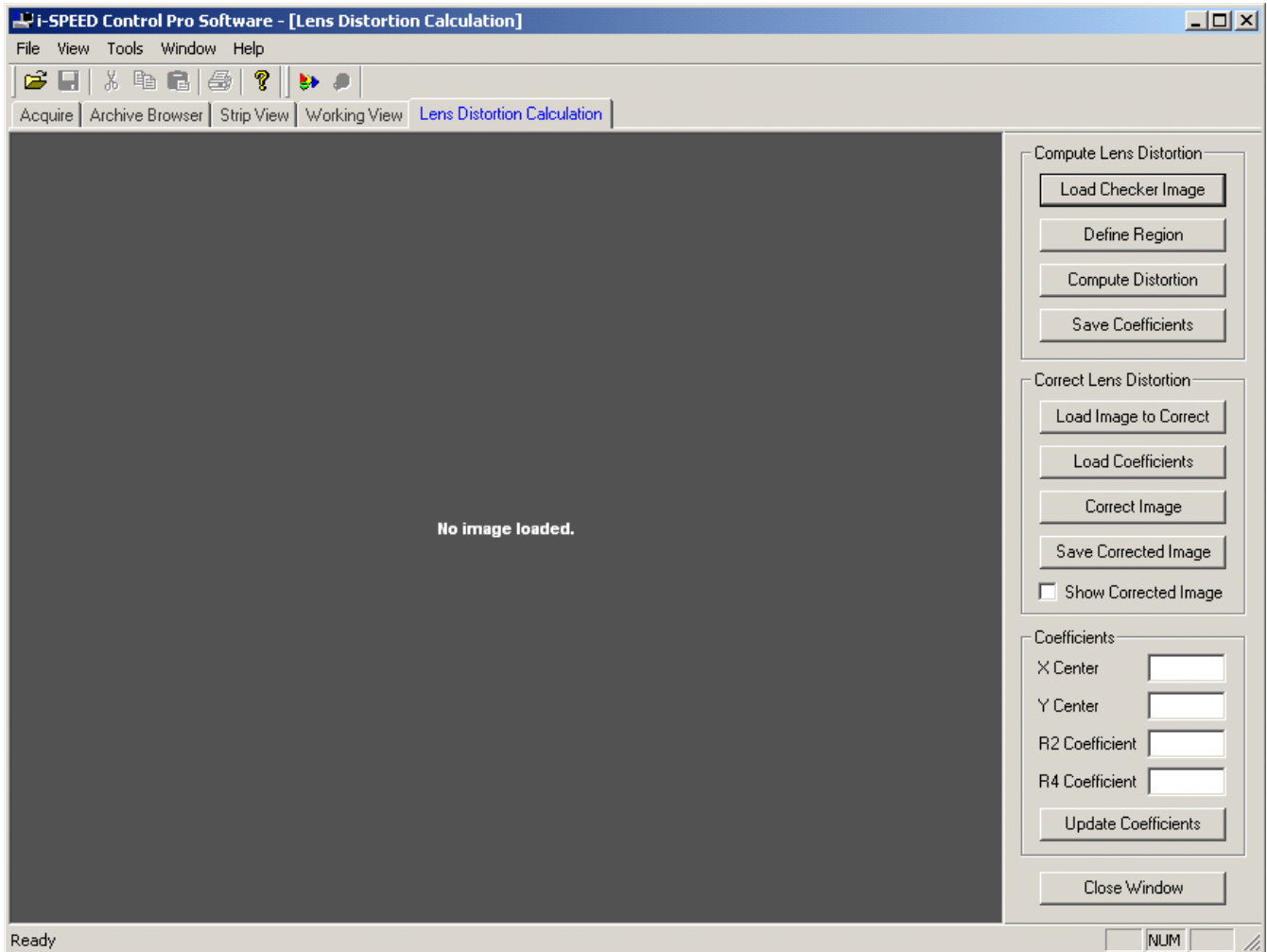
Introduction	172
Applying Lens Distortion Correction to a Video	174



Lens Distortion Correction

Introduction

The Lens Distortion Calculation window is available in the Control Pro version if the *i-SPEED* software. You can access this window by selecting Lens Distortion Calculation from the Tools menu. The Tools menu is visible when a video is open in the Working View.

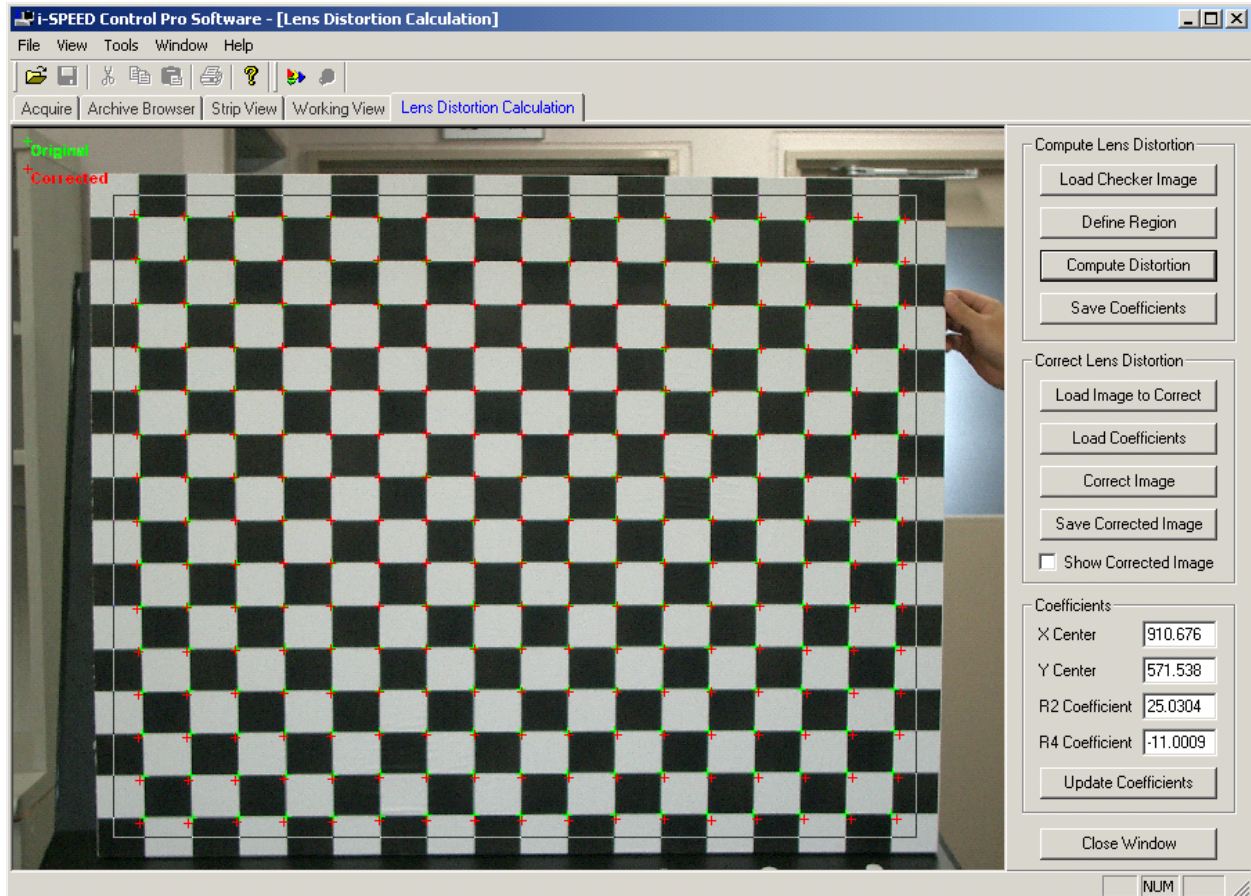


The Lens Distortion Calculation window calculates coefficients that can be used to remove lens radial distortion. In order to compute the amount of radial distortion in a lens, an image of a checkerboard pattern must be captured using the camera and lens of interest. Changing lens focus and zoom can affect the amount of distortion introduced by the lens. The checkerboard image should be taken with the lens set at the same focus and zoom settings that will be used to acquire the actual event.

To compute the amount of radial distortion:

- 1 Load a checkerboard image by clicking on the Load Checker Image button.
- 2 Define a rectangular region that is within the last set of squares of the checkerboard region. The rectangular region cannot cross a row or column of squares. If the distortion is so severe that you cannot draw a rectangular region without crossing a row or column of squares, try drawing a smaller rectangular region near the center of the distortion.

- 3 Click on Compute Distortion to begin the calculation.



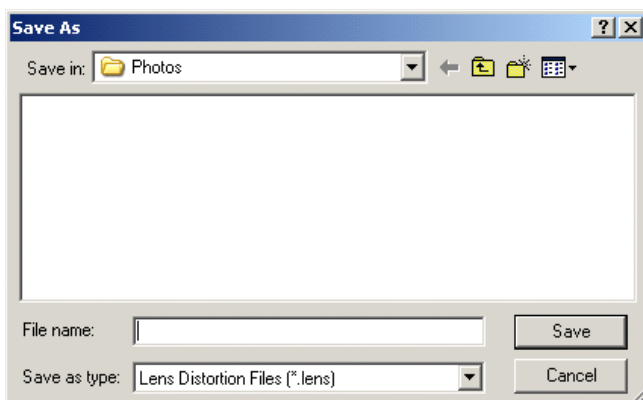
- 4 If the calculation was successful, the corners of the squares in the checkerboard should have been located with green + marks. The corrected locations should be indicated with red + marks.
- 5 To correct the image, click on the Correct Image button and check the Show Corrected Image checkbox.
- 6 If you are satisfied with the correction, click on the Save Coefficients button. If you are not satisfied, you can manually adjust the coefficients and click on the Update Coefficients button. The X Center and Y Center control the center of the radial distortion correction and the R2 and R4 coefficients control the magnitude of the radial distortion correction.

Saving Lens Distortion Coefficients

The coefficients from the Lens Distortion Calculation should be saved to a file for later use in correcting video images captured using the same camera and lens combination. These coefficients characterize the distortion of a given camera and lens combination, and are applicable to all images captured by that combination, as long as the zoom (and to a lesser degree, focus) have not changed.

Lens distortion coefficient files are saved with the .lens file extension. It is common to name the files according to the camera/lens combination being characterized or for the test setup being used.

To save coefficients, click on the Save Coefficients button in the Lens Distortion Calculation window.

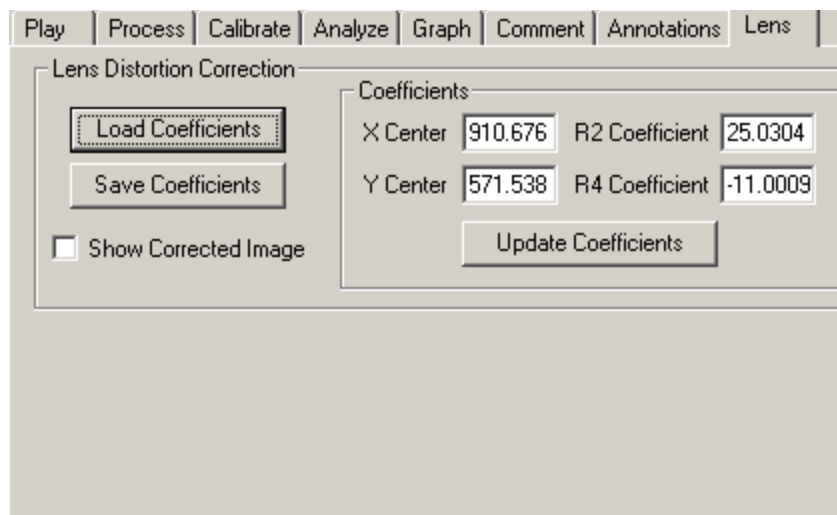


Applying Lens Distortion Correction to a Video

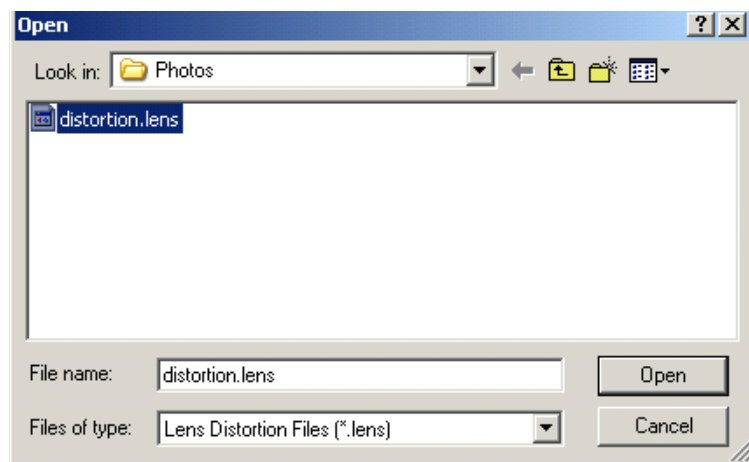
Lens Distortion Correction is done via the Lens tab in the Working View window. This tab is only available in the Control Pro version of the *i-SPEED* software.

To correct for lens distortion:

- 1 Open the video that has the radial distortion in the Working View.
- 2 Click on the Lens tab.

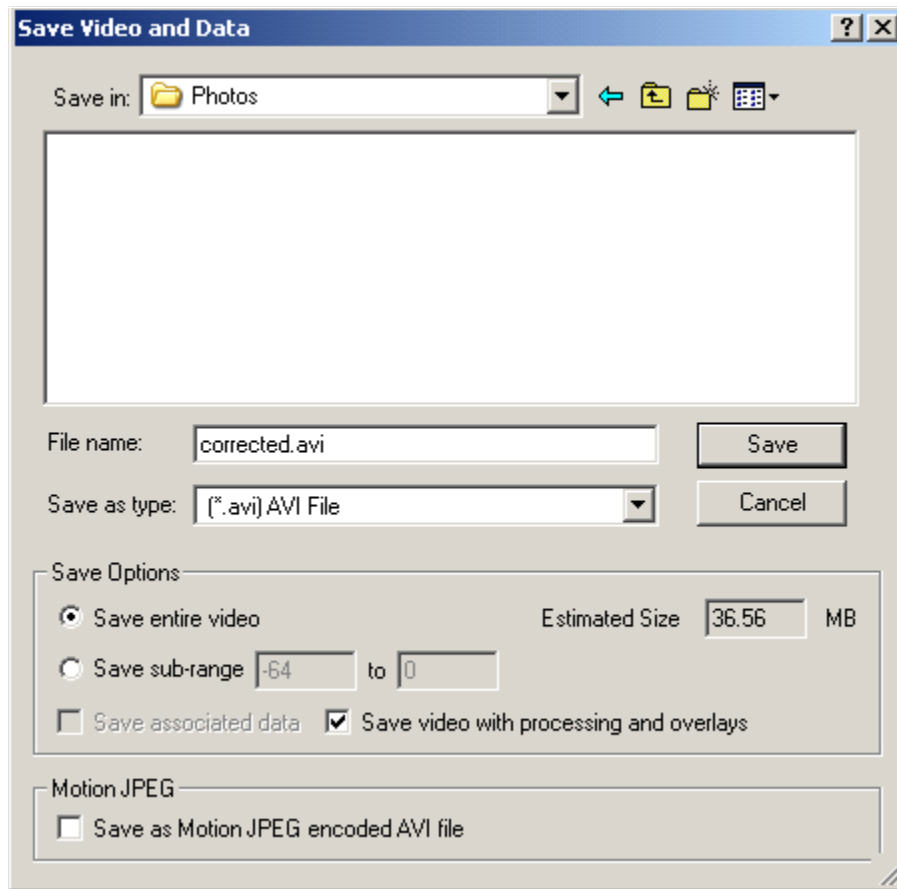


- 3 Click on the Load Coefficients button.
- 4 Select the Lens Distortion file that was previously saved for this camera/lens combination.



5 Click on Show Corrected Image in the Lens tab.

If you wish to save the corrected video, re-save the video and check “Save video with processing and overlays”.





OLYMPUS CORPORATION

Shinjuku Monolith, 3-1 Nishi-Shinjuku 2-chome, Shinjuku-ku, Tokyo 163-0914, Japan
Telephone: (81) 3-6901-4038

OLYMPUS EUROPA HOLDING GMBH

Wendenstrasse 14-18, D-20097 Hamburg, Germany
Telephone: (49) 40-23-77-30

OLYMPUS NDT INC.

48 Woerd Ave, Waltham, MA 02453, U.S.A.
Telephone: (1) 781-419-3900

KEYMED (MEDICAL & INDUSTRIAL EQUIPMENT) LTD.

KeyMed House, Stock Road, Southend-on-Sea, Essex SS2 5QH, United Kingdom
Telephone: (44) 0-1702 616333

OLYMPUS SINGAPORE PTE LTD.

491B, River Valley Road #12-01/04, Valley Point Office Tower, Singapore 248373
Telephone: (65) 6834-0010

OLYMPUS MOSCOW LIMITED LIABILITY COMPANY

117071, Moscow, Malaya Kaluzhskaya 19, bld. 1, fl.2, Russia
Telephone: (7) 495-958-2278

OLYMPUS AUSTRALIA PTY. LTD.

31 Gilby Road, Mount Waverley, Victoria 3149, Australia
Telephone: (61) 3-9265-5400