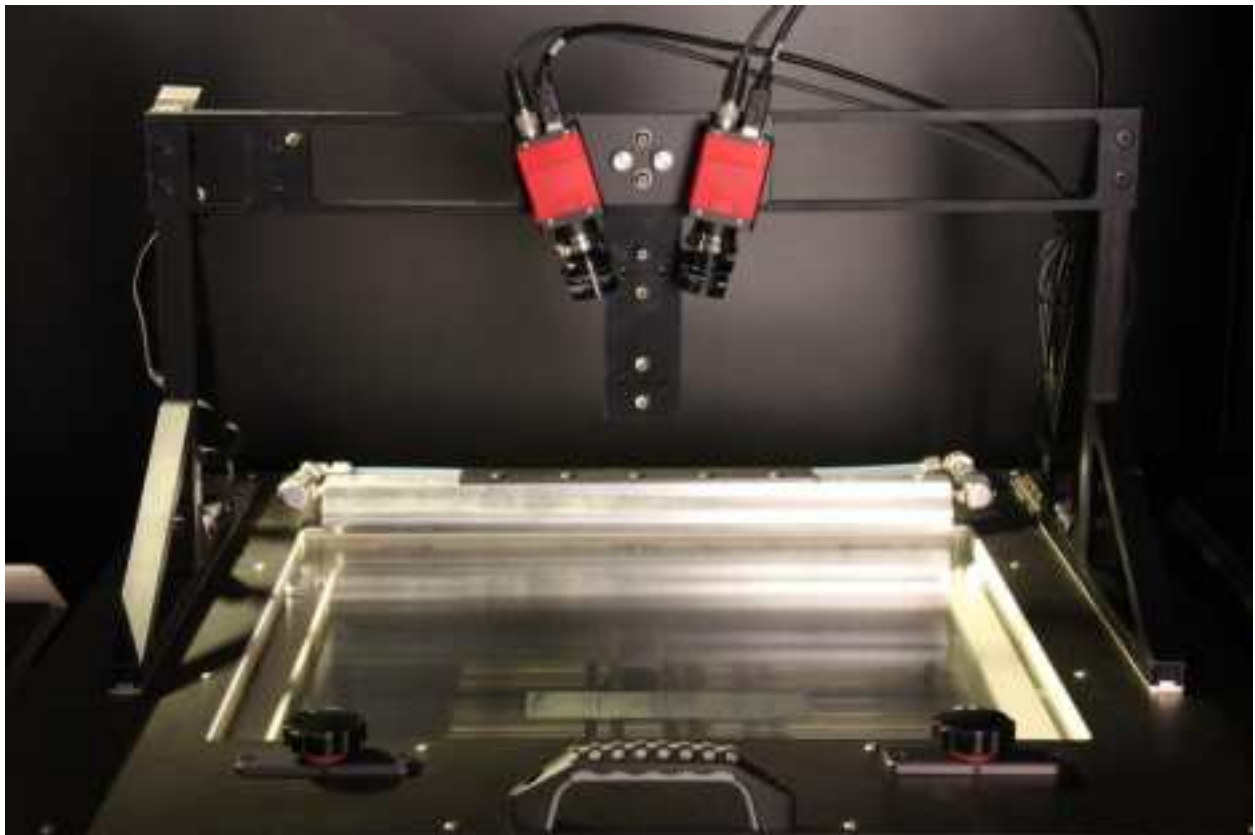




DIC



USER MANUAL

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DIC USER MANUAL

Contents

1 Introduction.....	4
1.1 Overview.....	4
1.2 Warnings and Precautions.....	4
1.3 System Configuration.....	6
1.4 Technical Support.....	6
2 Basic System Set-up	8
2.1 System Set-up	8
2.2 System Alignment.....	11
2.3 Calibration.....	13
2.4 System Removal and Shutdown	13
3 Troubleshooting	15
3.1 Failure to Initialize the Cameras	15
Appendix A - Miscellaneous Information	19
A.1 Equipment Ratings.....	19
A.2 Transport	19
A.3 Maintenance	19

1 Introduction

1.1 Overview

The DIC system is an add-on module to complement the Akrometrix TherMoiré AXP or Studio PS400. It is designed for measuring both in-plane and out-of-plane displacements of samples as a function of temperature. The module uses a full-field, non-contact optical technique called digital image correlation (DIC). Samples are measured inside a computer-controlled oven chamber with a temperature range from ambient to 300°C.

This manual describes the system hardware, image acquisition software (DIC), and data analysis software (Vic-3D). The DIC software is specific to the AXP and requires its system hardware to operate. The Vic-3D software may reside on the AXP computer or operate as a stand-alone application on a remote computer.

Before operating the system, the user should carefully read **Section 1.2**, which describes safety and health hazards associated with the system. The TherMoiré AXP or Studio PS400 system contains a high temperature oven, motorized sample stages, and electrical systems, all with the potential to injure if used or maintained improperly.

Section 1.3 identifies system components and controls. **Section 2** describes basic procedures for system setup and shutdown.

Appendix A describes the DIC system assembly, individual components and optical alignment of those components. It has recommended procedures for maintenance, storage, and transport of the DIC system. This section also contains equipment ratings, technical support material, and a description of software file types.

1.2 Warnings and Precautions

1.2.1 Health and Safety Hazards

- The DIC module is designed to work with the AXP or Studio PS400 system. Do not operate the DIC system separately. Doing so can cause potential damage of the DIC components.
- When installing or removing the DIC assembly, place the Akrometrix-supplied oven shield on top of the oven glass lid to protect the glass from any object that could be dropped from the DIC assembly.
- Always keep the six bolts on the triangle supports while installing or removing the DIC assembly.
- During installation or removal of the DIC unit, the user is required to lean inside the AXP or Studio PS400. Overhead obstacles such as the light source can cause slight head injury. During installation, be careful and aware of any overhead obstacles.
- Turn off both light sources prior to disconnecting the optical fiber bundle. Operation with the light on may cause severe discomfort due to the operator being exposed to a very bright light with the optical fiber bundle disconnected.

1.2.2 AXP/Studio PS400 System Operating Precautions

- Do not install additional software on the system computer, change computer system settings, or upgrade system software or hardware without consulting Akrometrix. Unauthorized modifications can cause problems in normal system operation.
- Handle the glass grating with care. Make sure there is adequate clearance between sample and grating before closing the oven lid. If the grating is discolored by smoke or other contamination, clean the grating using recommended procedures before performing another heating cycle.
- Do not touch the quartz heating elements in the IR heater bank. Do not operate quartz heating elements except in the horizontal position. These actions can reduce element life.

1.2.3 Warnings and Notes in this Manual

Warnings and Notes are marked throughout the manual with these icons:



Figure 1.1 Warning Icon



Figure 1.2 Note Icon

Warnings are specific health hazards for the operator or potential sources of system damage. Notes highlight system limitations or automatic responses that may require corrective action by the operator for successful operation.

1.3 System Configuration

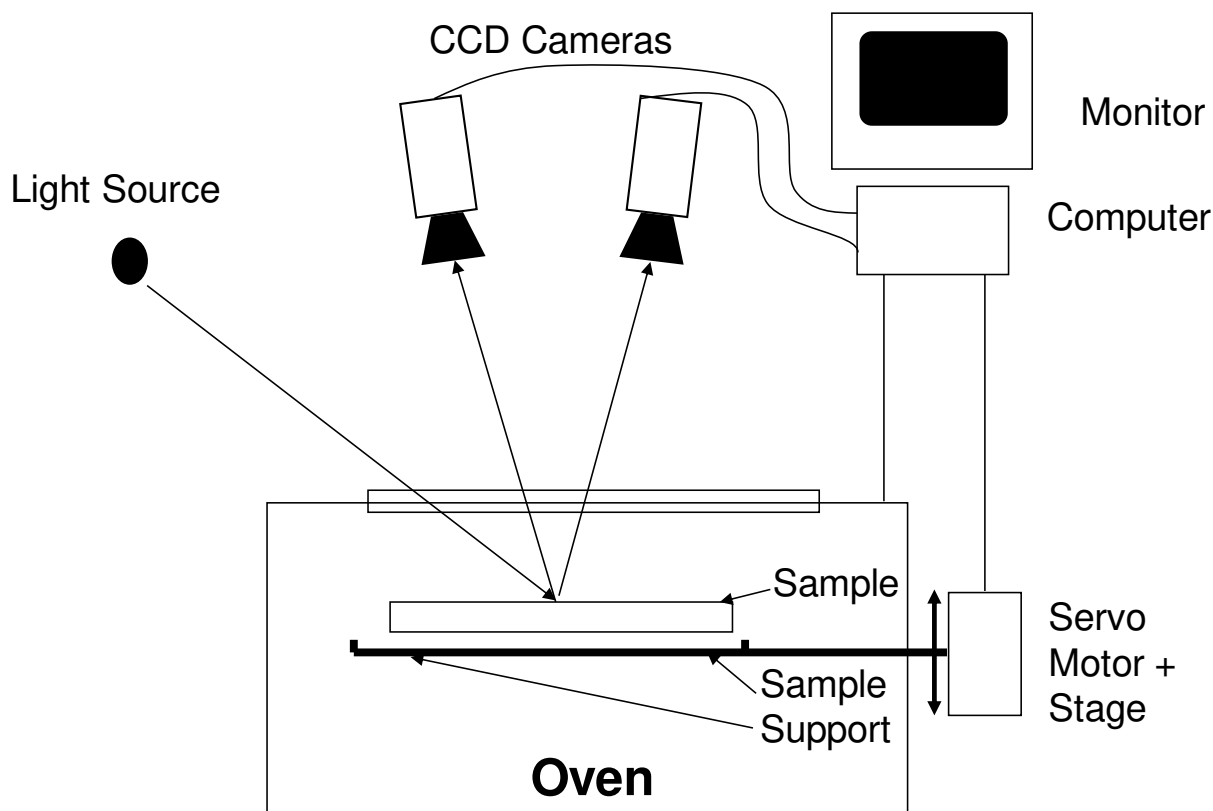


Figure 1.3 DIC System Diagram

Figure 1.3 shows the layout of the DIC system in the AXP or Studio PS400. Essentially, the system consists of two 1.4 megapixel CCD cameras mounted above the system's computer controlled infrared oven. Unlike Shadow Moiré, DIC does not require an optical grating. In fact, this grating must be removed in order for the technique to work. The double pane glass window remains to insulate the oven and provide a viewport into the thermal chamber. The system light source remains the same as well and provides diffuse illumination for the sample under test.

1.4 Technical Support

For technical support, contact Akrometrix:

Akrometrix 404-486-0880

support@akrometrix.com

2700 NE Expressway 404-486-0890 (fax)

<http://www.akrometrix.com>

Building B, Suite 500

Atlanta, GA 30345

When contacting Akrometrix, please provide the system serial number, the version numbers of the Akrometrix software being used, a description of the problem or question, and contact information for reply. If the question concerns a particular measurement or analysis, please provide electronic copies of the phase images,

reference images, and final results and a description of data acquisition and/or analysis conditions. If the problem concerns changes or failure in general system operation, please describe any events or system modifications that occurred immediately before the problem arose.

2 Basic System Set-up

2.1 System Set-up

2.1.1 Loading the DIC System



Warning: The user should carefully read **Section 1.2** (Warnings and Precautions) before installing the DIC module into the system.

1. Ensure that any other modular systems, such as the MP10 Fringe Projection System, have been completely removed per its removal instructions. The instructions to follow assume the system is in its basic shadow moiré state.
2. Ensure that the TherMoiré system has been shut down.
3. Remove the grating from the oven lid before loading the DIC system. The DIC system cannot be operated with the grating in place.
4. Place the oven shield on top of the oven lid. Then, carefully push the oven shield back until it touches the air knife as shown in **Figure 2.1**.



Warning: The DIC Camera Sub-Assembly is heavy. Accidentally dropping the whole assembly or components from it could damage the components themselves or the glass lid. The use of the Oven Shield will help prevent both types of damage.

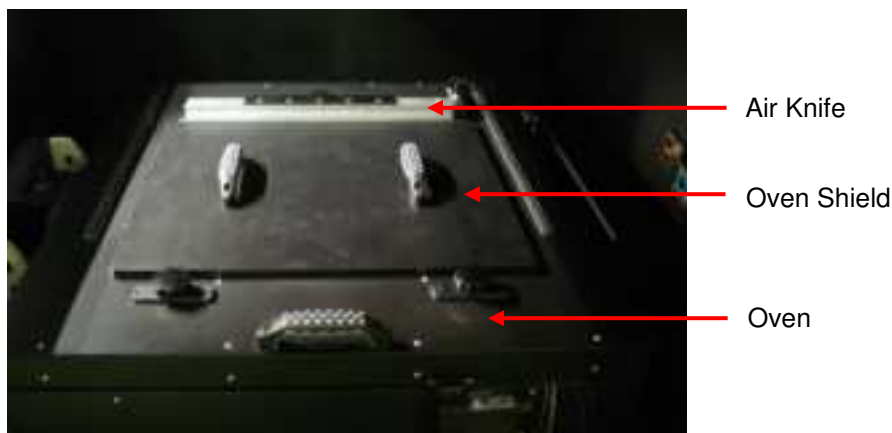


Figure 2.1 Oven Shield over the TherMoiré Oven Lid

5. Select the appropriate Camera Support Plate for the desired field of view (FOV). The widest plate is used for the largest FOV and vice versa (**Figure 2.2**). When aimed at the same spot these plates should give the camera system a stereo angle of $\sim 15^\circ$.

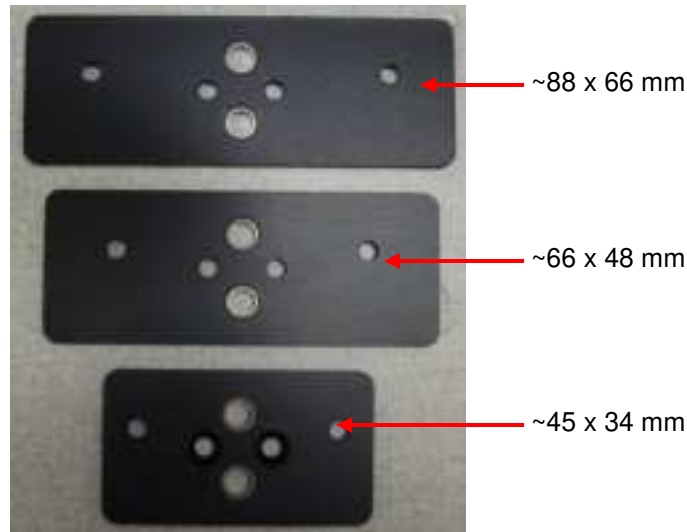


Figure 2.2 Large, Medium, and Small FOV Camera Adapter Plates

6. Attach the cameras to the plate using two ¼-20 button head screws (**Figure 2.3**). Only the widest mount has a front and back side. The back side has counter-bored holes so that it can sit flush against the Common Crossbar Mount Support. Their alignment is not critical at this point as they can be adjusted to view the same point once the assembly is installed.



Figure 2.3 Camera Sub-assembly, Backside

7. Place the DIC assembly support (Common Crossbar Mount Support with two Carriage Assembly Support Triangles) onto the two glide rails located on two sides of the oven lid (**Figure 2.1**). Align the whole assembly such that the cameras will be viewing the sample location. Attach them with three ¼-20 aluminum thumbscrews each. Make sure that the triangles are seated over the glide rails properly before tightening the thumbscrews.

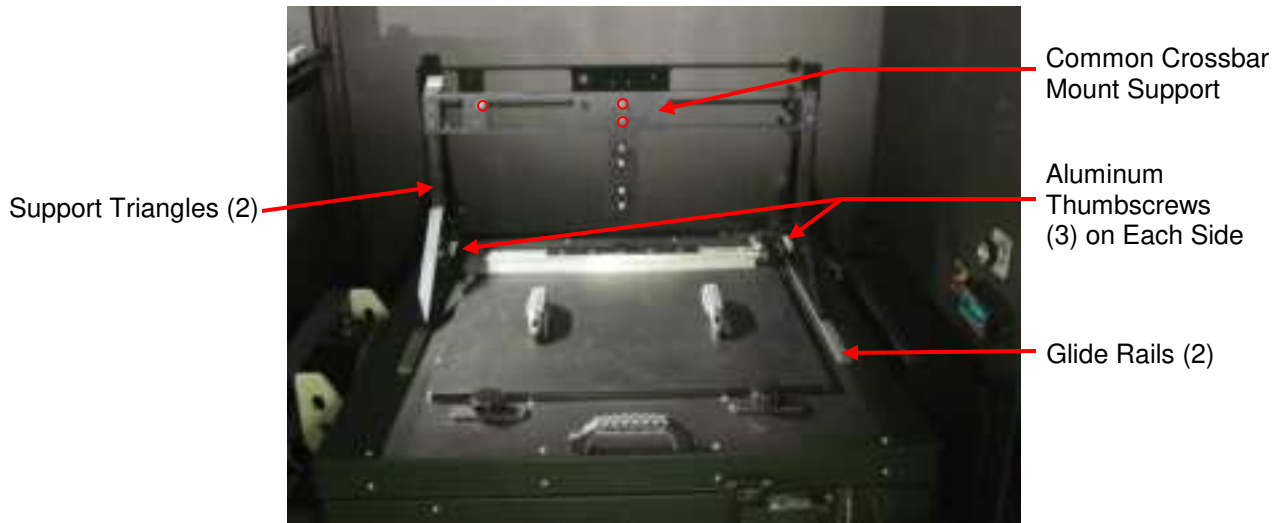


Figure 2.4 DIC AXP Carriage Support Assembly

8. Slide the Camera Sub-assembly over the two pins located at the center of the Common Crossbar Mount Support. There are three possible camera positions. Choose the position which corresponds with the desired FOV. Some rocking may be required to fully seat or unseat this assembly as the bushings and pins are a precise fit.
9. Once the Camera Sub-Assembly is located on the pins and is flush with the Common Crossbar Mount Support, place two aluminum thumbscrews into the appropriate holes (marked by red circles in **Figure 2.5**) and tighten by hand.
10. Attach a trigger box cable and firewire cable to each camera. Secure them to the top of the Common Crossbar Mount Support using the supplied Velcro strap as shown in **Figure 2.5**.



Warning: Plugging or unplugging the 1394b firewire cables while power is on can potentially damage 1394b firewire devices.

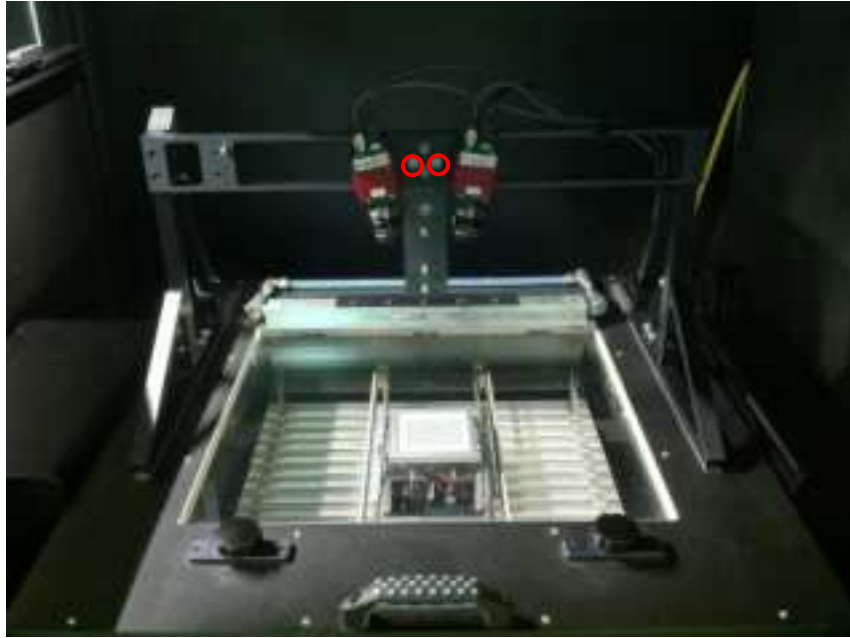


Figure 2.5 Fully Installed DIC system

11. Unplug the firewire cable from the AXP or PS400 camera.



Note: If the AXP system camera is connected at startup, the software may produce an error and not start.

2.1.2 System Start-Up

1. Please see the relevant base TherMoiré system manual for its start-up procedures.
2. Turn on the Light Source Power switches. Make sure the Light Source Adjustment knob is placed at approximately 90% of the maximum level.
3. Run the DIC Surface Measurement program by clicking its icon on the Studio Manager bar. A start-up splash screen appears while the software initializes. For operation of this program, refer to the Surface Measurement User Manual.
4. Check if there is any dust or other kinds of contaminations on the oven lid glass. If so, clean the glass according to **Appendix A.3**.

2.2 System Alignment

1. Choose the largest calibration target that will fit within the cameras' field of view (FOV). Place the calibration target on the sample support rails such that it is roughly in the center of the oven. The target should be oriented with the long dimension running left to right.
2. Close the oven lid, being careful that there is enough of a gap above the calibration target so that there is clearance when the lid closes.

3. Press the Adjust Height button and lower the TherMoiré sample support so that the level of the calibration target is the same as sample to be measured. Typically this will be such that the bottom of the calibration target is within 5 mm of the oven heater bulbs.
4. Adjust the right camera so that it is roughly centered on the calibration target dot field.
5. Move the calibration target left or right and up or down to make its dot field fit within the right camera's FOV.
6. Align the left camera such that it matches the right camera's FOV. There is a hole in the Common Crossbar Mount support behind where the camera attaches for the largest FOV. This allows for adjusting the left camera's angle while the camera mount plate is securely attached using the thumbscrews.



Note: Only the FOV that can be seen in both cameras will be useful for analysis. When connecting the cameras to their support bracket, it is important to line them up so that they image the same FOV.

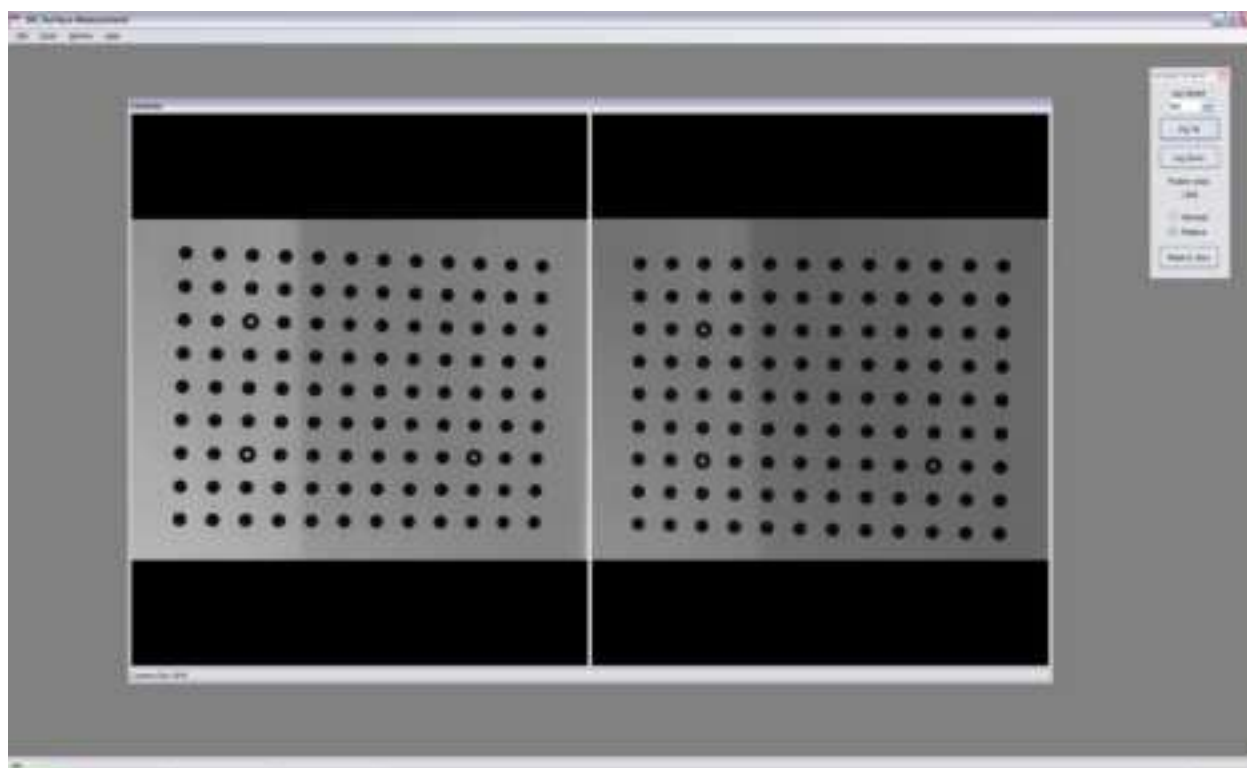


Figure 2.6 Two Images of Calibration Target in DIC Surface Measurement

7. Adjust aperture and focus so that the cal target is adequately bright and in focus.
8. To get best focus, open the iris fully on one camera lens and reduce the light source intensity to compensate.

9. Expand the images in the camera window by right clicking on either camera image and unchecking Shrink To Fit. The camera window can also then be expanded by dragging its edges to resize.
10. Unlock the focus ring on one lens and adjust its focus to maximum sharpness.
11. Lock the focus ring and close the lens iris.
12. Repeat steps 8 through 11 on the second camera lens.
13. Raise the light source intensity to original levels.

2.3 Calibration

Once the Cameras are properly aligned, a calibration needs to be performed before measurement. Please see the Surface Measurement User Manual for instructions on how to calibrate DIC system. After the calibration is done, no individual component should be moved without recalibration.

2.4 System Removal and Shutdown

1. Close the DIC Surface Measurement application.
2. Press the LID RELEASE button, open the oven, and remove the sample from the oven chamber.



Warning: The temperature control chamber cools much more slowly than it heats. The sample supports, sample and other components inside may retain significant heat long after the thermal cycle is complete. Use extreme caution in unloading the sample or other components. The Process Temperatures for each loop of the temperature controller display the **sample temperature**, which may not be an accurate indicator of the temperature of other oven components.

3. Close the oven lid.
4. Find the Akrometrix-supplied standby plate for the DIC system and place it on a flat surface (**Figure 2.7**).



Figure 2.7 DIC Standby Plate

5. Place the Oven Shield on top of the oven lid as shown in **Figure 2.1**.

6. Place lens caps on each of the DIC camera lenses.
7. Disconnect the two synchronization cables and two firewire cables from the top of each camera. Carefully place them to the back or right side of the oven. Keep them a safe distance from the oven body or any moving components.



Warning: The DIC Camera Sub-Assembly is heavy. Accidentally dropping the whole assembly or components from it could damage the components themselves or the glass lid. The use of the Oven Shield will help prevent both types of damage.

8. Loosen the six aluminum thumbscrews on the two triangles and take off the DIC assembly support (Common Crossbar Mount Support with two Carriage Assembly Support Triangles) from the oven lid. Attach the whole assembly onto the Akrometrix-supplied standby plate with six aluminum thumbscrews (**Figure 2.8**).



Figure 2.8 DIC System Installed on Standby Plate

9. Cover the DIC system with a piece of cloth and/or place it in a storage room to protect the optical components from dust and accidental damage.
10. Install the grating in the oven lid if the system needs to be operated in TherMoiré mode.

3 Troubleshooting

3.1 Failure to Initialize the Cameras

Symptom:

When opening the DIC Surface Measurement program, the cameras fail to be initialized. A window may pop up as shown in **Figure 3.1**.

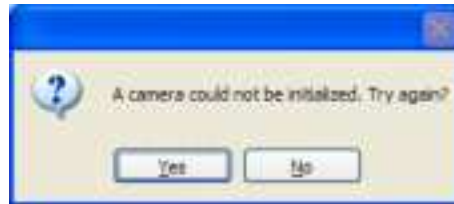


Figure 3.1 Camera Initialization Error

Cause:

- One or more of the camera cables is not connected properly.
- When a camera is first installed or replaced by another one, the driver is not installed or updated.
- When a camera cable is unplugged, the system may lose track of the camera. In this case, the software cannot recognize the camera even if its cable is plugged back in.
- A trigger signal was not found.

Solution:

1. Make sure the firewire cables are connected to both cameras and to the firewire hub. Also ensure the firewire hub is properly connected to the computer and is powered up. If problem is not resolved, go to 2.
2. Make sure that the trigger box cables are connected to both cameras and the box itself. Also ensure that the trigger box is properly powered on. A red blinking light indicates power is available. If problem is not resolved, go to 3.
3. Check the cameras with the 1394camera utility program:
 - a. Run the utility program from **Start→ All Programs→1394Camera Demo**.
 - b. In the 1394 Camera Demo application window, select **Camera→Check Link (Figure 3.2)**.
 - c. A dialog shows up and states "Found 2 Cameras". Press OK to continue (**Figure 3.3**). If "Found 0 Cameras", go to step 3.
 - d. Select either of the connected cameras: **Camera→Select Camera (Figure 3.4)**.

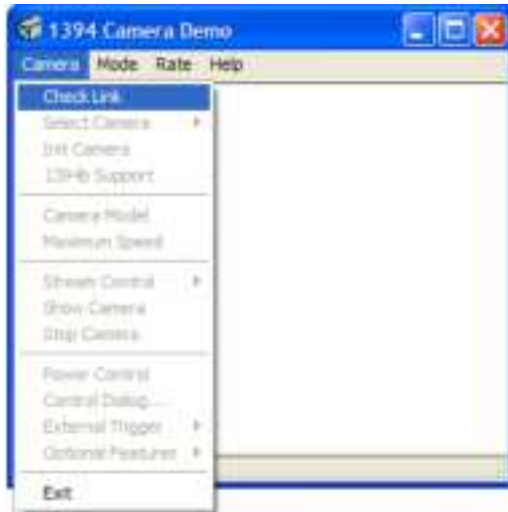


Figure 3.2



Figure 3.3

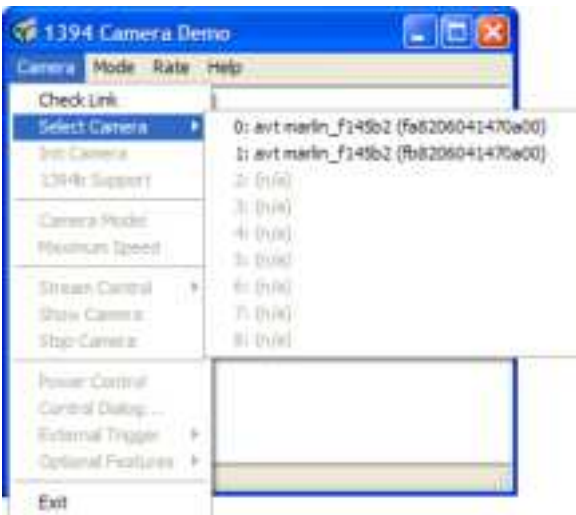


Figure 3.4

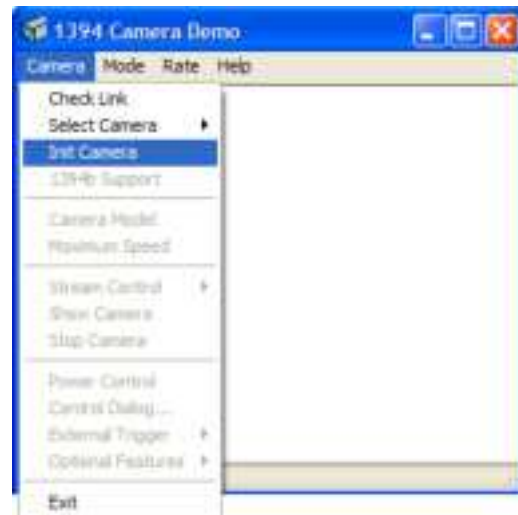


Figure 3.5

- e. Initialize the camera: **Camera→Init Camera (Figure 3.5).**



Warning: Selecting Yes will reset the camera configuration (e.g. brightness, shutter speed, gain, etc.) back to the defaults, which are not favorable conditions for the measurement system. Akrometrix has set these values from the factory. If they are accidentally reset please contact support to receive instructions on how to set these values.

- f. Press No when asked to reset to powerup defaults (**Figure 3.6**).



Figure 3.6 Don't Reset to Defaults



Figure 3.7 Show Camera

- g. Display the camera output: **Camera→Show Camera (Figure 3.7)**.
 - h. A live view of the camera will be shown in the camera output window. Adjust the light source intensity and/or lens iris as necessary.
 - i. If the camera is found and a live view can be seen in the utility program, repeat Step 2 for the second camera. If both camera images can be seen, close the utility program and reopen the DIC program. Otherwise, go to step 3.
4. Disconnect the non-functioning camera's cable and reconnect it. In the device wizard that appears:
- a. Do NOT connect to Windows Update to search for software (**Figure 3.8**).



Figure 3.8

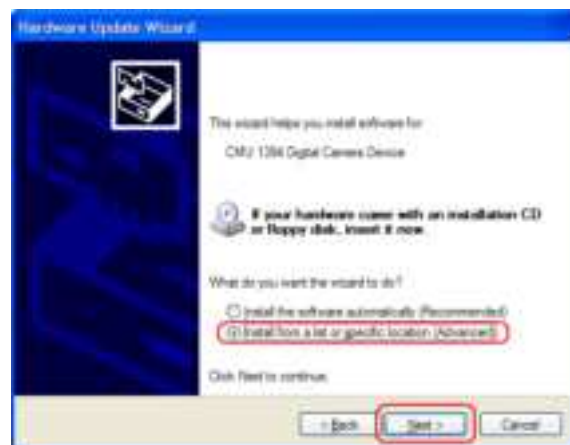


Figure 3.9

- b. Install from a specific location (**Figure 3.9**).
- c. Don't search; choose the driver to install (**Figure 3.10**).



Figure 3.10



Figure 3.11 Select Hardware Type

- d. Select Imaging Devices as the Hardware Type (**Figure 3.11**).
- e. Press Have Disk... and browse to "C:\Program Files\CMU\1394Camera\Driver\1394Camera.inf" (**Figure 3.12**).
- f. Continue Anyway when warned that the driver is not digitally signed (**Figure 3.13**).
- g. Go to step 3.



Figure 3.12 Install From Disk Window



Figure 3.13 Windows Logo Compatibility Bypass

Appendix A - Miscellaneous Information

A.1 Equipment Ratings

Electrical*	
Supply Voltage	220VAC, 50/60 Hz, 1 Φ
Amp Rating	~1 A
*All electrical requirements supplied by host AXP system, no additional facilities setup needed	
Mechanical	
Footprint	629 (w) x 355 (d) x 340 (h) mm
Weight	Camera Sub-Assembly: 0.6kg
	Camera Sub-Assembly with Common Crossbar: 3.2kg

A.2 Transport

When transporting the DIC system to a new location, Akrometrix recommends that certain components be removed from the system and packed and moved separately. These include:

- Cameras and lenses
- Grating and grating frame

A.3 Maintenance

A.3.1 Optical Lenses

The camera lenses are exposed directly to the air and may collect dust over time. Dust or dirt on the camera lenses will not be seen directly but may darken the images.

To clean dust on the lenses, use a non-flammable compressed air duster (canned air), such as would be used for cleaning computer components. Blow away dust without touching the lenses.



Warning: Do not use the tissue to rub the lens surface back and forth. This may leave scratches on the glass surface and damage the lens.

The lenses may also be contaminated with residues from dust or fingerprints. If this takes place, they should be removed from the cameras and cleaned with lint-free lens tissue (such as Kimwipes or other disposable absorbent papers designed for delicate use and high-absorbency) and lens cleaning fluid. When using lens tissue to clean the lenses, gently wipe the surface in one direction once and change to a new piece of tissue to clean continuously until the lens is clean.