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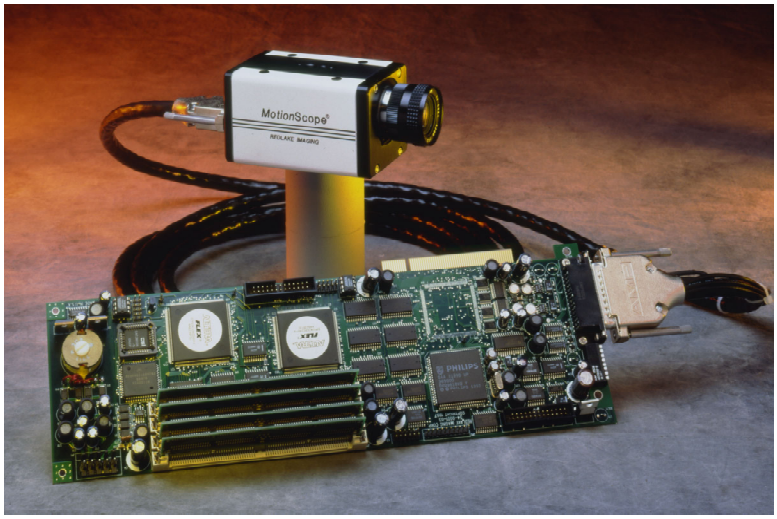
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Manual No. 9400-0010
Revision S
February 15, 2002

INSTRUCTIONS FOR OPERATING

THE *Motion*Scope® PCI

HIGH SPEED DIGITAL IMAGING SYSTEM



(Photo for illustration only. Your system may differ.)

REDLAKE

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List of Manual Revisions

Operator's Instructions for the MotionScope® PCI Model – 9400-0010

Revision	Date	EO No.	Notes
G			
H	11-02-99	1999080	General review and update. Remove Warranty. Add monochrome curve Incorporate changes from customer, marketing and engineering requests. Update image memory function description. Update reticle description. Add Models 250, 250 C, 500, 500 C, 4000 SC. Add shutter times of 40X, 80X, and 100X.
J			Remove shutter times 40X – 100X.
K	05-05-00		Add Windows 2000 OS (only affects the installation and specification). Change color monitor setting instructions.
L	06-19-00		General changes, delete 4000 fps. Add FCC Certification
M	07-17-00		Add procedure for synchronized recording.
N	10-25-00		Add PCI spec to Appendix B.
P	02-01-01		App A, add performance parameters for 500 and 500C.
R	05-15-01		Conversion to Redlake MASD, Inc. and general corrections.
S	02-15-02		Added CAUTION regarding saving files while in playback mode. Changed logo. All changes identified by vertical bar in margin.

FCC Declaration of Conformity

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

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- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This equipment has been certified to comply with the limits for a Class B computing device, pursuant to FCC rules. In order to maintain compliance with FCC regulations, shielded cables must be used with this equipment. Operation with non-approved equipment or unshielded cables is likely to result in interference to radio and TV reception. The user is cautioned that changes and modifications made to the equipment without the approval of the manufacturer could void the user's authority to operate this equipment.

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PREFACE

This manual describes how to operate and maintain a Redlake MASD, Inc. - *Motion*Scope® PCI - High Speed Digital Imaging System, monochrome or color. The *Motion*Scope PCI Controller is installed in a computer and runs on the Redlake MASD, Inc. PCI program. All controls and instructions are entered at the keyboard or by clicking the mouse pointer on a menu.
The system records sequences of images from 60 to 8000 frames per second, depending on the model and setting. Images from the camera or from the Image Memory are displayed on the computer monitor. Each sequence of images can be stored in a computer file, retrieved and replayed at various speeds to analyze a motion sequence in detail.

If your computer has more than one controller installed in the host computer, you need the Operator's Manual Addendum for Multiple Camera Operation, part number 9400-0050.

This manual contains the following sections:

Section 1	Introduction to High Speed Motion Analysis. This section gives a tutorial for recording an event using the *Motion*Scope PCI system, and analyzing the recorded images.
Section 2	Installing the *Motion*Scope PCI System. This specifies minimum computer system requirements. This section describes installing the Controller board into a computer, setting up the system and performing a power-on check.
Section 3	General Description of the *Motion*Scope PCI System, describes the Camera Head and PCI Controller. It also describes the application program menus.
Section 4	Operating the *Motion*Scope PCI System. This chapter provides operating procedures for setting up, recording, and playing back video images.
Section 5	Processing a Digital Image, describes how to use the *Motion*Scope PCI features to store, view and analyze digital images.
Section 6	Maintenance and Troubleshooting. This section identifies problems that may occur during installation and operation, and suggests a solution.
Appendices	The appendices show the frame storage and elapsed recording times, shutter speeds, performance specifications and the standard accessory kit.

WARNING!

ALWAYS make sure that power to the computer is turned OFF before connecting or disconnecting the camera head or camera cable.

WARNING!

The PCI circuit board is FRAGILE. Use caution when handling the board to avoid bending or flexing the board. Damage to the board will result from rough handling.

CAUTION: DO NOT attempt to save images while the system is actively playing them in PLAYBACK mode. Attempting to save images while playing them can result in lost or scrambled image files. Set PLAYBACK mode to STOP prior to saving your images.

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RELATED DOCUMENTS

Redlake MASD, Inc. Manual Addendum to Operate Multiple PCI Cameras, 9400-0050
Redlake MASD, Inc. Field Service Manual - PCI Digital Imaging System, 9400-0011
Redlake MASD, Inc. Manual Addendum for the Hi-G Camera Head, 9400-0016

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1 INTRODUCTION TO HIGH SPEED MOTION ANALYSIS

The *Motion*Scope High Speed Digital Imaging System records a sequence of digital images of an event at a frame rate of 60 to 8000 frames per second, depending on the model of video system used. The system stores these images in an Image Memory on the Controller Unit. These images can be viewed forward or reverse at selected frame rates from 1 to 8000 frames per second, frame-by-frame or freeze frame, to analyze motion and time during the event. You can also save the sequence, or part of the sequence, in a computer file on a computer disk or removable media for later retrieval and study.

This manual is written for a single camera system. If you have two or more cameras installed in the host computer, use the Manual Addendum, part number 9400-0050.

1.1 Capturing the Video Image

The lens on the Camera Head focuses the subject onto a CCD imager. The Camera Head accepts any C-mount lens or an optional CS lens, fixed or zoom, with a wide angle, normal view or telephoto. The telephoto lens may be used in its normal range or in macro to capture a very small subject. There is a locking ring under the lens to provide coarse focus adjustment.
The exposure of each frame is reduced at the higher frame rates, so more illumination is required as the frame rate increases. The correct exposure may be achieved by opening the aperture. If you still need more light, you must provide additional incandescent light. The *Motion*Scope system also provides a Strobe output to control a strobe light for additional illumination.

1.1.1 The Shutter

The system provides shutter control of image exposures that allows you to reduce the time of each frame exposure to eliminate image blurring due to motion. You must increase illumination to compensate for the shorter exposure. The Strobe output is synchronized to the shutter timing so a strobe may be used to increase illumination as well as to eliminate motion blur. Refer to Appendix C for shutter exposure information.

1.1.2 The Strobe Output

The Strobe output is enabled at all times during Live or Record mode. This is a TTL output pulse synchronized to the shutter, so that the strobe output signal goes high when the shutter is open and low when the shutter closes.

1.1.3 Lighting the Subject

The Camera Head Imager must receive enough light to see details of the image, and record the subject at the optimum size, so the significant parts of the motion can be seen clearly. The standard monochrome camera has an infrared filter to give subjects the correct gray scale appearance. The same filter balances the colors for the color models.

Table 1-1 Light Value Requirements for the PCI System.

	Standard Camera		Low-Light Camera Option	
Frame Rate (fps)	**LUX Value**	**Foot Candles**	**LUX Value**	**Foot Candles**
50, 60	1.03	0.10	0.10	0.01
250	4.3	0.41	0.43	0.04
500	8.6	0.83	0.86	0.08
1000	17.2	1.65	1.72	0.17
2000	34.4	3.31	3.44	0.33
4000	68.8	6.62	6.88	0.66
8000	137.6	13.24	13.76	1.32

The Low Light Camera Option does not have the IR filter, which increases the sensitivity of the system at low light levels. Table 1-1 gives minimum incandescent (tungsten) light requirements for the standard and low light cameras at a 1X shutter setting. Refer to Appendix C to determine the light values at other shutter settings.

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1.2 The Imager Responsivity Curves

The camera head has either the TC236 (color) or TC237 (monochrome) CCD imager. These imagers have the same characteristics. The imaging sensor has an image area of 658 (H) x 496 (V) pixels, each pixel being 7.4 microns square. The imager has a built-in electronic shutter to limit the exposure. See Appendix C. All standard cameras have the CM500 1mm IR filter. The filter is omitted on the low light version of the monochrome camera. Imagers and filters are installed at the factory and cannot be changed in the field.

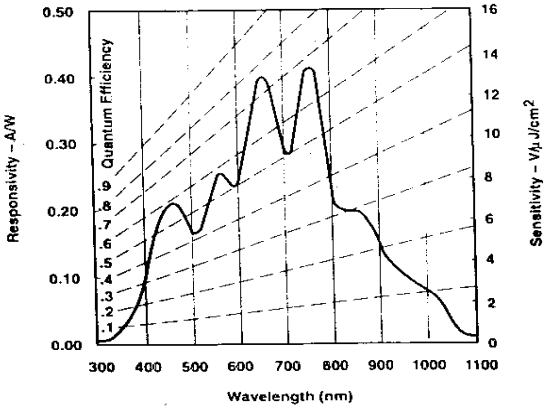


Figure 1-1 The Spectral Characteristics of the TC237 Sensor.

1.2.1 The Imager Base Characteristics

Figure 1-1 gives the responsivity and sensitivity of the TC237 monochrome CCD imager across the range of visible light without a filter.

1.2.2 Spectral Response with a CM500 IR Filter

Figure 1-2 shows the response of the red, green and blue signals from the TC236 imager with the IR filter installed.

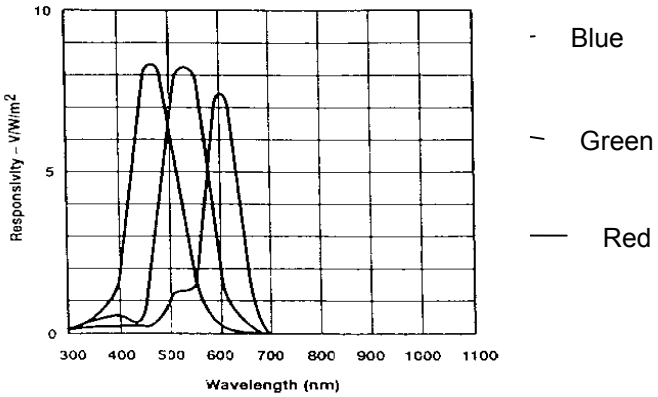


Figure 1-2 The Response of the RGB Signal with an IR Filter.

1.2.3 The Effect of the IR Filter

Figure 1-3 shows the blocking effect of the 1-mm CM500 IR filter.

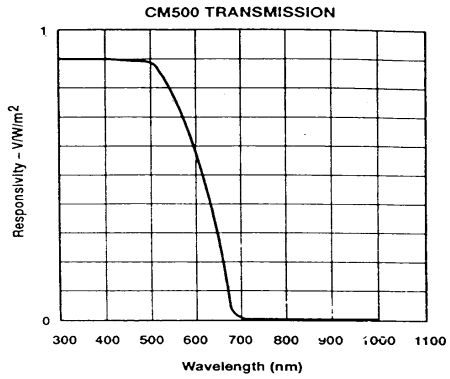
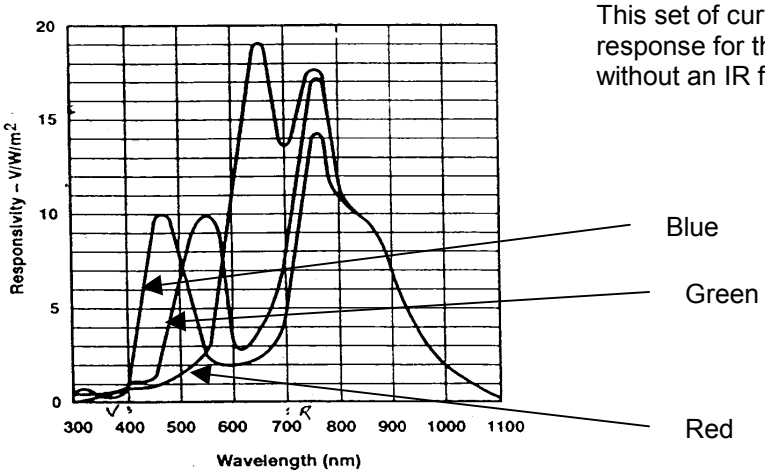


Figure 1-3 Filter Blocking Characteristics.

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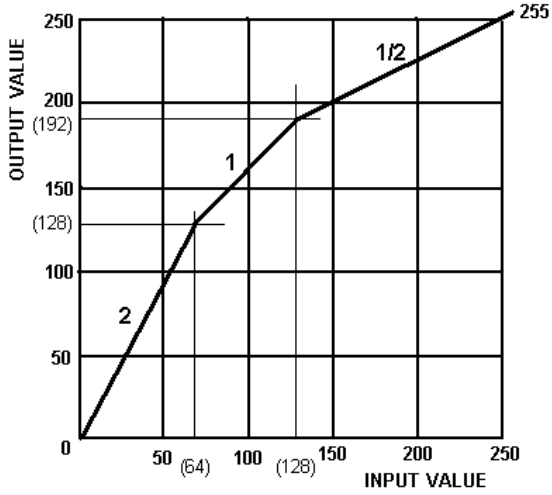
1.2.4 Spectral Response without the C500 IR Filter



This set of curves shows the spectral response for the red, green, and blue signals without an IR filter. See Figure 1-4.

Figure 1-4 Sensor RGB Spectral Response without an IR Filter.

1.2.5 The Monochrome Curve



- The Monochrome Curve shows the imager 8-bit gray scale with values from 0 to 255. See Figure 1-5.

Figure 1-5 The Monochrome Curve.

1.3 Capturing an Image

There are two types of application: recording a specific event, or viewing a continuous video until an event triggers an end to the sequence. The elapsed recording time depends on the number of frames per second recorded and the number of frames that the memory can store. Refer to Appendix A where the elapsed record time can be determined from the Record Rate selected and the capacity of the Image Memory.

1.3.1 Recording a Video Sequence

To record an event, the system records a subject until an operator gives a Stop **[ ]** command or a trigger generated by an external source stops the recording process. The Stop command stops the sequence and the frames show the sequence preceding the last frame. There is a delay through the system so the sequence shows a few frames after the system received the Stop command. The playback window has a Start Frame button so you can go to the frame showing the event, press Start Frame, which assigns Frame 0 to that frame and synchronizes the elapsed time to the event.

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The trigger input stops the sequence on the frame where the event occurred. You can set the Trigger Point to record part of the sequence before the event, and the remainder after the event. This insures that the event shows on Frame 0 of the sequence, which synchronizes the elapsed time on each frame in the sequence to the event. Refer to 1.3.3 and 1.5.2 for more details.

1.3.2 The Extended Record Option

The Extended Record Option gives longer record times at 60, 125, 250 and 500 frames per second. Appendix A in this manual shows the standard and extended times available. The additional times are obtained by reducing the sensor resolution, and are indicated on the display as 60E, 125E, 250E and 500E.

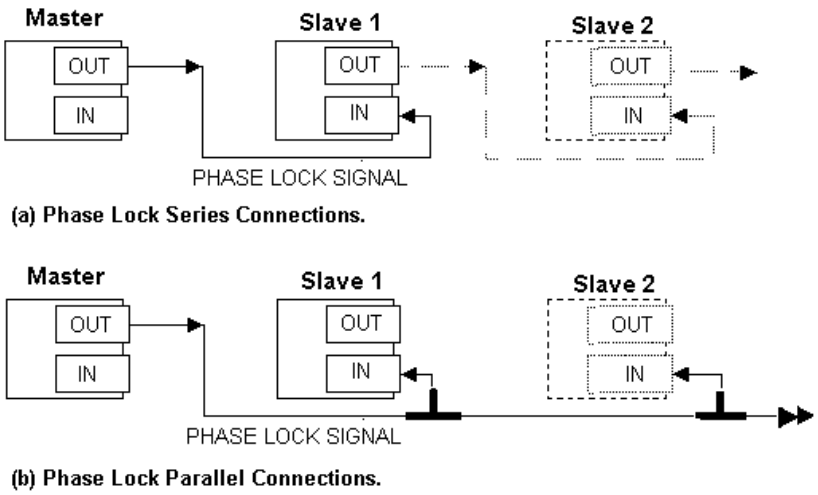
1.3.3 Stopping a Recording using a Trigger Input

The *Motion*Scope system has a trigger system that detects a signal from an external source and stops the recording at the frame active at the receipt of the trigger. This enables you to record an event that occurs very quickly, or happens without warning when the system is unattended. The active frame when the trigger is received is designated Frame 0. You should always use the trigger if you want the event coincide with Frame 0, since the stop button has a propagation delay so Frame 0 will follow the event even if the button is pressed simultaneously.
You can set the Trigger Point to determine how many frames you record before the event. Frames following Frame 0 have positive numbers, and frames preceding Frame 0 have negative numbers. The camera window shows the elapsed time of each frame in relation to Frame 0, in positive and negative times. Refer to paragraphs 1.5.2 and 2.8.4 for more information.
The Trigger input is always enabled and held at +5 volts through a 10K resistor. The customer supplies the trigger signal to the trigger input in one of the following ways. The camera must be set to receive a rising or falling signal:

1. An open circuit allows the trigger input to stay at +5 volts. The trigger causes a contact closure that pulls the input down to 0 volts.
2. A closed contact pulls the trigger input down to 0 volts. The trigger opens the contacts causing the trigger input to rise to +5 volts.
3. The trigger input operates with TTL or CMOS logic at the trigger source. A voltage from the source is pulled low at the source by a resistor up to 2Kohms in value. The trigger causes the signal to go to +5 volts to stop recording, and the signal to the trigger input can go as high as +30 volts.

1.3.4 Synchronization and Controlling the Record Speed

The Phase Lock feature provides a means to synchronize and control the frame rate of the recorded video. This enables two or more cameras to record different views of the same event and synchronize the frames in all cameras.



Alternatively a phase lock pulse, generated by an external source such as rotating equipment or a signal generator to the Phase Lock In connector, can synchronize the recorded frames in a camera.
The frame rate during record will follow the source signal and can be at any rate up to the Record Rate setting.

Figure 1-6 The Phase Lock Connections.

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The system records the events and assigns a sequential frame number to each frame. However, if the rate of recording frames varies from a record rate of 60, 125, 250, 500, 1000, 2000 or 8000 frames per second, the elapsed time (ET) displayed on the Playback window will not be the true elapsed time.

1.3.4.1 Synchronizing two or more *Motion*Scope systems

The cameras should be connected as shown in Figure 1-6. One camera is designated the Master and the other camera(s) are designated as Slave(s). Cameras are usually connected in series. The most common series connection requires a BNC cable to connect the Phase Lock Out from the Master or leading unit to the Phase Lock In connector on the next downstream unit. Alternatively, The signal can be distributed to each camera using a tee connector. All master and slave cameras must be set to the same Record Rate for accurate elapsed time (ET) indications.

1.3.4.2 Controlling the Record Rate of a Camera from an External Source

As a slave, the camera records one frame each time a phase lock signal is detected at the Phase Lock In connector. A stream of signals can be supplied at any speed to record a series of frames up to the maximum Record Rate set.
The Phase Lock In input is normally tied to +5 volts. The input signal to record a frame is a square-wave signal rising from 0 volts to +5 volts. The input signal must pull the Phase Lock In input to ground, and then provide a rising signal to record the frame. The elapsed time (ET) indications for the slave units are not true when the frame rate does not equal the record rate set. Refer to Section **2.8.5.1** for more details.

1.4 Marking a Frame (Data Record)

The *Motion*Scope provides a means to identify a frame or series of frames in the recorded sequence. This Data Record feature, when turned on, places two square markers at the top left corner of each frame. The Data Record inputs are held high (+5V TTL level) and the markers show as white squares on each frame. A contact closure to ground pulls the inputs low and they show as black squares.
These inputs must be enabled by switch SW-7 on the Controller rear panel. The Data Record inputs (Input 0 and Input 1) are through BNC connectors on pigtails on the camera cable.

1.5 Recording a Sequence in the Image Memory

When the camera is turned on and the first sequence recorded in the image memory, the first image is recorded in the Initial Frame, Frame 0. The system places the next images in Frames 1, 2 up to the last frame, and then records over Frame 0. The system records the latest video over the oldest frame so that the total number of frames available is equal to the number of frames in the image memory. See Figure 1-7.

1.5.1 Stop Recording

When you click on Stop, the system stops recording and goes into a pause mode, waiting for an instruction for the next function. You may enter an instruction to record again, playback from the image memory, save the sequence or return to Live mode. All images in the memory precede the active frame when you clicked on Stop.
The first frame of the next recorded sequence follows the last frame of the previous sequence.

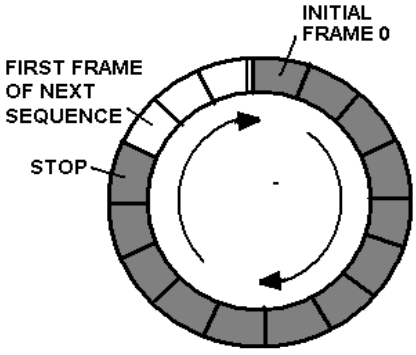


Figure 1-7 The Image Memory.

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1.5.2 Stop Recording using the Trigger

The camera also stops recording when it receives a signal through the Trigger input. Recording stops at the frame determined by the Trigger Point setting, see Figure1-8. The trigger can be set from 0% to 100% in 10% increments to adjust the length of time the images show before and after the event that caused the trigger. The percent value represents the proportion of the sequence shown before the event.

For example, if the trigger is set to 50% as illustrated, the camera continues to record over the second half of the image memory and then stops. Half of the sequence shows frames that precede the trigger and half shows events after the trigger. If the Trigger Point were set to 20%, then 20% of the images would precede the trigger, and 80% follow the trigger.

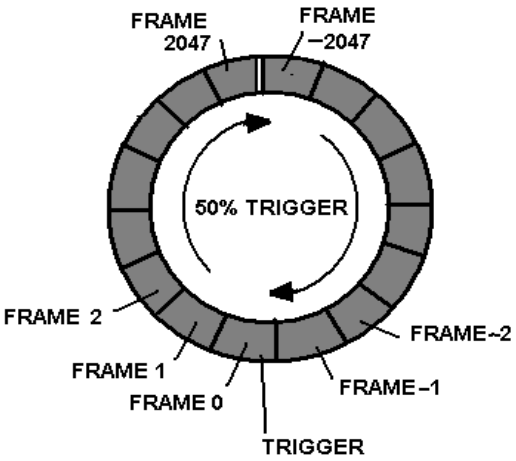


Figure 1-8 The 50% Trigger.

The active frame when the trigger is received is Frame 0 for that sequence. If the Trigger point were set to 0%, all images in the memory would show events after the trigger occurred. If the Trigger Point were set to 100% all images would precede the trigger, the equivalent of using the manual stop. A message shows on the screen between the time of receipt of the trigger signal and the time the camera stops recording to confirm that the trigger was received and to prevent the operator from pressing Stop manually.

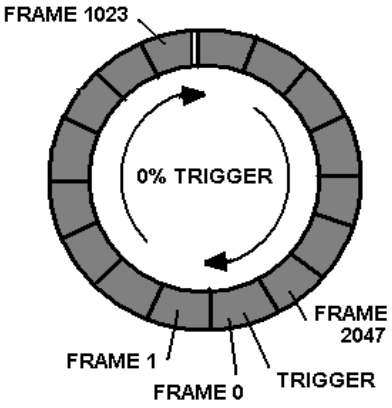


Figure 1-9 The 0% Trigger.

1.5.3 Playing Images from the Image Memory

You can play back the images from memory as soon as the sequence is recorded. The system plays the images in Step mode, or at playback rates of 1 fps to 8000 fps. The images can be saved in a computer file and replayed at any time.

1.5.4 Frame Numbers and Elapsed Time Display

During playback from the image memory or from a computer file, the Playback dialog box or menu shows the frame number and time of the frame of the frame currently displayed. These numbers are referenced from the Frame 0 assigned to that sequence. Frames following Frame 0 trigger are assigned positive frame numbers from Frame 1 to the last frame stored. Frames preceding the trigger are given negative frame numbers from Frame –1 to the first frame stored. The dialog box or window shows the time of each frame to 0.0001 seconds with reference to Frame 0. Frames that follow Frame 0 show positive elapsed times; frames preceding Frame 0 show negative elapsed times.

The Playback dialog box has a Start button that reassigns Frame 0 to the frame currently displayed. This allows you to select a new frame 0 for that sequence and reference all other frames to it. The camera renumbers all other frames with the appropriate positive or negative frame numbers. The dialog box also shows the new elapsed times. This allows you to choose more convenient frame numbers and time markers. The revised Frame 0 is not stored, and if the sequence is stored and retrieved, the system loads the original Frame 0.

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1.5.5 Saving a Sequence in a Computer File.

Images recorded in the image memory will be lost if another recording is made. Therefore any video data required later must be stored in a computer file before making another recorded sequence. The formats available are an AVI file, or a sequence of BMP, JPEG, PCX or TIFF files. The file contains all of the frame and elapsed time references of the original file together with the video data.
For a high-capacity memory, the system may be able to record several sequences, since the next record sequence starts at the first frame following the last frame of the previous recording.

1.6 Viewing the Image Sequence

CAUTION: DO NOT attempt to save images while the system is actively playing them in PLAYBACK mode. Attempting to save images while playing them can result in lost or scrambled image files. Set PLAYBACK mode to STOP prior to saving your images.

The video images from the camera in Live mode, from the Image Memory, or from an AVI file are displayed in a window on the computer monitor. Click on the right mouse button and select Properties to see the status and setup values set at the time of recording. The display may be monochrome or color depending on the model.
The video image can be viewed on a remote monitor connected to the video output through the Composite Out cable connector. You can view the image during record when the computer monitor screen goes blank. The *Motion*Scope PCI system provides either NTSC or PAL video.

1.6.1 Loss of Frames During Playback

Playback at high frame rates may cause the loss of frames displayed in the sequence. This is due to limitations of the host computer processor speed and memory capacity. A graphics accelerator card may improve this condition. This does not indicate a loss of video data. All frames can be accessed at lower playback rates.

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1.6.2 Analyzing the Motion of a Subject

The *Motion*Scope system provides several features to examine a recorded sequence, whether the sequence is still in the image memory or has been recorded and retrieved from a computer file. These features are available on all models.

1. Slow or Fast Motion. You can replay the video sequence at speeds of 1 fps to 8000 fps, forward and back.
2. Viewing Frame by Frame. You can step through the sequence one click at a time, forward and back.
3. Fast Forward and Reverse. Using the Slider on the application window you can go to any frame in the video sequence.
4. Frame and Time References. The Playback window shows the frame number currently displayed and the time from Frame 0. The Start button allows you to reset Frame 0 so the elapsed times shows for each frame are referenced to the event.
5. The Reticle. The Reticle is a position reference that you can superimpose on the video image stored in the image memory or a computer file. The Reticle is a horizontal and a vertical line that intersect at a target providing X and Y coordinates.
6. Distance and Velocity Measurements. The reticle enables you to determine distances between two points in the picture. The system must be calibrated by measuring the physical distance between two points of interest and entering the distance between the set points in the system. The system then calculates the distance between any two points on the monitor. If the points are on different frames, the system also calculates the velocity of the point of interest.
   All measurements are in two dimensions perpendicular to the camera. When you enable the Reticle feature, the Reticle button displays the position of the cursor in pixels from the top left corner of the window (refer to paragraph 3.5). You can select distances in inches, feet, meters, centimeters, decimeters, or millimeters.

1.7 Composite Out

The system supplies a video signal that can be viewed on an external monitor or recorded on a VCR. A computer can receive the video signal and store it in a file, provided the computer has a video processor board. The video may be output as an NTSC RS170 signal or a PAL signal.

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2 INSTALLING THE *MOTION*SCOPE PCI SYSTEM

This section specifies the minimum computer requirements, and gives procedures to install the *Motion*Scope adapter and software. It describes how to connect the Camera Head and power up the system. It also describes how to connect to external equipment. Follow the instructions in the order given here.

WARNING!

ALWAYS make sure that the computer is turned OFF when connecting or disconnecting the Camera Cable or the Camera Head. Damage to components may occur if either Camera or Cable is connected or disconnected with power on.

2.1 Minimum Computer Requirements

- Computer: power supply: 200 watts minimum. The Controller requires 0.8 amps from the +12-volt supply and 2.0 amps from the +5-volt supply.
- Operating System: Windows 2000 or Windows NT 4.0 with Service Pack 4 or higher.
- Main board: Two adjacent full size PCI slots, one slot for the board connector and one slot provide space for the Controller components.
- Processor: Pentium II or equivalent, MMX, 200MHz minimum.
- RAM: 64 Megabytes minimum, 128 Megabytes recommended.
- Monitor: VGA 1024x768. The color *Motion*Scope is 10X slower than monochrome, and when mono and color cameras are mixed the system runs at the speed of the color cameras. Set 16 or 24-bit full color depending on speed vs. resolution requirements.
- Video Adapter: 8 Megabytes on-board memory.

*2.2 Unpacking and Installing the Motion*Scope *System*

WARNING!

Do not remove the Controller from its anti-static wrapper until you are ready to install it into the computer. Wear an anti-static wrist strap before handling the Controller board. The circuit board is FRAGILE. Handle with caution to avoid bending or flexing.

2.2.1 List of Equipment

Check that you have the following items in the *Motion*Scope package.

1 - Controller Board. 1 - Camera cable. 1 - Camera Head.
1 – Wrist ground strap. 1 – Allen key 3/32”.
1 - CD-ROM containing the *Motion*Scope PCI software program.

2.2.2 Installing and Connecting the *Motion*Scope System

Turn the computer off and unplug the power cord before performing this procedure.

1. Remove the computer enclosure.
2. Choose a PCI slot on the main board with a vacant slot on the component side to provide additional space. Remove the associated rear plate.
3. Attach a grounded wrist strap to your wrist.
4. Remove the PCI Controller board from the anti-static bag and insert it into the PCI slot. Handle the Controller by the edge, and do not touch any of the components.
5. Screw the Controller rear plate to the computer enclosure frame.
6. Unpack the camera cable, connect and secure the 44-pin plug to the rear plate connector.
7. Remove the Camera Head from the package. Connect and secure the 26-pin cable connector to the rear connector of the Camera Head.
8. Remove the lens thread cover and screw the lens into the Camera Head lens mount.
9. Replace the computer enclosure and plug in the power cord.

Note: Always install components with matched serial numbers together. Mixing components will degrade picture quality, especially if the components have different revision levels.

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2.3 Setting Up the Computer Monitor

Turn on the computer and set the computer monitor as described here.

2.3.1 Setting Up for a Monochrome PCI System

From the Windows NT Menu:

1. Click on the Start/Settings/Control Panel and load the Control Panel window.
2. Select the Display/Settings tab.
3. Under the Color Palette, select 256 colors.
4. Under the Desktop Area, select 1024 X 768.

2.3.2 Setting Up for a Color PCI System

Note: The PCI card does not support 16 colors or 32768 (15-bit) color.

1. Click on the Start/Settings/Control Panel and load the Control Panel window.
2. Select the Display/Settings tab.
3. Under the Color Palette, select True Color (24-bit 16.7 million colors **or** 32-bit).
4. Under the Desktop Area, select 1024 X 768.

2.4 Power On and Loading the Software (Windows 2000)

Windows 2000 requires that the drivers are loaded from the CD-ROM using the "Found New Hardware Wizard" window. When the drivers are loaded, you can install the *Motion*Scope application program.

2.4.1 Installing the MotionScope Drivers

First install the *Motion*Scope drivers as follows:

1. Turn the host computer ON.
2. Immediately load the Redlake MASD, Inc. CD-ROM, revision 2.20 or higher.
3. Let Windows 2000 load.
4. When Windows 2000 is loaded, the "Found New Hardware Wizard" window appears on the screen.
5. Click **NEXT**.
6. See "Install Device Driver" which defaults to "Search for suitable driver".
7. Click **NEXT**.
8. See "Locate driver files". Defaults to CD-ROM drive reference.
9. Click **NEXT**.
10. Screen shows CD-ROM drive reference, then changes to the destination folder.
11. Click **Finish**.

The drivers are loaded. Proceed to 2.2 below.

NOTE: The Wizard window may show the driver file with a yellow "?" icon. This should not cause concern, and only means that Windows does not recognize the Redlake MASD, Inc. file format.

2.4.2 Installing the *Motion*Scope Application Program

1. Double-click on My Computer.
2. Double-click on the CD-ROM icon.
3. See the Redlake MASD, Inc. Installation window on the screen. Follow the installation directions shown.
4. When the program is loaded, restart the computer.

2.4.3 Loading the Application Program

When the program and drivers are loaded, you may load the *Motion*Scope program in one of two ways:

1. Click on Start/Programs and select *Motion*Scope from the list of programs.
2. Double-click on the Redlake MASD, Inc. icon on the desktop.

The screen shows the Main Application window. Go to paragraph 2.5 in the Operator's Manual to set the camera options and make the external connections.

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2.5 Power On and Loading the Software (Windows NT 4.0)

1. Turn the computer ON.
2. Insert the *Motion*Scope PCI CD-ROM into the drive. Follow the installation directions.
3. When installation is complete, restart the computer.
4. Click on Start/Programs, highlight and click on *Motion*Scope. Monitor shows the Initial menu.

2.6 Viewing the Live Picture

- Click on *Open – Camera 1*. This opens the Camera 1 window showing the live view from the camera. If the Camera responds, go to paragraph 2.5 for the external connections, or to Section 4 for operating instructions.
- If there is no picture, adjust the aperture ring. If there is still no picture, increase the light on the subject.
- If the image is not clear adjust the focus of the lens. If a simple lens adjustment does not focus the picture, adjust the back focus by loosening the screw under the lens mount using a 3/32 Allen key. Rotate the lens mount to focus the picture. Tighten the screw.

Warning!

Do not over-tighten this screw or you will damage the locking ring and lens thread.

- If the system does not respond, refer to Section 6, Maintenance and Troubleshooting.

2.7 Setting the Camera Options

This procedure gives the camera a reference or name, and determines whether the default camera size and position is loaded each time, or whether any changes are stored when you exit the program.

2.7.1 Naming the Camera and Loading Default or New Data

1. Click on the Setup… button. This brings up the Properties dialog box, General tab.
2. Enter a name for the Camera 1. This name will appear on the title bar of the Camera 1 window.
3. Check Save Camera Size and Position if you wish to store the size changes you may make.
4. Click OK.

2.8 Connecting the External Options

This section gives details of the connections and electrical specifications for the Trigger, Strobe, Data Recording, Video Out and Phase Lock options. Connect the input or output to the appropriate BNC connector attached to the camera cable. The switch setting instructions refer to the DIP switches on the adapter rear plate above the camera cable connector.

2.8.1 Composite Out

The “COMPOSITE OUT” BNC connector supplies a video signal to an external monitor, VCR or computer. A computer must have a video capture board to receive or transmit video to the Control/Display Unit. The system is factory set to the NTSC (30 fps) or PAL (25) standard. Change this standard by resetting Switch 8.

2.8.2 The Strobe Output

The Strobe signal is a positive-going pulse that rises when the shutter opens and falls when the shutter closes (see Figure 2-2). The Strobe signal is always enabled. The length of the pulse depends on the record rate set (frames per second) and the shutter setting (1X - 20X, where X is the record rate). Refer to Appendix C.

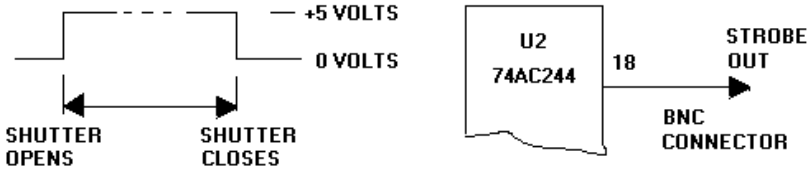


Figure 2-1 The Strobe Circuits.

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The Strobe signal is a TTL pulse generated by U2 on the Controller board, a 74AC244 device, shown in Figure 2-2. The output is through a lead to a BNC connector on the camera cable labeled “STROBE”. The user must supply a coax cable terminated with a female BNC connector.

2.8.3 The Data Record Inputs

The DATA 0 and DATA 1 inputs to the video cable connector connect the Data Record inputs. Set DIP Switch 7 RIGHT to enable Data Recording. Each Data Record input shows as a white square when the input is +5 volts. A contact closure to ground turns the marker black.

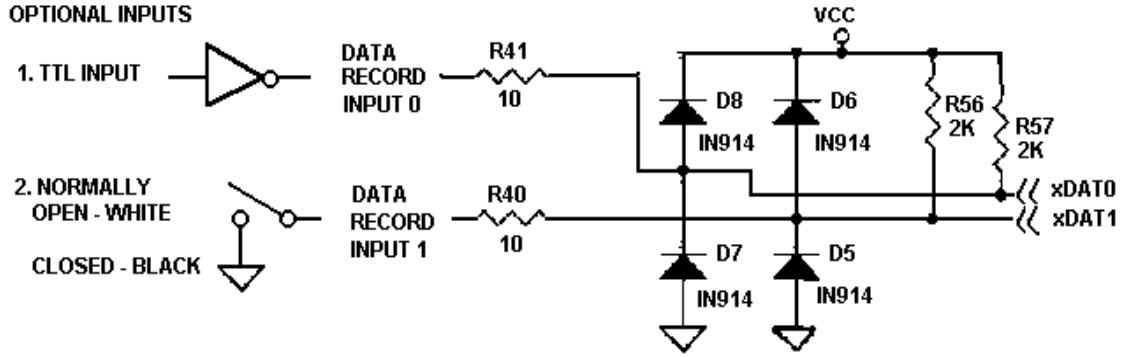


Figure 2-2 The Data Record Input Circuits.

There are two types of input that may be applied to the Data Record inputs (see figure 2-1):

a) A TTL or CMOS-compatible logic signal or other ground-based logic up to +5 volts.
b) A dry-contact closure between open and ground.

2.8.4 The Trigger Input

The Trigger input is a BNC connector labeled “TRIG” that is always enabled in Record mode. The Trigger circuit on the Controller board supplies a +5-volt level to the connector by way of a 6.8K pull-up resistor. The microprocessor monitors the Trig-In lead and detects when a trigger signal is transmitted from an external source to the Trigger Input. A signal from an external source when the system is recording stops the record sequence at a point determined by the trigger point setting.

There are three types of signal that may be supplied to the Trigger circuit to stop a record sequence (see Figure 2-3).

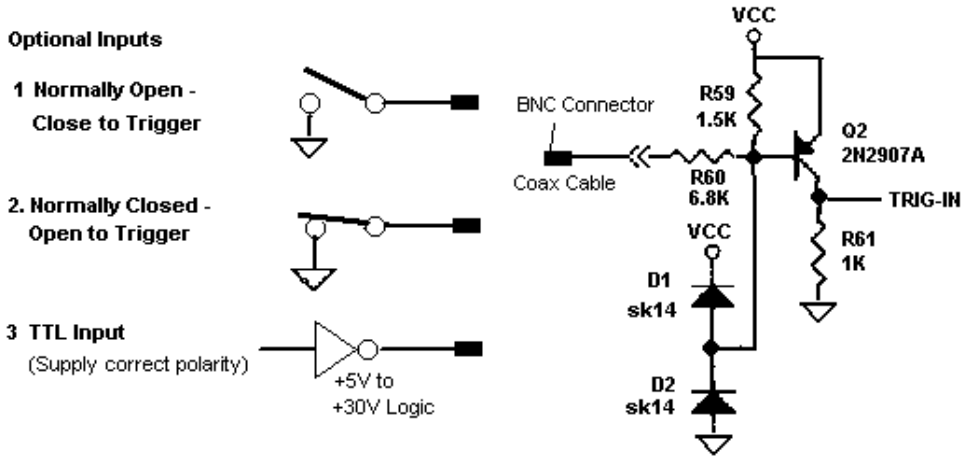


Figure 2-3 Trigger Input Circuits.

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1. The signal input is held at +5 volts. A contact closure to ground caused by the Trigger pulls the input to 0 volts to stop recording. This presents a falling signal edge to the trigger input so you must check the Falling box in the Trigger dialog box.
2. A contact closure holds the input to 0 volts. The trigger opens the contacts causing the input to rise to +5 volts. This presents a rising signal edge to the trigger input so you must check the Rising box in the Trigger dialog box.
3. A TTL- or CMOS-compatible logic signal, or other ground-based logic with a maximum of 2K ohms holds the Trigger input at 0 volts. The Trigger signal allows the Trigger input to go to +5 volts to stop recording. This signal can go as high as +30 volts. You must check the Rising box in the Trigger dialog box.

2.8.5 The Phase-Lock Input and Output

1. Determine which system will be a master and generate the sync pulses, or a slave and receive the sync pulse from a master (see Figure 1-6).
2. At the master system, connect a BNC connector and cable from the PHASE LOCK OUT connector.
3. Select the Settings menu for the Master unit. In the Master/Slave line, select Master.
4. **Series Connection.** Connect the cable from Step 2 to the PHASE LOCK IN connector on the first slave unit. In any downstream *Motion*Scope system, connect a BNC connector and cable from the PHASE LOCK OUT from the first slave to the PHASE LOCK IN of the next slave unit.
5. **Parallel Connection.** Install a tee to the cable installed in Step 2. Connect the tee to the Phase Lock IN connector of the Slave, and install cables and tees to the downstream Slaves.
6. Select Slave in the Master/Slave line of the Settings menu on all Slave units.

2.8.5.1 Connecting *Motion*Scope Systems to an Equipment Source

One or more systems can be synchronized to an equipment source. If there is more than one Slave unit, the connections can be series or parallel. Follow the instructions given in 2.8.5 above, substituting the equipment source for the Master unit.
The Phase Lock signal from the equipment source must conform to the following specification. The normal signal level is +5 volts, which must fall to 0 volts prior to the next frame exposure. This signal's rising edge coincides with the start of a frame exposure (see Figure 2-4).

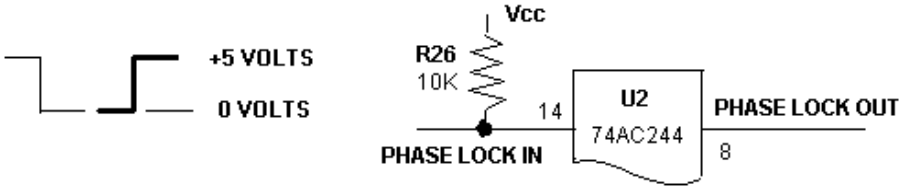


Figure 2-4 The Phase Lock Signal and Circuit.

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3 DESCRIPTION OF THE *MOTION*SCOPE PCI SYSTEM

The *Motion*Scope PCI system has a Camera Head, a camera cable, and a full length PCI Controller board. The product includes the *Motion*Scope PCI application software provided on a CD-ROM disk. This system is installed into a computer that has the minimum parameters specified in paragraph 2.1.
When the system and software are installed, all instructions are entered through the main menu displayed in the monitor. The video images are shown in a window in the application window. There are several *Motion*Scope models available with variations in features, refer to Table 3-1 below. Refer to Appendix A for the *Motion*Scope PCI Performance Specifications. Refer to Appendix D for the Accessory Kit that specifies the lenses available, mounting hardware and lighting equipment.

3.1 MotionScope Model and Part Numbers

This table gives the model numbers of *Motion*Scope systems covered by this manual.

Table 3-1 The PCI Model and Part Numbers.

Model No.	Part No.	Frames per Second
PCI 500	1108-0015	60, 125, 250, 500
PCI 1000 S	1108-0008	60, 125, 250, 500, 1000
PCI 2000 S	1108-0009	60, 125, 250, 500, 1000, 2000
PCI 8000 S	1108-0014	60, 125, 250, 500, 1000, 2000, 8000
PCI 500 C	1108-0016	60, 125, 250, 500
PCI 1000 SC	1108-0011	60, 125, 250, 500, 1000
PCI 2000 SC	1108-0012	60, 125, 250, 500, 1000, 2000

3.2 The Camera Head

The Camera Head is a 2-1/2 inch x 2-1/2 inch x 4-inch enclosure that contains a CCD sensor and imaging circuits. The Camera Head has a C-mount lens, or an optional factory-installed CS mount. The enclosure has a 1/4-20 and a 3/8-16 threaded hole in the top and bottom of the enclosure to mount the Camera Head onto a tripod or other fixed mount. There are no controls or indicators on the Camera Head. There is a coarse adjustment ring in the lens mount that allows you to adjust the back focus of the lens, but do not over-tighten the screw or you will damage the lens thread. There are two camera models, monochrome and color. All cameras have IR filters that give the subject accurate color or grayscale rendering. Monochrome models without these filters are available for low light applications. Refer to Paragraph 1.1.1 for the light value requirements for each of these models. If you have the HI-G camera used in high shock conditions, you need the manual addendum 9400-0016.

3.3 The Camera Cable Auxiliary Connectors

The camera cable connects the Camera Head to the rear panel of the Controller Board in the computer. The following external functions connect to the camera cable and are available through leads terminated with a BNC connector:

1. Trigger. Connect the trigger signal to the Trigger connector with a CO-AX cable terminated with a BNC connector. Refer to paragraph 2.8.4 for details of the trigger signal.
2. Phase Lock In; Phase Lock Out. These connections enable a *Motion*Scope system to record a sequence in synchronization with another *Motion*Scope system. The slave system records one frame for each pulse, hence the slave system must be set to the same frame rate as the master system.
3. Composite Out. This output provides a video signal (NTSC or PAL) to a remote video monitor or VCR. The remote monitor shows the video image during Record when the computer monitor goes blank.

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4. Data Record Input 0; Data Record Input 1. Each Data Record input controls a marker on the video image. These inputs must be TTL signals; when the signal is +5 volts, the marker is white, and when the signal goes low (0 Volts), the marker goes black. These signal levels may be changed independently at any time during Record to identify a specific frame.
5. Strobe Out. This is a TTL output pulse, normally low that goes to +5 volts to indicate a frame exposure. The length of the pulse is synchronized to the shutter setting.

3.4 The MotionScope PCI Controller Board

Warning!

The Controller board is FRAGILE. Handle with caution to avoid bending or flexing board.

This PCI Controller board plugs into a PCI connector on the Main Board, and contains all control and image digitizing functions for the system. There are eight switches on the rear plate referenced S1 through S8. Switches S1 to S6 are factory set and must not be changed. Switch 7 enables the Data Record function when set to the RIGHT. S8 selects NTSC (LEFT) or PAL (RIGHT) for the "Composite Out" connection to a remote monitor or VCR.

3.5 The MotionScope Control Functions

All controls, status and setup values are shown in the application window. The video pictures are shown in camera windows or computer file windows. The system has five principle functions: Live, Record, Save, Load and Playback.

3.5.1 The Initial Application Window

When the program loads, the application window comes up with four menu choices:

1. Open Camera. This shows a list of cameras for you to make a selection. Clicking on a camera reference activates the Live/Setup mode and opens the camera window showing the live camera picture. See Figure 3-1.
2. Load. This brings up an Open dialog box. You can load and view a recorded sequence from a computer file on the computer disk or removable media.
3. Setup. This brings up the Property dialog box that allows you to name the camera. See Figure 3-2. This is very important if you are using more than one camera…Click on the Save Camera Size and position check box.
4. Help. Shows the Software version.

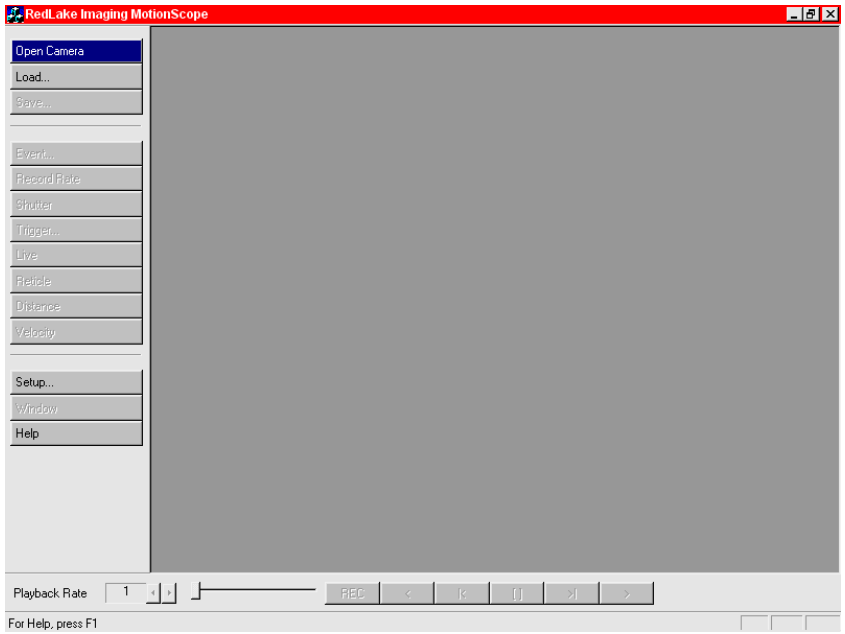


Figure 3-1 The Initial Menu.

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When you open the camera window for the first time you are prompted for a camera name, see Figure 3-2. The window then shows the live picture from the camera. When a recording has been made, this window shows live video from the camera (Live mode) or the recorded sequence stored in the image memory if you click on Play (Play mode). Each camera picture and computer file is shown in a separate window. The setup and control buttons in the application window act on the highlighted window. Click on the Window button to select a Tile or Overlay form for multiple windows.

The display under each window shows the current frame number, the number of the reference frame, and the Elapsed Time (ET) of the frame from Frame 0. If you stopped the record sequence by clicking on the Stop button, Frame 0 is the last frame in the Image Memory. All frames precede the frame when the Stop button was pressed, and all frames have negative numbers. If the Trigger ended the sequence, the Trigger Point, Frame 0, is the reference frame. When the Trigger is set to 0%, the system continues to record to the end of the image memory and all frames have positive numbers. The images follow the event that caused the Trigger. If the Trigger is set to 100%, reference Frame 0 is the last frame in the Image Memory. A mid-range Trigger Point, for example 50%, would place reference Frame 0 at the middle frame, following frames would have positive ascending numbers showing post-event images. Preceding frames have negative descending numbers and show the pre-trigger images.

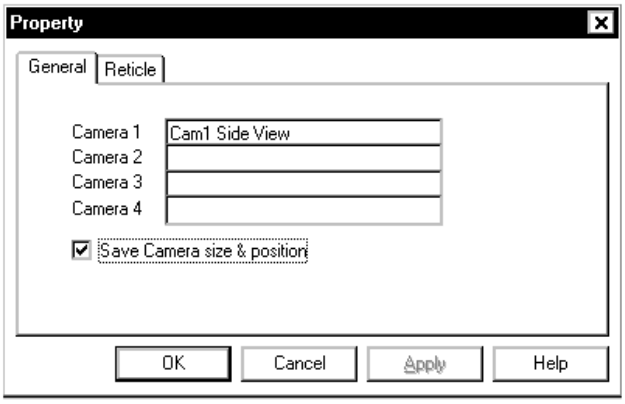


Figure 3-2 The Property/General Dialog Box.

To change the Frame 0 reference in a recorded sequence, go to the frame you want as the new reference and click on Start Frame. All frame numbers and times are referenced to the new Frame 0. This new frame is not stored and the reference is lost when the file is closed. This preserves the original trigger point information.

3.5.2 The Camera Window

When you click on Open Camera, the Main Menu appears, see Figure 3-3. A camera window opens showing live video from the camera. This mode allows you to review the current record settings (Record Rate, Shutter setting and Trigger Point setting) and enter new settings. When you click the right mouse Properties, shows system characteristics, including the model number, serial number, color/monochrome, maximum record rate, image memory capacity, driver and board revision level, and an operating message.

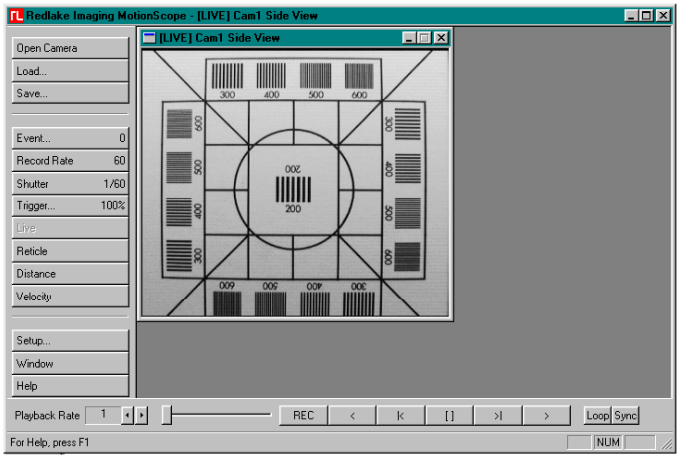


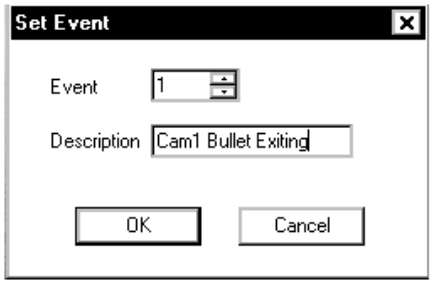
Figure 3-3 The Open Camera Window.

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Viewing and Setting the Operating Parameters

These parameters must be set to record a sequence: the Event number and description; the Record Rate; and the Shutter. Set the Trigger if it will be used to stop the recording.

3.5.2.1 Event Number

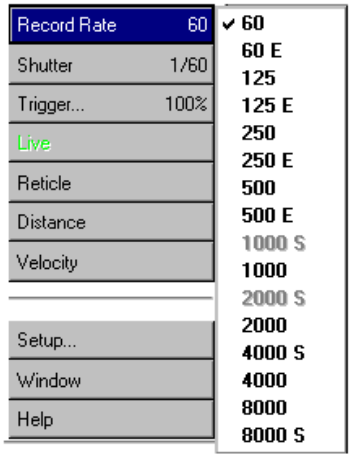


The system assigns the next number to each newly recorded sequence. The system retains the last event number when turned off so you can restart the system without resetting the event number. The Event number increments by one from 0 to 65,536, then resets to 0. You can reset this number to any value by clicking on Event and resetting the number in the dialog box. You may also enter notes for each event, up to 255 characters long. See Figure 3-4.

Figure 3-4 The Set Event Dialog Box.

3.5.2.2 The Record Rate

The Record Rate button indicates the number of frames recorded each second, measured in Frames per Second (fps). Click on the Record Rate button to see the range of record rates available on your model. As the record rate increases, the system needs more bandwidth to transmit more pixel data. At the higher rates the image size must be reduced to retain the resolution of the picture. The suffix 'S' indicates images that are reduced to half height in order to present the picture on the monitor. Refer to Appendix A for the number of pixels and the aspect ratio of the video image. Click on the button and click on another rate to change the value. See Figure 3-5.



3.5.2.3 Extended Record Rate

The Extended Record increases the recording time at frame rates up to 500 fps. This feature displays an additional range of frame rates in the Record Rate list with the suffix E, 60E, 125E, 250E and 500E.

Figure 3-5 The Record Rate Table.

3.5.2.4 The Shutter

The *Motion*Scope Camera Head has an electronic shutter with speeds of 1X, 2X, 3X, 4X, 5X, 10X and 20X, where X is the record rate that divides the exposure time. The Shutter Speed sets the exposure time for each frame to eliminate blurring due to motion. See Figure 3-6 and refer to Appendix C. Note that the picture brightness decreases as the shutter setting reduces exposure time.

When you click on the Shutter button in the application window the monitor displays the range of Shutter values. Click on a value to select a new value.

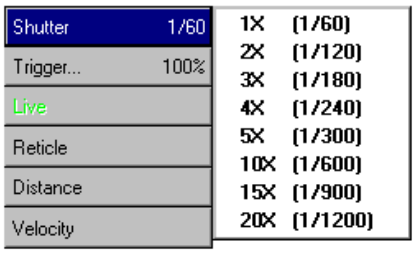


Figure 3-6 The Shutter Dialog Box.

3.5.2.5 Trigger Point

The TRIGGER POINT sets reference Frame 0 when the system receives the Trigger Signal to stop the record sequence. Use the Up and Down Arrows to select a Trigger Point value from 0% to 100% in 10% increments.

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These values must be set before you make a recording, see Figure 3-7. The Pre- and Post-Event windows show the number of frames that precede and follow Frame 0. Select the Rising Edge or Falling Edge box depending on whether the incoming Trigger signal is a positive-going or negative-going signal.

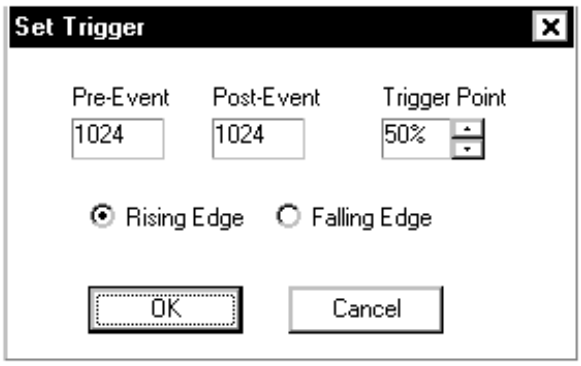


Figure 3-7 The Set Trigger Dialog Box.

3.6 Viewing Camera Properties

You can view the parameters of your PCI video system by placing the mouse pointer into a camera window during live or playback functions, and click the right mouse button. This brings up the Camera Properties dialog box with the following information. See Figure 3-8.

- Model number. The number 500, 1000, etc. denotes the maximum frame rate for the system.
- System Serial Number. Always make sure that the serial numbers for components in a system are the same. Redlake Imaging products are checked out as a system and exchanging component parts will degrade the picture quality.
- Color/Mono. This indicates whether the system presents a monochrome or color picture. This determines the settings for the host computer monitor, see Section 2-3.
- Max Record Rate. Refer to Appendix A to see the record times for your system.
- Memory Installed. Refer to Appendix A for performance details for your system.
- Drive and Board version. This information is not useful for an operator.
- Description. This indicates the current status for the system. Normally the message says: "The Camera is working properly." Contact Redlake MASD, Inc. or your supplier if this field shows any other message.

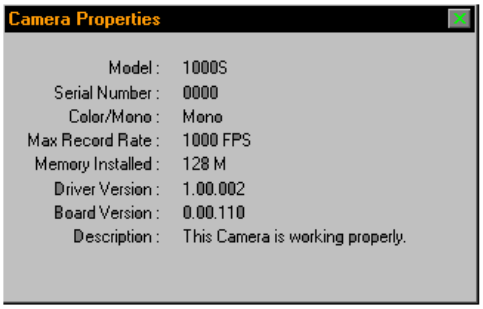


Figure 3-8 The Camera Properties.

3.7 Recording an Event

Click on the REC button and the REC button flashes to indicate that the system is recording the live image from the camera. The display goes blank but the image from the camera can be seen on a monitor connected to the Composite Out connector. The system continues to record until you click on the Stop **[ ]** button, or a Trigger signal from an external source stops the recording sequence. The display shows the last frame recorded. See Figure 3-9.

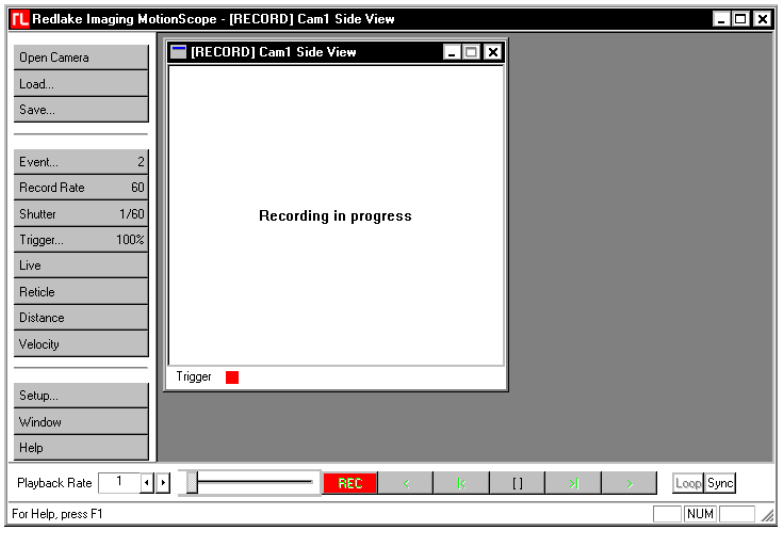


Figure 3-9 The Record Camera Window.

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The Slider stops at the position of the last frame. The display shows the number of frames recorded and the elapsed time of the sequence referenced to Frame 0. Since the image memory is overwritten in a loop, the recorded sequence will never be longer that the memory available. The number of images stored depends on the frame rate, and image memory size, refer to Appendix A.
All buttons under the display are disabled during Record, except the Stop button. The system remains in a Record/Playback mode where you may click on any of the Playback buttons to view the recorded sequence. You may also point to the window and click on the right button which shows a menu with the record parameters of the sequence, including record rate, shutter speed, trigger point (%), number of frames recorded, elapsed time of the sequence, and frame resolution. Click on Live to return to the camera view.

3.8 Saving an Event Sequence

CAUTION: DO NOT attempt to save images while the system is actively playing them in PLAYBACK mode. Attempting to save images while playing them can result in lost or scrambled image files. Set PLAYBACK mode to STOP prior to saving your images.

Since the system overwrites data in the memory, you must save the contents of the memory into a computer file before you make another recording. Click on the Save button on the application window to save the sequence stored in the image memory. This brings up a standard Save As dialog box that enables you to select the required folder and assign a filename (or accept the default Event*N* Filename, where N is the event number).

3.8.1 Selecting Frames from the Sequence

Before you click on Save, you must consider which frames you want to save and the file format to save them in. The Save dialog box defaults to recording all frames in an AVI file without compression, see Figure 3-10. The AVI file format is the only format that stores all frames under one filename, and runs continuously as a sequence. Each sequence in the image memory requires one filename.

- Range. Range enables you to specify the frame numbers you want to save and reduce the memory capacity required. The frames will retain the original frame numbers and elapsed times.
- Current Frame. This saves only the frame displayed in the active camera window.
- Frame Saving Step. This saves frames at selected intervals.

3.8.2 Selecting a File Format

There are file formats, other than AVI, that may suit your application. You can save single frames or the whole sequence in one of the formats shown below, but each frame is saved under a separate filename and cannot be run as a sequence during playback. Select a file format from the following:

- AVI file of all or part of the sequence.
- Bitmap .bmp. Single frame or a sequence of .bmp frames.
- JPEG .jpg. Single frame or a sequence of .jpg frames.
- PCX .pcx. Single or a sequence of .pcx frames (monochrome only).
- TIFF .tif. Single or a sequence of .tif frames.

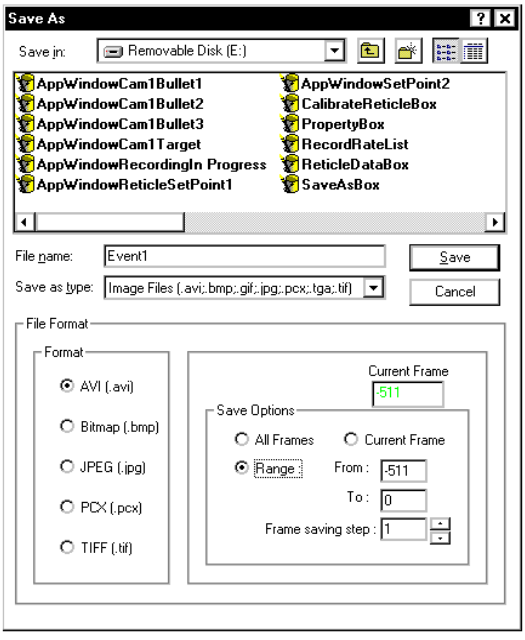


Figure 3-10 The Save As Dialog Box.

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3.8.3 File Compression

When you save an AVI file, you are prompted for a compression standard. Select a compression standard from the list, or go with the default of no compression, see Figure 3-11. Select from:

- Microsoft Video 1.
- Cinepak Codec by Radius.
- Intel Indeo (R) Video R32.

The Preview provides a window with a slider to view the compressed video, see Figure 3-12.

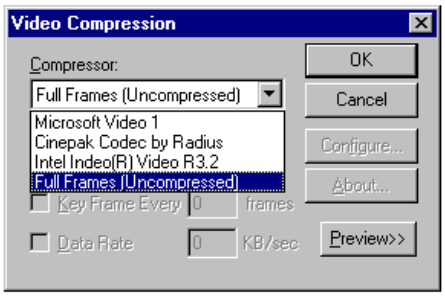


Figure 3-11 Video Compression Options.

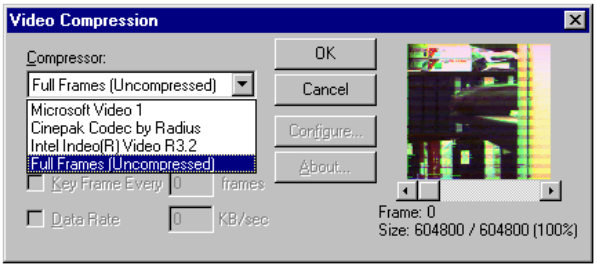


Figure 3-12 Compression Preview.

3.9 Playing from the Image Memory or a Saved File

All Play controls are on the bottom of the main menu window, and control the currently active window. The Playback Rate can be selected from a range of Step, 1, 2, 3, 4, 5, 10, 15, (25 PAL, 30 NTSC), (50 PAL, 60 NTSC), 125, 250, 500, 1000, 2000, 4000, or 8000 frames per second. You set the rate by clicking on the down ◂ or up ▸ buttons before or during a play sequence. Note that if you play back images at a faster rate than you recorded it, the frames may not run smoothly. All frames can be seen when played at a slower rate, or shown as single frames (**|<**, or **>|**). During Playback, the Slider indicates the location of the current frame in the sequence, and the display shows the current Frame number, and the elapsed time (ET). Click and hold on the Slider and drag it right or left to another frame in the sequence. The Frame number and ET windows show the current frame parameters as the Slider moves.

3.9.1 Playing from the Image Memory

CAUTION:	DO NOT attempt to save images while the system is actively playing them in PLAYBACK mode. Attempting to save images while playing them can result in lost or scrambled image files. Set PLAYBACK mode to STOP prior to saving your images.

With the camera window selected, click on a Play button (**<** or **>**) to view the sequence from the image memory. Click on the step buttons (**I< >I**) to see the next frame forward or reverse. Click and hold the Slider to fast forward or rewind the sequence.

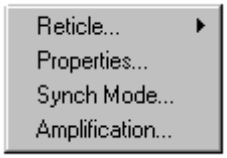
3.9.2 Playing from a Computer File

Click on the Load button to view a computer file. Select the folder and file from the dialog box. The system loads that file in a window identified with the file name. Click on the Slider to scan the contents of the file. Click on a Play button to view the video sequence at the rate shown. You may change the playback rate during play, or change the direction of replay. Click on the Live button to return to the current camera view.

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3.9.3 Reviewing the Right Click Menu

Place the pointer on the file window and click on the right mouse button for a drop-down menu with these functions:



- Reticle... Click on Reticle to activate and use the Reticle function, see 3.10 below.
- Properties... Right click on an AVI file to bring up a dialog box showing the record parameters of the file, see Figure 3-13.
- Synch Mode... See the Phase Lock feature in Section 3-11 below.
- Amplification. Color Models only. This feature, when enabled, brings out the details in dark shadows in color pictures.

Figure 3-13 The Playback Menu.

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The Dialog box shown in Figure 3-14 gives details of the record settings such as the record rate, shutter setting, number of frames stored, length of the sequence and the resolution of the video frames in pixels.

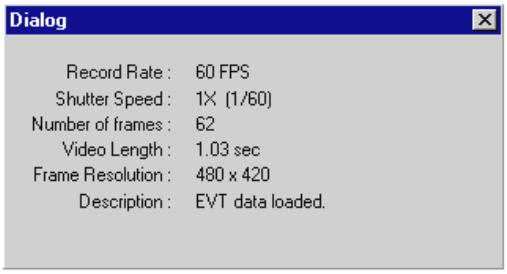


Figure 3-14 The Camera Properties.

3.10 Using the Reticle to Measure Motion

The Reticle is a playback feature that puts reference markers on a recorded video image shown in a camera or computer file window. This enables you to measure a location on an image, or measure the motion of a point of interest from frame to frame. When you enable the Reticle feature, the Reticle button shows the position of the pointer from the top left corner of the window. When you click on a position, the Reticle horizontal and vertical lines move to that point. When you right click on the picture, the system puts a colored marker on the point of point of interest.

3.10.1 Setting up the Reticle Parameters

Click on the Setup button and see the Property dialog box. Click on Reticle for the reticle details. See Figure 3-15. This shows the following:

- The width and color of the Reticle lines. To increase the width, increase the line width from 1 to 5. To change the color of the Reticle line, click on the **...** (Color) button, and select another color from the range displayed. Click Apply to view the color, and OK to color the lines.

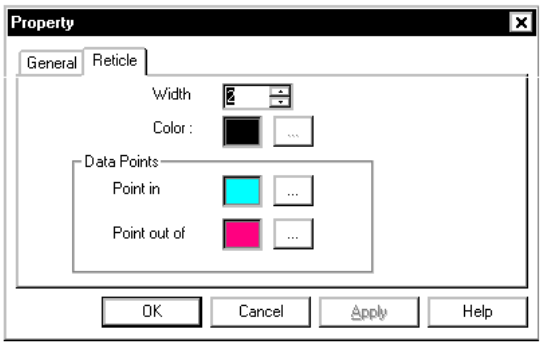


Figure 3-15 The Reticle Lines Settings.

- The color of the Reticle Data Set Points, Point In and Point Out Of. The Data Point In is the marker in the current frame. Data Point Out Of is a marker not in the current frame. To set or change the Data Point color, click on the **...** button, and select a color from the range displayed. Click Apply to view the color, and OK to color the marker, see Figure 3-16.

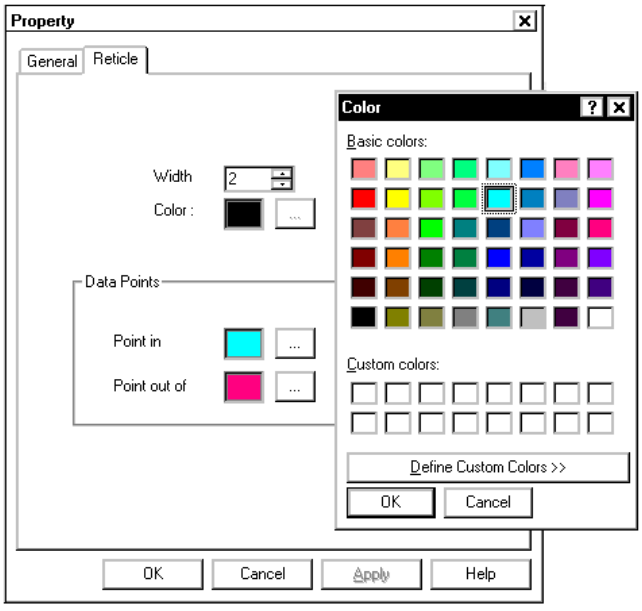
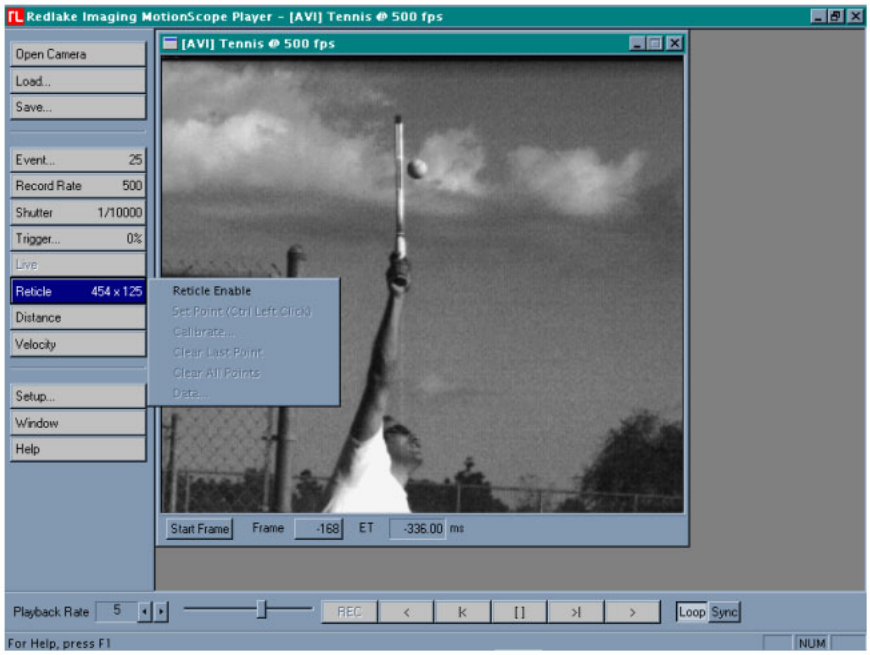


Figure 3-16 Setting the Colors of the Data Set Points.

You can proceed with the default reticle settings, or change the settings as described. When you have activated the Reticle feature as described in Section 3.10, you are ready to enter set points to mark points of interest. If you want to measure distances, you must follow the Calibration procedure below.

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3.10.2 Enabling the Reticle



- With a recorded image sequence in the window, click on the Reticle button. The Reticle menu appears with the Reticle Enable field shown. Alternatively you may right click on the image and a menu appears. Click on Reticle Enable and a check mark appears on the menu. You can now set data points and calibrate the reticle markers. See Figures 3-17 and 3-18.

Figure 3-17 Enabling the Reticle Feature.

3.10.2.1 Entering Set Points

Click and drag the reticle (or place the pointer over a location and click) to place the reticle cross point over the point of interest on the image. Release the mouse button to place the reticle at the desired location. See Figure 3-19.

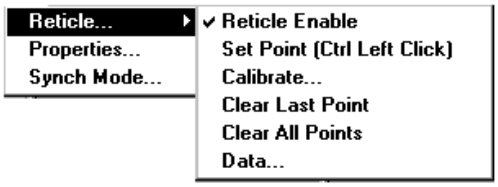
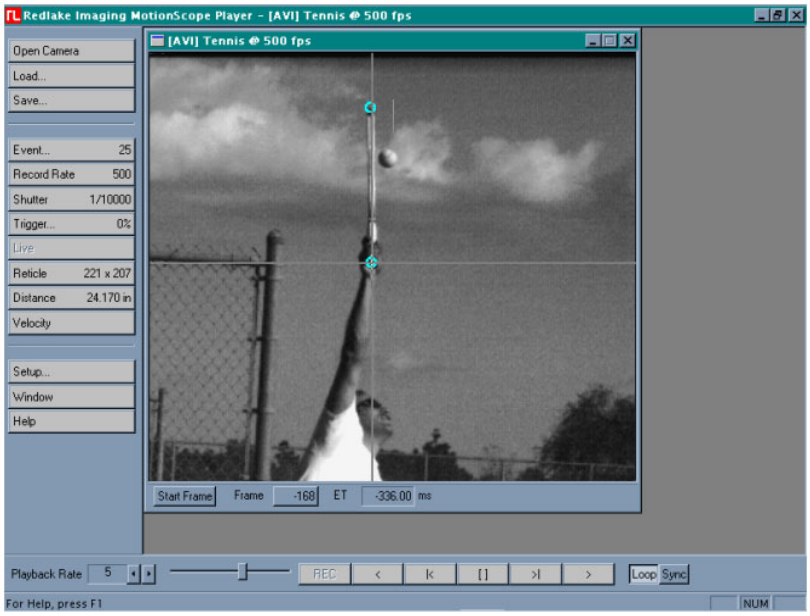


Figure 3-18 The Right Click Reticle Menu.



This places a Set Point at where the reticle lines intersect. The color of the marker indicates that this point is on the current frame. Refer to paragraph 3.10.1 above. Place another set point on the image to enable you to scale or calibrate the reticle. In this case we place the second marker at the end of the handle of the racquet since we know the length of the racquet.

Figure 3-19 The Second Marker.

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3.10.3 Calibrating the Reticle Feature

When you calibrate the reticle feature, you can measure physical distances on the monitor. If you set another data point on the frame, the system shows the distance between the two points in the units selected in the Calibration dialog box.

1. Measure the distance between two points on the subject. In this case we know the length of the racquet.
2. Click on Reticle/Calibrate. This shows the Calibrate Reticle dialog box.

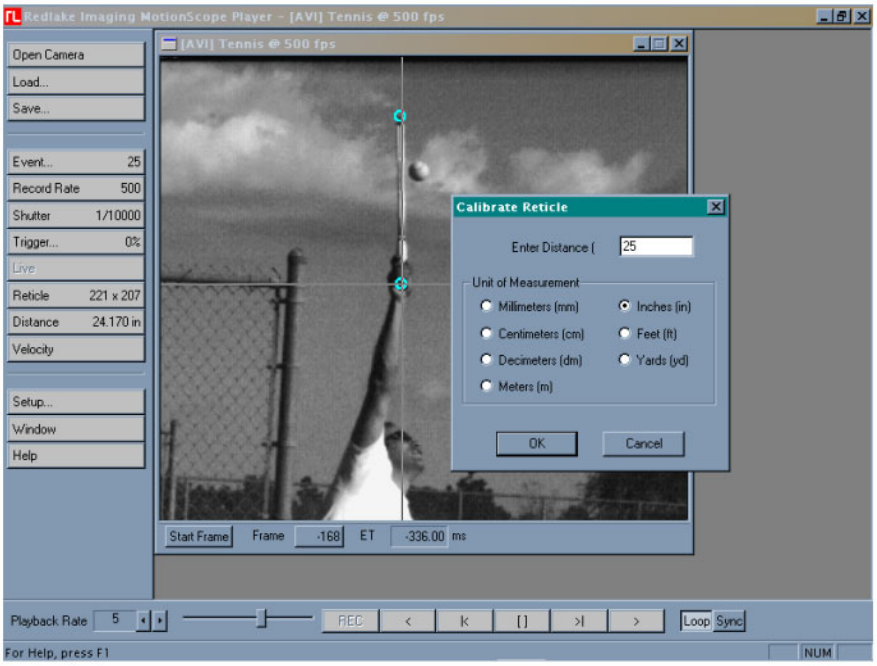


Figure 3-20 The Calibrate Reticle Dialog Box.

3. Select the unit of measurement, inches, feet, yards, millimeters, centimeters, decimeters, or meters in the dialog box, see Figure 3-20.
4. Enter the distance measured on the subject in the Distance field and click on OK.
5. Click on the Reticle button or the mouse right button while pointing in a window to bring up the Reticle dialog box:
6. The system calculates the distance between markers. Once the system is calibrated, it can measure all distances.
7. If you go to another frame and place a set point on that frame, the system can calculate the time and distance between the data points and show the velocity on the Velocity button. See Figure 3-21.

Note:
To calibrate the distance accurately, you must set the camera level and perpendicular to the plane of motion.

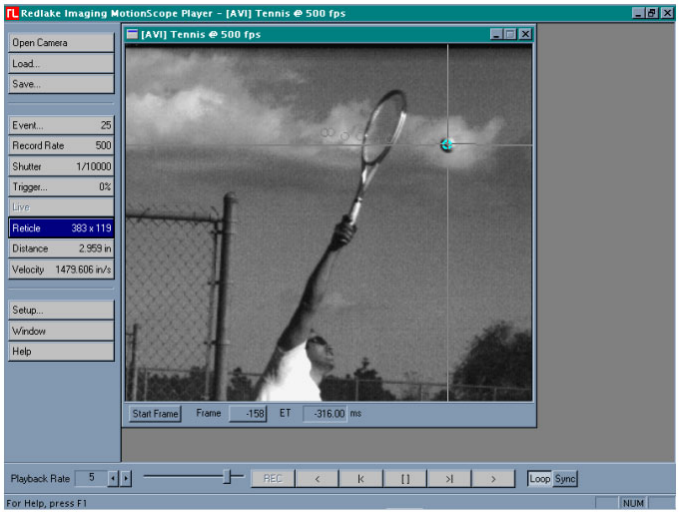
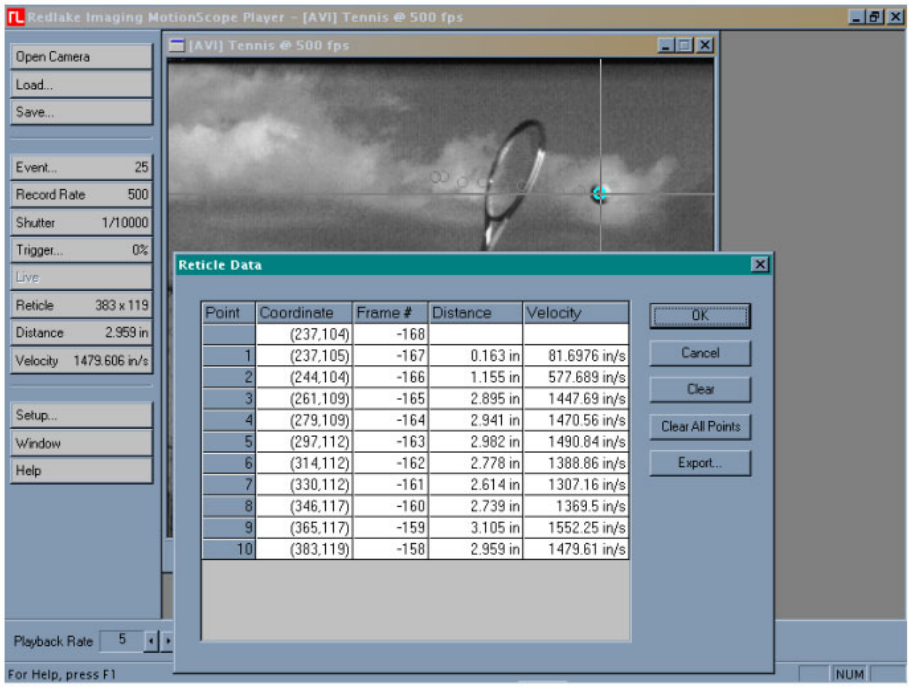


Figure 3-21 Entering a Data Point in a Later Frame.

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3.10.3.1 Data…



You can manually track the target, in this case the ball, by moving a few frames forward or back and placing a set point on the ball in each frame.
Call up the Reticle menu and click on Data… See Figure 3-22.
This brings up a dialog box listing the current set points. You may use this display to delete set points.

Figure 3-22 The Set Point Data Listing.

3.10.3.2 Deleting Set Points

There are three ways to delete set points.

1. Clear Last Point. Bring up the Reticle menu and click on Clear Last Point.
2. Clear All Points. Bring up the Reticle menu and click on clear All Points.
3. Using the Data Listing. Bring up the Reticle menu and click on Data… Select a data point in the list and click on the Clear button to clear that point. To clear all points, click on the Clear All Points button.

3.10.4 Exporting the Data Points Listing

The data points listed in Figure 3-22 are in a form that can be exported to a spreadsheet program like Excel. To export the data, highlight the points to be exported, then press the Export button.

3.11 Synchronizing a Video Sequence.

A *Motion*Scope camera can be synchronized to another MotionScope camera, or receive signals from an external source. Refer to paragraphs 1.3.4 and 2.6.5 for details of connecting the systems through the Phase Lock In and Phase Lock Out connectors.

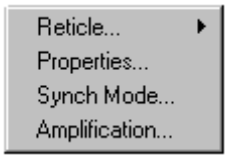


Figure 3-23 Right Click Menu.

To set up a camera, make the connections, then set the camera up as a Master or Slave by calling up the Right Click dialog box. See Figure 3-23. Make the selection on the Synch dialog box. See Figure 3-24.

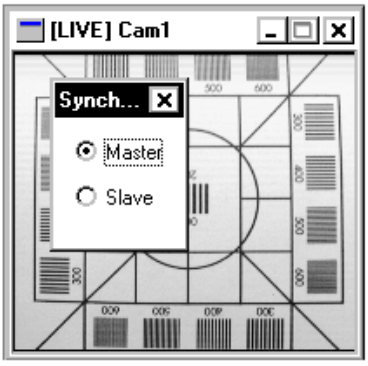


Figure 3-24 Master/Slave Selection.

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4 RECORDING ON THE *MOTION*SCOPE PCI SYSTEM

This Section describes how to load the *Motion*Scope program and open the camera window. You can then enter the required record parameters and record a video sequence in the image memory.

4.1 Load the MotionScope Program and Open the Camera Window

The program was installed in Section 2 of this manual. To load, select Start/Programs and click on *Motion*Scope. The monitor shows the Initial Menu.
To view live pictures from the camera, click on Open Camera and Select Camera 1. This opens up a window showing the live view from Camera 1. Go to paragraph 4.2.

4.2 Setting up the Camera to Record

4.2.1 Setting the Camera Parameters

Click on the Setup… button. This brings up the Properties dialog box, General tab.

1. Enter a name for Camera 1. This name will appear on the title bar of the Camera 1 window.
2. Check Save Camera Size and Position. If checked, this saves any changes you make to the camera window and its position on the screen. If not checked, the system loads default values each time the camera window is opened.
3. Click OK.

4.2.2 Set the Record Values.

Click on the following buttons at the left of the screen.

4.2.2.1 Event.

This button displays the current event number.

1. Click on Event/Set to enter a new event number and an event description. The event counter automatically increments by one each time you record an event.
2. Click on Event. Enter notes up to 255 characters about the event.

4.2.2.2 Record Rate.

The button shows the current rate set.

1. The default rate is 60 frames per second.
2. Click on this button to set a new record rate. The button displays the record rates available. Extended record rates have an E suffix.
3. The 8000 fps record rates show either a normal aspect ratio image, (8000) or the Special wide aspect ratio image (8000S).

4.2.2.3 Shutter.

This shows the current Shutter Speed.

1. The default rate set is 1X (1/60 seconds).
2. Click on Shutter to set a new speed, refer to paragraph 1.1.1 and 2.8.3 for information on the Strobe feature.

4.2.2.4 Trigger.

This button shows the current Trigger setting.

1. The default Trigger setting is 0%. This puts the Reference Frame 0 as the first frame in the Image Memory, and the system continues to record to the end of the buffer. The record sequence shows the images following the event that caused the Trigger to the end of the image memory.
2. To see the images before the event, set the Trigger to 100%. To see images before and after the event, set the Trigger to 10% to 90%, depending on the number of before and after pictures you want. The setting indicates the number of frames preceding the event.
3. Check for a rising or falling Trigger Signal.

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4.2.2.5 Data Record Inputs.

1. These inputs are normally disabled.
2. If you are using the Data Record Inputs 0 and 1, enable the feature by setting SW7, refer to paragraph 3.4.

4.3 Recording an Event Sequence

When the parameters described in paragraph 4.2 have been set, you are now ready to record. The system should be in Live mode with the live image showing in the Camera 1 window.

4.3.1.1 Click on the REC button.

1. The new image is recorded over the existing image in the Image Memory.
2. The camera window goes blank but the image being recorded can be seen on a video monitor connected to the Composite Out lead.
3. The REC button flashes.
4. The window display shows the frame number and time as the recording progresses.
5. All controls except the Stop button [ ] are disabled.
6. Recording continues and the images wrap around the image memory.

4.3.1.2 Click on the Stop [ ] button.

1. This stops the record sequence.
2. If you clicked on the Stop [ ] button to stop the record sequence, the window shows the last frame in the sequence (Reference Frame 0), and the Slider indicates the position of Reference Frame 0 in the image memory (the far right position). All other frames are shown as negative numbers with negative times, and precede Reference Frame 0.
3. If the Trigger terminates the sequence, the recording ends at the point determined by the Trigger Point setting.
4. You may now view the pictures in the image memory, record another event sequence, or click on Live to view the current camera picture. Go to Section 5 for procedures to save a sequence and analyze the data in the video pictures.

4.4 Recording on Several Synchronized Cameras

Follow this procedure to record an event on two or more synchronized cameras. Connect the cameras through their Phase Lock BNC connectors located on pigtails on the camera cable.

Set the same record rate on all cameras. Only connect and set the trigger on the Master camera. The Slave cameras will follow the Master frame by frame and stop recording when the Master stops recording. Since in the Slave(s) do not receive a trigger signal, the frame numbers and elapsed times shown assume that the Trigger Point was set to 100% and precede the last frame.

- Select the Master camera. Check that the camera is set to Master, refer to Section 3.11.
  1. Set the Record Rate, Shutter and Trigger values for the Master camera.
  2. Connect the Phase Lock Out connector of the Master to the Phase Lock Input of the Slave camera. Refer to paragraphs 1.3.4 and 2.7.5.
  3. Set the Slave camera to Slave in the Synch dialog box.
  4. Set the Record Rate to the same rate as the Master camera.
  5. Set the Shutter Speed on each camera the same unless required other wise.
  6. Connect the Phase Lock Out from the Master to the Phase Lock In on the Slave.
  7. Repeat Steps 4 through 6 on other Slave cameras.
  8. Put all cameras in Live mode, showing a live picture in each window.
  9. Click on the **REC** button of the Slave(s). The Camera Window goes white, but the Slave cameras do not record.
  10. Click on the Master **REC** button to record the sequence; the Camera Window goes white.
  11. To stop the video sequence, click on the Master Stop **[ ]** button or send a trigger signal.
  12. Click on the Stop buttons of the Slave(s).
  13. Click on the Play **< >** buttons to view the sequence. Click on Live to return to Live mode.

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4.5 Recording from an External Signal Source

A *Motion*Scope camera in Slave mode can record images synchronized to an external source, when a phase lock signal is input into the Phase Lock In connector. Refer to paragraph 2.7.5 for details of the Phase Lock In signal. All cameras are set to Slave, and the Trigger function does not operate on a Slave camera. The Record Rate set on the Slave(s) must be faster than the pulses received by the Phase Lock In connector. If the Record Rate deviates from the standard range of 50/60 through 8000 fps., the Playback Window does not show accurate elapsed times.

1. Set the Slave camera to Slave in the Synch dialog box (refer to paragraph 3.11).
2. Set the Record Rate to a rate faster than the source signal rate.
3. Set the Shutter Speed on each camera the same unless required other wise.
4. Connect the external source to the Phase Lock In on the Slave (refer to paragraph 1.3.4).
5. Repeat Steps 1 through 3 on other Slave cameras.
6. Put all cameras in Live mode, showing a live picture in each window.
7. Click on the **REC** button of the Slave(s). The Camera Window goes white, but the Slave cameras do not record.
8. Control the recorded sequence using the pulses from the external signal source.
9. Click on the Stop **[ ]** buttons of the Slave(s).
10. Click on the Play **< >** buttons to view the sequence. Click on Live to return to the Live mode.

4.6 Viewing the Stored Image

CAUTION:	DO NOT attempt to save images while the system is actively playing them in PLAYBACK mode. Attempting to save images while playing them can result in lost or scrambled image files. Set PLAYBACK mode to STOP prior to saving your images.

You can review the image in the Image Memory immediately.

1. Set the Playback Rate to the playback speed required. This can be faster or slower than the Record Rate.
2. To fast forward to find the frames of interest, click and hold on the Slider, and move the Slider forward or back. The video display and the Frame number and elapsed time indications follow the position of the Slider.
3. Click on the play buttons to view the video forward (>) or reverse (<) at the frame rate set in the Playback Rate window.
4. Click on the Step buttons to view each frame of the video forward (>I) or back (I<).
5. To change the reference frame, click on Start Frame. This resets Reference Frame 0 to the frame currently displayed. All other frames are renumbered, and the time of each frame (ET) is set in relation to the new Reference Frame 0.
6. To display the record parameters for this sequence, point to the Window and click on the right mouse button.
7. To go back to the live camera image, click on the Live button.

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5 VIEWING AND PROCESSING STORED IMAGES

Each recorded sequence overwrites the existing contents of the Image Memory. You must save an event sequence in a computer file before you make another recording. This section describes how to save a sequence of images, replay them, and study the subject by viewing at different frame rates. This section also describes using the Reticle feature used to measure the distances traveled and velocities of points of interest. Each sequence from the Image Memory may be stored in one AVI file. Single frames and streams of frames may be saved in other graphic file formats for editing and import into other applications. In all video standards except AVI, each frame is assigned a different file name. This is done by the computer and does not affect the operating procedures.

CAUTION: DO NOT attempt to save images while the system is actively playing them in PLAYBACK mode. Attempting to save images while playing them can result in lost or scrambled image files. Set PLAYBACK mode to STOP prior to saving your images.

5.1 Saving the Contents of the Image Memory

When the recorded sequence is stopped by clicking on the Stop **[ ]** button, the monitor shows the last frame in the image memory that is Reference Frame 0. If a trigger stops the recording process, the reference frame location is determined by the Trigger Point setting.

1. Click on the Save button. A Save dialog box appears.
2. Assign a file and folder name to the sequence. All other related data are stored with the file, such as the record parameters, event number, frame numbers, camera name, and notes made in the Event dialog box.
3. The screen defaults to saving the complete sequence in an AVI file. If you want all of the contents of the image memory, click on Save now. Go to paragraph 5.2.
4. To save the Current Frame, or a Range of frames, click on the radio button. For a Range, specify the start and finish frame numbers, and whether to save all frames, or one frame per interval through the sequence (Frame Saving Step), such as, for example, saving every third frame.
5. To save a single frame and import it into another applications program, you may want to use one of the standard graphic file formats (.bmp; .gif; .jpg; .pcx,; .tga; .tif).
6. Click on Save.
7. The Compression dialog box appears with no compression as standard. Click on OK or select a compression standard and click on OK. The file is saved in the specified folder.

5.2 Replaying a Saved File

To retrieve and replay a stored video sequence:

1. Click on the Load button. The Open window shows lists of files.
2. Select the required file and click on Open.
3. A new window appears showing the Reference Frame 0. If you stopped recording with the Stop [ ] button, the file loads showing the last frame in the file as Reference Frame 0. If a trigger stopped the recording, the Reference Frame 0 is located as determined by the Trigger Point setting.
4. Set the Playback Rate for the optimum speed.
5. Click on a play or step button to view the file, or use the Slider to fast forward or rewind the sequence.
6. Click on the Stop [ ] button to stop the display.
7. To display the record parameter settings, click on the right mouse button.
8. Click on Properties to display the record parameters.
9. Click on the Live button to return to the current picture from the camera.

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5.3 Setting up the Reticle to Measure Motion

The Reticle can be used to measure the distances and speed of travel of a point of interest in the event sequence. First enable the Reticle feature, create the Set Points, and then calibrate the Reticle to give accurate distance and velocity readings.

5.3.1 Setting the Reticle Attributes

1. Click on the Setup… button and select the Reticle tab or click on Reticle/Data.
2. Set the width of the Reticle cross lines (1-5 pixels) and their color.
3. Set the color of the Data Points, giving a different color for the Point In Set Point, and the Point Out Of Set Point for clear frame-to-frame identification.
4. Click on Apply or OK.
5. Go to paragraph 5.3.2.

5.3.2 Setting and Clearing Data Points

1. Click on the Reticle button, and click on Reticle Enable. Or: right click with the pointer in a Playback or File window. Click on Reticle Enable.
2. Find the frame showing the first point of interest.
3. Click and hold the left mouse button and drag the reticle to the first point of interest. When the target lines are accurately placed, release the left button. Enter the Set Point location. This defines the Point In.
4. Find the frame showing the next point of interest.
5. Click and hold on the video display at the location of the next point of interest, and when the target lines are placed accurately, release the left button on the newest Set Point location.
6. At any time you may clear the last Set Point, or clear all Set Points.

5.3.3 Calibrating for Distance and Velocity Measurements

1. Go to the subject and physically measure the distance between two points perpendicular to the camera view. Set the two points.
2. Click on Reticle/Calibrate. Enter the units of measurement and the physical distance between the two points.
3. Note that the camera can only measure these distances in two dimensions perpendicular to the camera angle.

5.3.4 Data

A table shows the current list of active Data Points. You may use this box to view the current data points and delete data points not required.

5.4 Analyzing the Motion of the Subject

1. Use the Slider to locate the part of the sequence to be viewed.
2. Set the Playback Rate for the required speed of viewing.
3. Click on the play (< >) or step (I< >I) buttons to view the sequence.
4. Click on the Loop button to repeat the sequence continuously.
5. Stop the playback function at the frame where the point of interest as the image shows the frames with the Set Points, the Distance and Velocity fields show the values for this event.
6. Click on Live to return to the current image from the camera.

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6 MAINTENANCE AND TROUBLESHOOTING

6.1 Routine Maintenance

The *Motion*Scope system requires no scheduled routine maintenance, except for cleaning the lens. The frequency of cleaning depends on the operating environment. Use a lens brush; do NOT wipe the lens with a cloth or tissue.
If the suggestions given in this section do not resolve the problem, call Redlake MASD, Inc. or your local representative.

6.2 Troubleshooting

6.2.1 System does not Load

1. Check that both camera cable connectors are properly seated. Tighten the screws.
2. Check that the Controller board is properly seated in its PCI slot.

6.2.2 No Picture in the Camera Window

1. Lens cover on?
2. Lens aperture closed?
3. F/SEC RECORD or SHUTTER SPEED settings too fast?
4. Camera cable connected?
5. Camera cable damaged?
6. Insufficient illumination? The *Motion*Scope camera requires very high illumination to operate at high speeds and short shutter settings.
7. Display not set correctly (Start/Settings/Control Panel/Display). Set the resolution to 1024x768.
    - Monochrome systems – 256 colors.
    - Color systems – True Color 24- or 32-bit.
8. Wrong software revision level.
9. Dirty contacts on the Controller board PCI connector. Remove the board and clean the contacts with an appropriate cleaner or a pencil eraser.

6.2.3 Waffle Pattern on the Monitor

This pattern, see Figure 6-1, or black screen indicates that there is no video signal to the monitor. This could be a result of:

1. The camera or camera cable not connected. Check that the connectors are fully installed.

WARNING!
Do NOT disconnect or reconnect the camera or camera cable with the power ON.

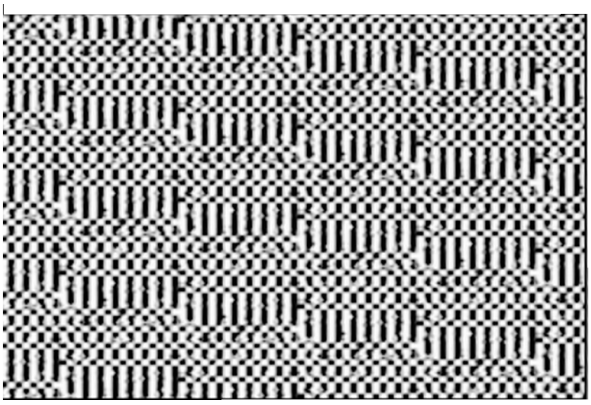


Figure 6-1 The Waffle Pattern.

2. You have connected the camera or camera cable with the power ON. Turn the computer OFF. Check that the cable connectors are properly installed, and then reboot the system.
3. If this does not restore the picture, call Redlake MASD, Inc. or your service center.

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6.2.4 Video Channel Imbalance

The video image is taken from two analog video channels from the Imager in the camera. If these two channels are not balanced you will see a picture with horizontal lines as shown in Figure 6-2. Call your nearest service representative or Redlake MASD, Inc..



Figure 6-2 Video Channel Imbalance.

6.3 Using Another Camera or Cable to Locate a Fault

If you have more than one *Motion*Scope system, you can connect another camera head and camera cable to the Control/Display Unit to determine whether the fault is located in the camera head, the cable or connectors, or in the Controller board.

NOTE: Always replace a camera or camera cable with one of the same version. For example, a –07 camera must replace an existing –07 camera. A –06 camera will not work with that system. Check that the Serial Number and Revision Level are the same on each component in a system.

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APPENDIX A PERFORMANCE PARAMETERS

These tables give the record times and frame storage for all PCI models. The suffix E denotes extended record time. The suffix S indicates a full width reduced size image.

*Motion*Scope® 1000 S Monochrome Recording Time (Sec.) / Frame Storage

Frame Rate	Resolution	Standard Memory		Enhanced Memory		Maximum Memory	
(Frames/Sec)	(Pixels)	# of Frames	Record Time	# of Frames	Record Time	# of Frames	Record Time
50	480 x 420	512	10.2 Sec.	1,024	20.5 Sec.	2,048	41.0 Sec.
50E	240 x 210	2,048	41.0 Sec.	4,096	82.0 Sec.	8,192	163.8 Sec.
60	480 x 420	512	8.5 Sec.	1,024	17.1 Sec.	2,048	34.2 Sec.
60E	240 x 210	2,048	34.2 Sec.	4,096	68.3 Sec.	8,192	136.5 Sec.
125	480 x 420	512	4.1 Sec.	1,024	8.2 Sec.	2,048	16.4 Sec.
125E	240 x 210	2,048	16.4 Sec.	4,096	32.8 Sec.	8,192	65.5 Sec.
250	480 x 420	512	2.0 Sec.	1,024	4.1 Sec.	2,048	8.2 Sec.
250E	240 x 210	2,048	8.2 Sec.	4,096	16.4 Sec.	8,192	32.8 Sec.
500	320 x 280	1,024	2.0 Sec.	2,048	4.1 Sec.	4,096	8.2 Sec.
500E	240 x 210	2,048	4.1 Sec.	4,096	8.2 Sec.	8,192	16.4 Sec.
1000S	320 x 156	2,048	2.0 Sec.	4,096	4.1 Sec.	8,192	8.2 Sec.

*Motion*Scope® 2000 S Monochrome Recording Time (Sec.) / Frame Storage

Frame Rate	Resolution	Standard Memory		Enhanced Memory		Maximum Memory	
(Frames/Sec)	(Pixels)	# of Frames	Record Time	# of Frames	Record Time	# of Frames	Record Time
50	480 x 420	512	10.2 Sec.	1,024	20.5 Sec.	2,048	41.0 Sec.
50E	240 x 210	2,048	41.0 Sec.	4,096	82.0 Sec.	8,192	163.8 Sec.
60	480 x 420	512	8.5 Sec.	1,024	17.1 Sec.	2,048	34.2 Sec.
60E	240 x 210	2,048	34.2 Sec.	4,096	68.3 Sec.	8,192	136.5 Sec.
125	480 x 420	512	4.1 Sec.	1,024	8.2 Sec.	2,048	16.4 Sec.
125E	240 x 210	2,048	16.4 Sec.	4,096	32.8 Sec.	8,192	65.5 Sec.
250	480 x 420	512	2.0 Sec.	1,024	4.1 Sec.	2,048	8.2 Sec.
250E	240 x 210	2,048	8.2 Sec.	4,096	16.4 Sec.	8,192	32.8 Sec.
500	320 x 280	1,024	2.0 Sec.	2,048	4.1 Sec.	4,096	8.2 Sec.
500E	240 x 210	2,048	4.1 Sec.	4,096	8.2 Sec.	8,192	16.4 Sec.
1000	240 x 210	2,048	2.0 Sec.	4,096	4.1 Sec.	8,192	8.2 Sec.
2000S	240 x 92	4,096	2.0 Sec.	8,192	4.1 Sec.	16,384	8.2 Sec.

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*Motion*Scope® 8000 S Monochrome Recording Time (Sec.) / Frame Storage

Frame Rate	Resolution	Standard Memory		Enhanced Memory		Maximum Memory	
(Frames/Sec)	(Pixels)	# of Frames	Record Time	# of Frames	Record Time	# of Frames	Record Time
50	480 x 420	512	10.2 Sec.	1,024	20.5 Sec.	2,048	41.0 Sec.
50E	240 x 210	2,048	41.0 Sec.	4,096	82.0 Sec.	8,192	163.8 Sec.
60	480 x 420	512	8.5 Sec.	1,024	17.1 Sec.	2,048	34.2 Sec.
60E	240 x 210	2,048	34.2 Sec.	4,096	68.3 Sec.	8,192	136.5 Sec.
125	480 x 420	512	4.1 Sec.	1,024	8.2 Sec.	2,048	16.4 Sec.
125E	240 x 210	2,048	16.4 Sec.	4,096	32.8 Sec.	8,192	65.6 Sec.
250	480 x 420	512	2.0 Sec.	1,024	4.1 Sec.	2,048	8.2 Sec.
250E	240 x 210	2,048	8.2 Sec.	4,096	16.4 Sec.	8,192	32.8 Sec.
500	320 x 280	1,024	2.0 Sec.	2,048	4.1 Sec.	4,096	8.2 Sec.
500E	240 x 210	2,048	4.1 Sec.	4,096	8.2 Sec.	8,192	16.4 Sec.
1000	240 x 210	2,048	2.0 Sec.	4,096	4.1 Sec.	8,192	8.2 Sec.
2000	160 x 140	4,096	2.0 Sec.	8,192	4.1 Sec.	16,384	8.2 Sec.
8000S	160 x 30	16,384	2.0 Sec.	32,768	4.1 Sec.	65,536	8.2 Sec.
8000	60 x 68	16,384	2.0 Sec.	32,768	4.1 Sec.	65,536	8.2 Sec.

*Motion*Scope® Color Models 1000 SC/2000SC.Recording Time (Sec.) / Frame Storage

Frame Rate	Resolution	Standard Memory		Enhanced Memory		Maximum Memory	
(Frames/Sec)	(Pixels)	# of Frames	Record Time	# of Frames	Record Time	# of Frames	Record Time
50(C)	480 x 420	512	10.2 Sec.	1,024	20.5 Sec.	2,048	41.0 Sec.
50E	240 x 210	2,048	41.0 Sec.	4,096	82.0 Sec.	8,192	163.8 Sec.
60(C)	480 x 420	512	8.5 Sec.	1,024	17.1 Sec.	2,048	34.1 Sec.
60E	240 x 210	2,048	34.2 Sec.	4,096	68.3 Sec.	8,192	136.5 Sec.
125(C)	480 x 420	512	4.1 Sec.	1,024	8.2 Sec.	2,048	16.4 Sec.
125E	240 x 210	2,048	16.4 Sec.	4,096	32.8 Sec.	8,192	65.6 Sec.
250(C)	480 x 420	512	2.0 Sec.	1,024	4.1 Sec.	2,048	8.2 Sec.
250E	240 x 210	2,048	8.2 Sec.	4,096	16.4 Sec.	8,192	32.8 Sec.
500(C)	320 x 280	1,024	2.0 Sec.	2,048	4.1 Sec.	4,096	8.2 Sec.
500E	240 x 210	2,048	4.1 Sec.	4,096	8.2 Sec.	8,192	16.4 Sec.
1000(C)	240 x 210	2,048	2.0 Sec.	4,096	4.1 Sec.	8,192	8.2 Sec.
2000(SC)	240 x 92	4,096	2.0 Sec.	8,192	4.1 Sec.	16,384	8.2 Sec.

*Motion*Scope® 500/500C Recording Time (Sec.) / Frame Storage

Frames	Resolution	Standard Memory		Memory Upgrade		Enhanced Memory		Maximum Memory	
(Frames /Sec)	(Pixels)	# of Frames	Record Time	# of Frames	Record Time	# of Frames	Record Time	# of Frames	Record Time
50	480 x 420	256	5.1 Sec.	512	10.2 Sec.	1,024	20.5 Sec.	2,048	41.0 Sec.
50E	240 x 210	1024	20.5 Sec.	2,048	41.0 Sec.	4,096	82.0 Sec.	8,192	163.8 Sec.
60	480 x 420	256	4.2 Sec.	512	8.5 Sec.	1,024	17.1 Sec.	2,048	34.2 Sec.
60E	240 x 210	1024	17.1 Sec.	2,048	34.2 Sec.	4,096	68.3 Sec.	8,192	136.5 Sec.
125	480 x 420	256	2.0 Sec.	512	4.1 Sec.	1,024	8.2 Sec.	2,048	16.4 Sec.
125E	240 x 210	1024	8.2 Sec.	2,048	16.4 Sec.	4,096	32.8 Sec.	8,192	65.5 Sec.
250	480 x 420	256	1.0 Sec.	512	2.0 Sec.	1,024	4.1 Sec.	2,048	8.2 Sec.
250E	240 x 210	1024	4.1 Sec.	2,048	8.2 Sec.	4,096	16.4 Sec.	8,192	32.8 Sec.
500	320 x 280	512	1.0 Sec.	1,024	2.0 Sec.	2,048	4.1 Sec.	4,096	8.2 Sec.
500E	240 x 210	1024	2.0 Sec.	2,048	4.1 Sec.	4,096	8.2 Sec.	8,192	16.4 Sec.

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APPENDIX B PERFORMANCE SPECIFICATIONS

Software	Point and click environment for Windows NT® with Service Pack 5; or Windows 2000®.
Computer Requirement	Minimum Pentium II with MMX, 1024x768 display, 128Mb RAM, 3Gb Hard Drive, CD-ROM Drive, ZIP or JAZ Drive, 2 PCI Slots.
Multi-Camera Operation	Up to four systems in one computer.
Sensor Resolution:	656x496 Pixels, each pixel 7.4 microns square.
Record Rates:	(50 PAL), 60, 125, 250, 500, 1000, 2000, and 8000 fps.
Exposure Rates:	Electronic shutter operates at 1X, 2X, 3X, 4X, 5X, 10X, 20X of the set recording rate. Exposure times range from 1/60th sec. (1/50th for PAL) to 1/80,000th sec. depending upon the model.
Record Mode:	The system records when you click on the **REC** button. **(Manual)** Continues to store images in the memory until you click on the Stop **[ ]** button. **(Trigger)** If the Trigger signal stops the Recording sequence, the system may continue to store images to the end of the buffer, depending on the Trigger Point setting.
Frame Storage:	512, 1024, 2048, 4096, 8192, 12,288, 16384, 24576, 32768 or 65536-frames depending on the model.
Playback Rates:	Single frame (Step) mode, 1, 2, 3, 4, 5, 10, (25 PAL), 30, (50 PAL), 60, 125, 250, 500, 1000, 2000, and 8000 frames per second, forward or reverse.
Status Display:	Event No., Record Rate, Shutter, Trigger Point, Reticle Distance and Velocity. Frame No, Time of Frame (ms).
External Connections	Input connections on the Camera cable for the Trigger, Strobe, Data Record, Composite Out and Phase Lock In-Out.
Trigger Input:	(1) 0-volt input (held to ground by a 2K resistor at the source), rising to +5 volts (up to +30 volts permitted). (2) Contact closed rising to +5 volts when contact opens. (3) +5 volts falling to 0 volts by a contact closure. BNC connector.
Phase Lock In/Out Signal:	TTL level, square wave, activated on the rising edge. PHASE LOCK IN is pulled to high by an internal 10K resistor.
Video Output**:**	RS-170 NTSC and PAL (monochrome or color, selectable) BNC connector to VCR's and external monitors.
Video Display**:**	Computer monitor or an external video monitor through the Video Out connector.
Data Recording:	Two TTL inputs (Inputs 0 and 1) through two BNC connectors on the Camera cable. Input at +5 volts gives a white marker; 0 volts gives a black marker. Operated by contact closure.
Strobe Output:	TTL pulse normally low, goes high during exposure, available through the Strobe BNC connector on the Camera cable.
Lens:	Standard C-mount, refer to Appendix D.
PCI Interface	The Controller board conforms to PCI 2.1, and uses a PLX 9080 Bridge IC.
Size:	Controller, full size PCI card, two slots required. Camera Head: 2-1/2”(6.2cm) H, 2-1/2” (6.2) W, 4” (10cm) L.
Weight:	Controller: 1 lb. (0.5 kg). Camera Head: 1.5 lb. (0.7 kg)
Power:	Controller: +12 volts DC, 0.8 amps; +5 volts, 2.0 amps.
Operating Environment:	0°F to 115° F (-18°C to 40°C).

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APPENDIX C EXPOSURE AT EACH SHUTTER SPEED

This table gives exposure times and the length of the strobe signal output over the range of the shutter speeds. Shutter speeds of 1X to 20X are available on all models.
This table gives record rates in frames per second (fps). The model number indicates the maximum frame rate for each system. For example, a 1000 S has frame rates of 60 (50 PAL), 125, 250, 500 and 1000 fps.

Exposures vs. Shutter Speeds and Record Rate (Frames per Second)

Shutter Speed	50	60	125	250
1X	20.0 ms	17.00 ms	8.00 ms	4.00 ms
2X	10.0 ms	8.30 ms	4.00 ms	2.00 ms
3X	6.7 ms	5.60 ms	2.67 ms	1.33 ms
4X	5.0 ms	4.20 ms	2.00 ms	1.00 ms
5X	4.0 ms	3.30 ms	1.65 ms	0.80 ms
10X	2 0 ms	1.70 ms	0.80 ms	0.40 ms
15X	1.3 ms	1.10 ms	0.54 ms	0.27 ms
20X	1.0 ms	0.83 ms	0.40 ms	0.20 ms

Shutter Speed	500	1,000	2,000	8000
1X	2.000 ms	0.910 ms	0.410 ms	0.120 ms
2X	1.000 ms	0.500 ms	0.250 ms	0.060 ms
3X	0.665 ms	0.335 ms	0.165 ms	0.040 ms
4X	0.500 ms	0.250 ms	0.125 ms	0.030 ms
5X	0.400 ms	0.200 ms	0.100 ms	0.025 ms
10X	0.200 ms	0.100 ms	0.050 ms	0.010 ms
15X	0.130 ms	0.060 ms	0.030 ms	0.005 ms
20X	0.100 ms	0.050 ms	0.025 ms	0.005 ms

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APPENDIX D ACCESSORIES

Standard Accessory Kit for the *Motion*Scope System	**1900-0001**

Includes Tripod, Light Kit, Zoom Lens, Trigger Switch, Articulated Arm with Clamp, and Storage/Shipping Case.

Memory Upgrade	2700-0003
Enhanced Memory Upgrade	2700-0001
Maximum Memory Upgrade	2700-0002
Hi-G Camera Option	1700-0004
Low Light Camera Option (Factory installed)	1700-0005
CS Lens Mount Option	1700-0006
C-Mount Lenses:	
8 mm Lens, f/1.3, DO Industries	9001-0389
12.5 mm Lens, f/1.3, DO Industries	9001-0390
17 mm Lens, f/0.95, DO Industries	9001-0391
25 mm Lens, f/0.95, DO Industries	9001-0392
50 mm Lens, f/0.95, DO Industries	9001-0393
4.3 mm Lens, f/1.6 Cosmicar	9001-0401
6 mm Lens, f/1.2 Cosmicar	9001-0402
8.5 mm Lens, f/1.5 Cosmicar	9001-0403
12.5 mm Lens, f/1.2 Cosmicar	9001-0404
25 mm Lens, f/1.8 Cosmicar	9001-0405
3.5 mm Lens, f/1.6 Rainbow	9001-0406
50 mm Lens, f/1.4 Cosmicar	9001-0408
C Mount Zoom Lenses:	
12.5-75 mm Zoom Lens, f/1.8 w Macro, Toyo	9001-0376
8-48 mm Zoom Lens, f/1.2, Cosmicar	9001-0386
Lens Accessories:	
C-Mount extension tube set	9002-0001
Nikon F to C Mount Adapter	9002-0023
49 mm Close-up Lens Set (+1, +2, +4) Toyo only	9002-0058
52 mm Close-up Lens Set (+1, +2, +4) Fujinon only	9002-0055
55 mm Close-up Lens Set (+1, +2, +4) Cosmicar only	9002-0059
2X Extender for C-Mount Lens	9002-0056
Trigger and Remote Control:	
Trigger Switch, 10 ft Cable and BNC Connector	1700-0001
Remote Control Unit, 15 ft Cable and Serial Connector	1700-0003
Tripods and Mounting Devices:	
Tripod, Bogen #3021 Stand and #3047 Head	9005-0059
Tripod, Bogen #3021S Stand and #3030 Head	9005-0071
Tripod, Bogen #3008 Stand and #3009 Head	9005-0070
Clamp, Bogen, #2900	9005-0060
Bogen variable friction arm with camera mount	9005-0061

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Appendix C (Continued):

Cables:	
Camera Cable, 15 ft with seven 12” Pigtail Connectors	1800-0002
Camera Cable, 50 ft with seven 12” Pigtail Connectors (Monochrome only)	1800-0004
Cable Co-Ax 10-foot with BNC Connectors	9031-0019
Power cord,	9037-0011
Monitors and VCRs:	
Monitor, Sony PVM-137, 14” Monochrome with underscan	9017-0007
Monitor, Sony PVM-14M2U, 13” Color	9017-0013
VCR, Sony GV-A500 4 Head, Super 8, portable	9017-0079
VCR, Panasonic AG1330 4 Head, HQ System	9017-0080
BNC to RCA Adapter	9042-0519
Lights and Light Accessories:	
Light, Lowell Pro #P1-10	9003-0037
Bulb, #GCA, 120V, 250W	9003-0039
Set of barn doors for Lowell light #IP20	9003-0040
Bogen light stand #3373	9003-0038
Lowell Light Kit	1900-0002
Cart:	
Cart, 4-Wheel for *Motion*Scope S Series, Monitor, Video Recorder, Cables and Accessories	9018-0079
Cases:	
Carrying Case for *Motion*Scope and System Accessories	9033-0039
Carrying Case for *Motion*Scope and System Accessories (ATA Rated)	9033-0040

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