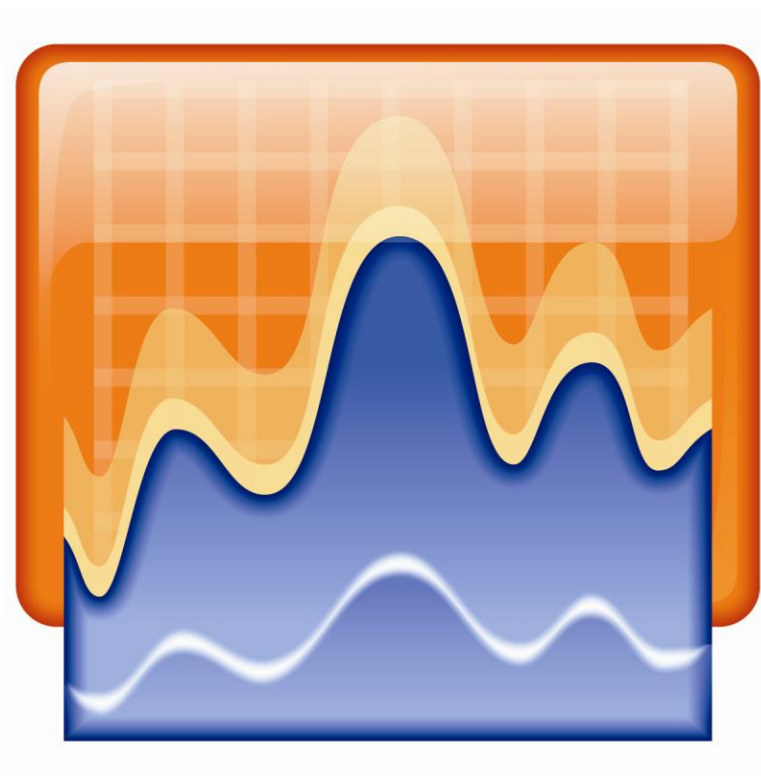




THERMAL PROFILER



USER MANUAL

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Contents

1 Introduction.....	4
1.1 Overview.....	4
1.1 Warnings and Precautions.....	4
1.2 Technical Support.....	4
2 Thermal Profiler	6
2.1 Overview.....	6
2.2 Graphical User Interface Layout and Description	6
2.3 File Menu Bar	11
2.4 Changing Thermal Source	12
2.5 Profile Setup	12
2.6 DFP/DIC Modes.....	13
2.7 Part Tracking Mode.....	14
Appendix A - Miscellaneous Information	17
A.1 File Formats.....	17
A.2 Keyboard Shortcuts	17

1 Introduction

1.1 Overview

As part of the Akrometrix Studio software platform, Thermal Profiler is designed as the automated temperature control and data acquisition package for any Akrometrix hardware utilizing the shadow moiré, fringe projection, or DIC techniques. It features a 4 screen interface where all relevant profile and data information can be displayed and compared on screen at one time.

This manual describes the interface and functions of the Thermal Profiler software. Manual data acquisition is described in the Surface Measurement User Manual and analysis is described in the Surface Analysis User Manual. Thermal Profiler requires system hardware to operate and, thus, will only be installed on computers attached to Akrometrix measurement equipment. Surface Analysis may reside on the measurement equipment computer and/or on a remote computer.

A user unfamiliar with shadow moiré, fringe projection, and DIC and their application in Akrometrix measurement systems is advised to first read Akrometrix Optical Techniques and Analyses 101.

Section 2 describes the Thermal Profiler application. **Appendix A** describes software file formats and keyboard shortcuts.

1.1 Warnings and Precautions

1.1.1 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.

1.2 Technical Support

For technical support, contact Akrometrix:

Akrometrix 404-486-0880

2700 NE Expressway 404-486-0890 (fax)

Building B, Suite 500

Atlanta, GA 30345

support@akrometrix.com

<http://www.akrometrix.com>

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 Thermal Profiler

2.1 Overview

TherMoiré systems are designed to automatically make surface measurements on the sample at specified points during a user-defined thermal profile. Temperature profiles are created using the Profile Generator application as xml documents with the extension .akx_profile. These files can also be created and edited in any text or xml editing program. For more details on how these files are constructed see the Profile Generator User Manual.

Profile steps occur at a constant time interval, which is set at run-time using the Time Per Step parameter in the Profile Setup dialog (see **Figure 2.19**). Although a data acquisition instruction is placed at a discrete step, it may take more than one step to execute. This is due to the fact that the time to acquire data is dependent on the delay per step, the camera shutter time, and the motor speed. These factors can lengthen the time per data acquisition. This is especially true for DFP and, to a lesser extent, shadow moiré measurements. In general, DFP will require the most time, due to the movement of its precise linear motor. Shadow moiré acquisition takes less time, and DIC is the fastest, as it is limited solely by the camera shutter speed. The Thermal Profiler application takes all of these variables into account when the profile is loaded and adds rows to the profile accordingly.

The Control Criteria allows measurement points to be taken against time or temperature and is selected by the user at run-time. In time-based execution, automatic data acquisition is triggered when a specific time is reached, regardless of the actual sample temperature. With temperature-based profiling, automatic data acquisition is triggered only when the target temperature is reached, independent of the amount of time that has elapsed. The specific measurement temperature depends on the value of the Error Band, which defines the allowable deviation from the target temperature to initiate a data acquisition.

A Pause feature allows the profile to be halted at any point during the profile execution. This is useful during the time-based control if sample temperature is lagging behind. While the profile is paused, sample temperature is continuously recorded to both the table and graph. With temperature-based control, the profile is Auto-Paused before the phase measurement step of the profile is executed. The program can remain in Auto-Pause mode for at most 30 minutes.

2.2 Graphical User Interface Layout and Description

The Thermal Profiler GUI (see **Figure 2.1**) consists of 4 main window panes where all pertinent profile information can be seen at one time.

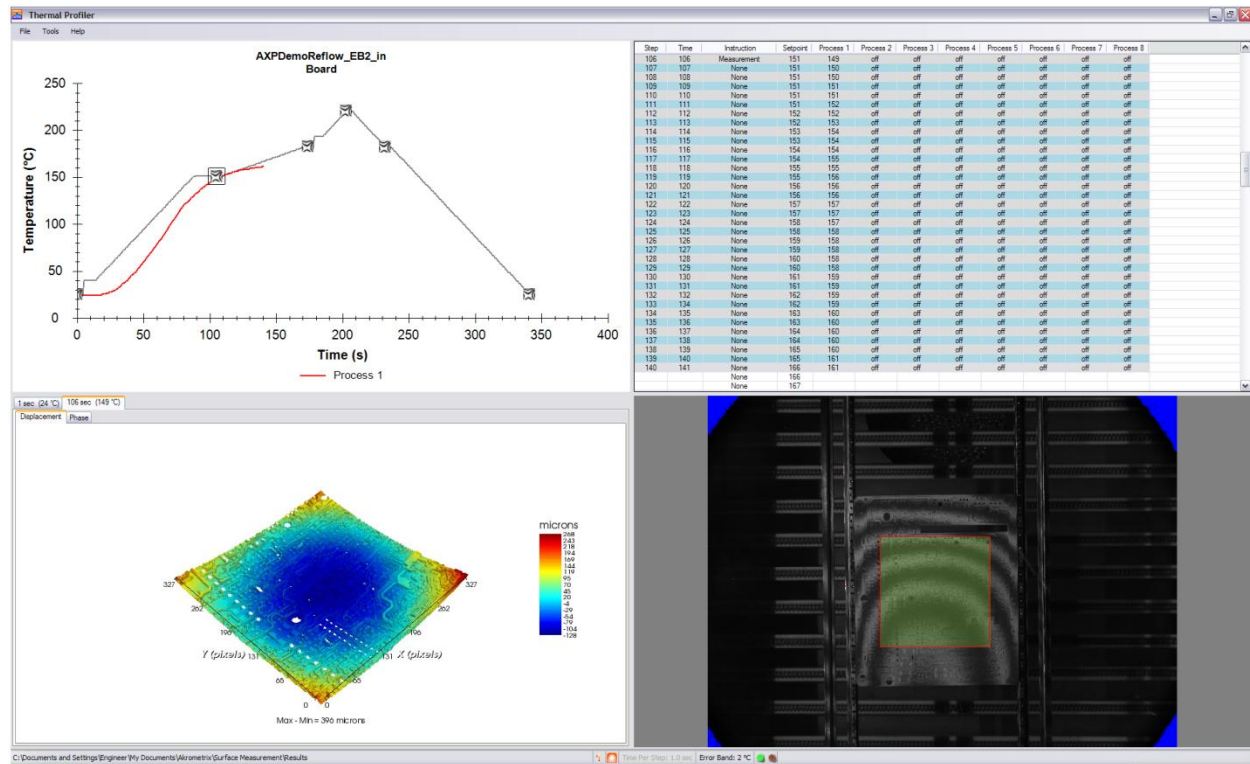


Figure 2.1 Thermal Profiler GUI

2.2.1 Profile Graph Pane

The top left pane shows the profile graph view. Right-clicking anywhere in this pane will bring up a context menu, similar to that in **Figure 2.2**. Note that although all three possible context menus are shown in **Figure 2.2**, this is not possible in the actual software. They are shown for illustration purposes only.

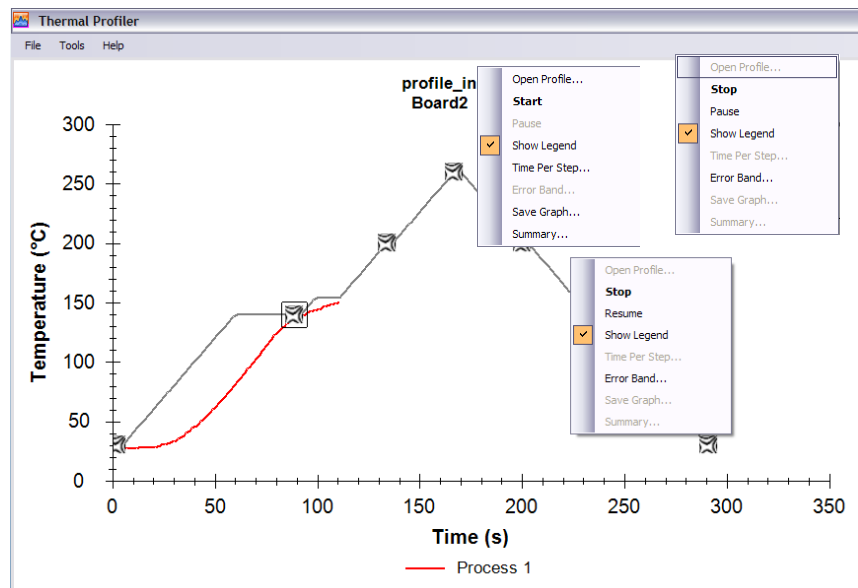
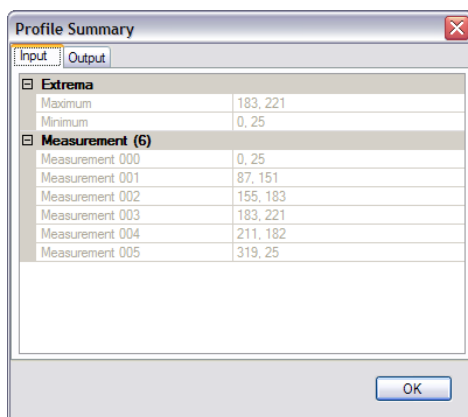


Figure 2.2 Graph Pane

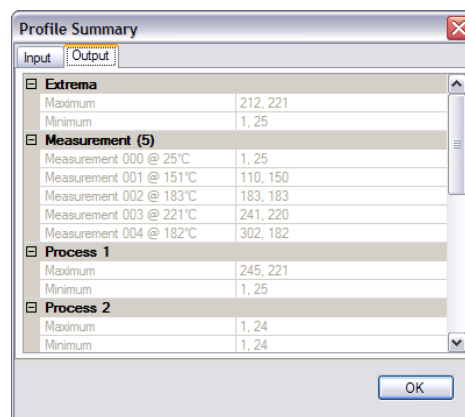
The context menu options and a brief description of each are listed below:

1. Open Profile: Brings up a file select dialog where the user can point to an input profile and load it into the Thermal Profiler application.
2. Start/Stop: If Start is available, it means there is no profile actively running. Selecting this option will bring up the Profile Setup Window (see **Figure 2.19**). If Stop is available, it means there is an actively running profile. Selecting Stop will stop the profile and prompt the user to save the text and graphical outputs of the profile.
3. Pause/Resume: Pauses the profile. Rows in the Table Pane will show up as yellow (see **Figure 2.5**) to indicate that the profile was paused.
4. Show Legend: Check to show the Graph Pane legend. Uncheck to hide.
5. Time Per Step: Before the profile has been executed, the user can click this option to open a dialog where the profile Time Per Step can be set.
6. Error Band: While the profile is running the user can select this option to bring up a dialog where the Error Band can be set. The Error Band only comes into play when the profile is running in Temperature Base and defines the allowable deviation from the target temperature, while autopausing, to initiate a data acquisition.
7. Save Graph: Allows the user to save the profile graph as an image file (.jpg, .bmp, etc.)
8. Summary: Displays the Maximum, Minimum, and Measurement Points for both Profile Input and Output (see **Figure 2.3** and **Figure 2.4**)



Profile Summary	
Input	
Extrema	
Maximum	183, 221
Minimum	0, 25
Measurement (6)	
Measurement 000	0, 25
Measurement 001	87, 151
Measurement 002	155, 183
Measurement 003	183, 221
Measurement 004	211, 182
Measurement 005	319, 25

Figure 2.3 Profile Summary Input



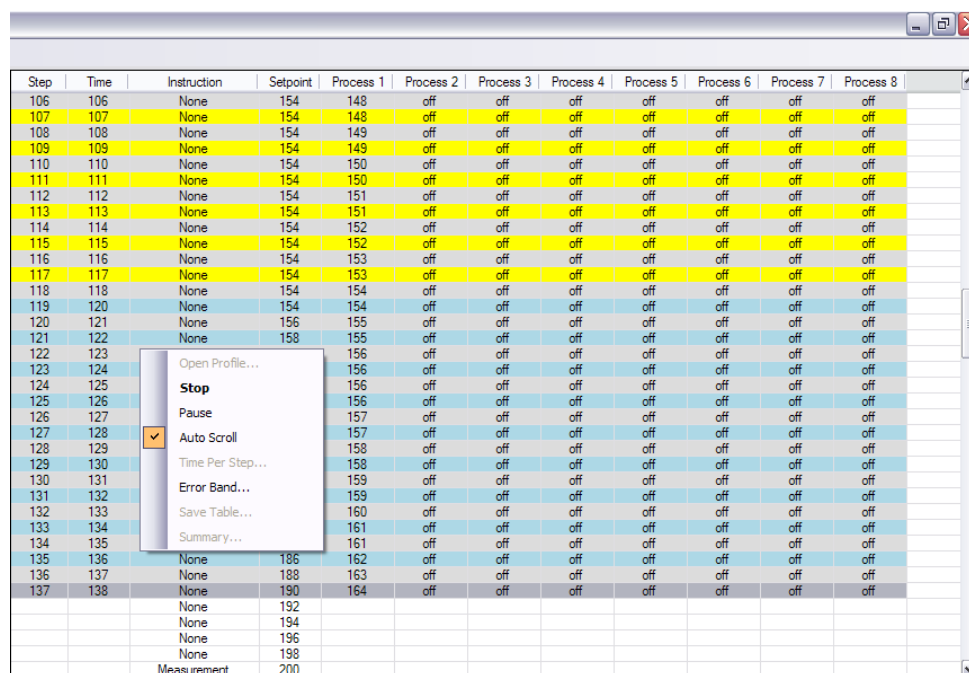
Profile Summary	
Output	
Extrema	
Maximum	212, 221
Minimum	1, 25
Measurement (5)	
Measurement 000 @ 25°C	1, 25
Measurement 001 @ 151°C	110, 150
Measurement 002 @ 183°C	183, 183
Measurement 003 @ 221°C	241, 220
Measurement 004 @ 182°C	302, 182
Process 1	
Maximum	245, 221
Minimum	1, 25
Process 2	
Maximum	1, 24
Minimum	1, 24

Figure 2.4 Profile Summary Output

2.2.2 Profile Table Pane

The top right pane shows the profile table view, which consists of individual temperature points and instructions for when to take measurements, turn on system

blowers, etc. Yellow highlighting of a row indicates that it has been inserted automatically by the software either because of autopausing while in Temperature Base Control or a manual pause initiated by the user.



Step	Time	Instruction	Setpoint	Process 1	Process 2	Process 3	Process 4	Process 5	Process 6	Process 7	Process 8
106	106	None	154	148	off	off	off	off	off	off	off
107	107	None	154	148	off	off	off	off	off	off	off
108	108	None	154	149	off	off	off	off	off	off	off
109	109	None	154	149	off	off	off	off	off	off	off
110	110	None	154	150	off	off	off	off	off	off	off
111	111	None	154	150	off	off	off	off	off	off	off
112	112	None	154	151	off	off	off	off	off	off	off
113	113	None	154	151	off	off	off	off	off	off	off
114	114	None	154	152	off	off	off	off	off	off	off
115	115	None	154	152	off	off	off	off	off	off	off
116	116	None	154	153	off	off	off	off	off	off	off
117	117	None	154	153	off	off	off	off	off	off	off
118	118	None	154	154	off	off	off	off	off	off	off
119	120	None	154	154	off	off	off	off	off	off	off
120	121	None	156	155	off	off	off	off	off	off	off
121	122	None	158	155	off	off	off	off	off	off	off
122	123			156	off	off	off	off	off	off	off
123	124			156	off	off	off	off	off	off	off
124	125			156	off	off	off	off	off	off	off
125	126			156	off	off	off	off	off	off	off
126	127			157	off	off	off	off	off	off	off
127	128			157	off	off	off	off	off	off	off
128	129			158	off	off	off	off	off	off	off
129	130			158	off	off	off	off	off	off	off
130	131			159	off	off	off	off	off	off	off
131	132			159	off	off	off	off	off	off	off
132	133			160	off	off	off	off	off	off	off
133	134			161	off	off	off	off	off	off	off
134	135			161	off	off	off	off	off	off	off
135	136	None	186	162	off	off	off	off	off	off	off
136	137	None	188	163	off	off	off	off	off	off	off
137	138	None	190	164	off	off	off	off	off	off	off
		None	192								
		None	194								
		None	196								
		None	198								
		Measurement	200								

Figure 2.5 Table Pane

Right-clicking on the Table Pane will bring up a context menu (see **Figure 2.5**) which is very similar to that of the Graph Pane. The only difference is the substitution of a switch to turn on or off the table's Auto Scroll behavior instead of the Show Legend switch.

2.2.3 Displacement Data and Phase Data Pane

The bottom left pane shows both phase and displacement data in a tabbed window format. The top row of tabs displays the time and temperature at which a data acquisition has occurred. Below this, for each acquisition, there is a Displacement and a Phase tab. **Figure 2.6** shows the displacement data while **Figure 2.7** shows the phase data view. The top row of tabs is also linked to the Profile Graph Pane so that the currently selected acquisition point is highlighted on the profile graph by a black square outline.

At the very bottom of this window the current Output Path is listed. This is the directory where all the displayed results are stored. It can be changed at the start of a profile in the Profile Setup Window (see **Figure 2.19**).

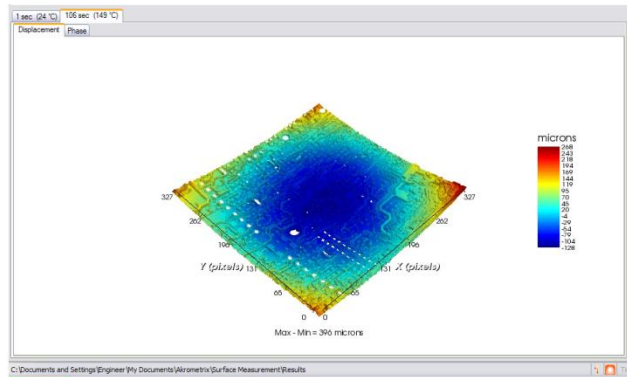


Figure 2.6 Displacement Data

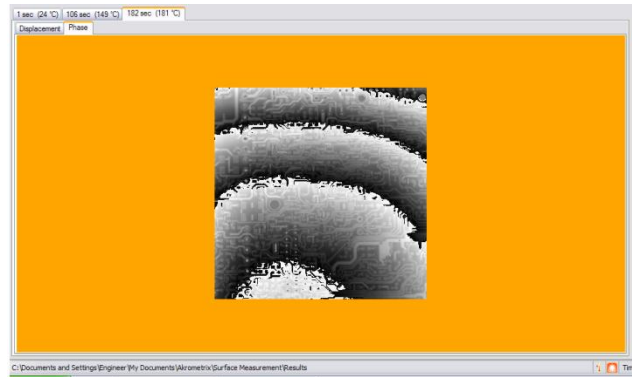


Figure 2.7 Phase Data

2.2.4 Camera Window Pane

The bottom right pane shows the live camera view and the current ROI location. The camera view can be zoomed to the ROI by right-clicking anywhere in the Camera pane and selecting Zoom To Region Of Interest as in **Figure 2.8**.

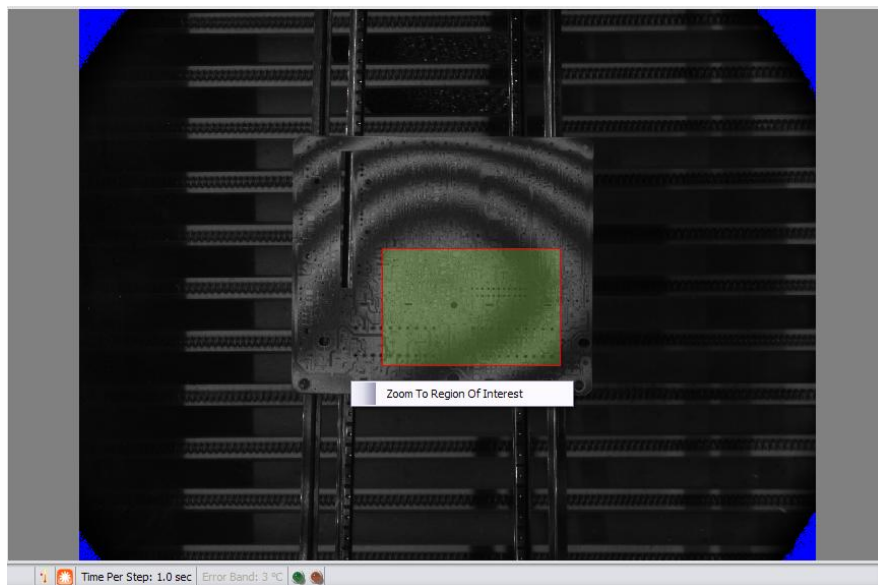


Figure 2.8 Camera Window Pane

At the bottom of the camera window pane there is a small information bar which tells the user about the current state of various settings.

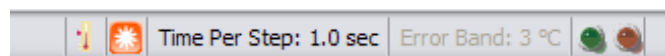


Figure 2.9 Information Bar

The leftmost indicator describes whether the current profile (or last run profile) is in Time or Temperature base mode (see **Figure 2.10**). To the right of this icon is the Radiant/Convective Mode Indicator Icon (see **Figure 2.11**). The thermal source can be changed by clicking on this icon to bring up the Select Thermal Source dialog shown in **Figure 2.16**. Current Time Per Step and Error Band settings are shown in the

Information Bar as well. The Error Band section can be clicked to bring up a dialog where the Error Band can be changed while a profile is running.

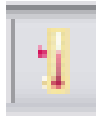


Figure 2.10 Time/Temperature Base Indicator



Figure 2.11 Radiant/Convective Mode Indicator



Figure 2.12 Profile Status Indicator Lights

The indicator lights shown in **Figure 2.12** tell the user what state the profile is in using the conditions shown in **Table 2.1**.

Table 2.1 Profile Status Indicator Light Conditions

Light Condition	Profile Status
Solid Green	Running
Blinking Green	Auto-pause
Solid Green & Blinking Yellow	Manual Pause

2.3 File Menu Bar

At the top of the Thermal Profiler application window there is a standard Windows File Menu bar (see). It contains the following menu categories:

- File
- Tools
- Help

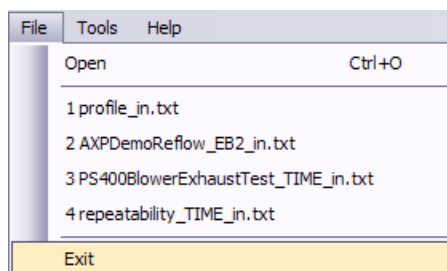


Figure 2.13 File Menu

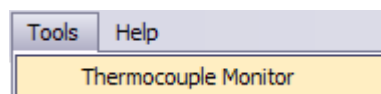


Figure 2.14 Tools Menu

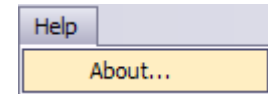


Figure 2.15 Help Menu

2.3.1 File

This menu category is where the user can open thermal profiles (*.akx_profile). It also shows the last 4 recently opened profiles.

2.3.2 Tools

This menu category is where the user can open the Thermocouple Monitor, which allows the user to quickly see all thermocouple temperatures for setup purposes. This tool can also be opened from the Monitor... button in the Profile Setup dialog (see **Figure 2.19**).

2.3.3 Help

This menu item contains a link to the Thermal Profiler User Manual as well as an About command for determining program version information.

2.4 Changing Thermal Source

The Thermal Profiler application can control either the built in TherMoiré IR heater source or an optional add-on called the Convective Module. In order to switch to Convective mode the user must tell the software to use the Convective Module controller. In order to do so the user clicks on the Radiant/Convective Mode Indicator (see **Figure 2.11**) icon at the bottom of the Camera Window Pane. A dialog (see **Figure 2.16**) pops up asking the user to select either Radiant or Convective sources.

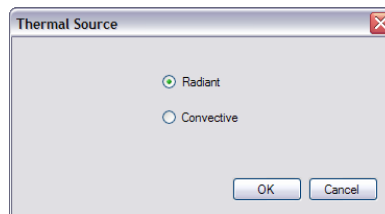


Figure 2.16 Select Thermal Source Dialog



Note: In order to change from Radiant to Convective mode the Convective Module must be turned on and hooked up as described in the Convective Module User Manual.

When changing between thermal sources, dialogs will pop-up (see **Figure 2.17** and **Figure 2.18**) reminding the user what actions should be taken in order to use the desired thermal mode.

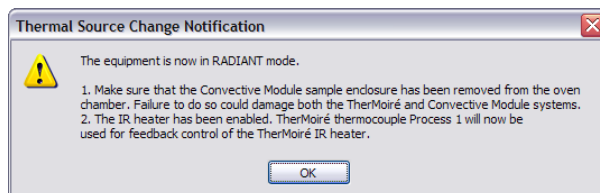


Figure 2.17 Radiant Mode Notification

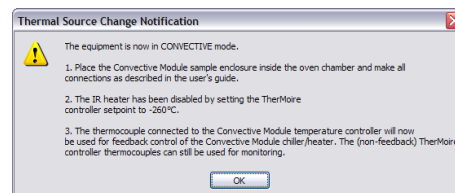


Figure 2.18 Convective Mode Notification

Thermal Profiler operation is exactly the same whether in Radiant or Convective mode. The only thing that changes is the hardware used.

2.5 Profile Setup

The Profile Setup dialog is accessed by right-clicking on either the Profile Graph (**Figure 2.2**) or Table Panes (**Figure 2.5**) and choosing Start. It is in this dialog where the user can set up the parameters for a profile run. The first thing to enter is the Prefix Name. This is the filename prefix for all data files gathered during the course of the thermal profile. Next is the profile Time Per Step, described in **Section 2.1**. The Control Criteria must then be set to either Temperature or Time based, and an Initial Error Band selected if Temperature base is chosen. The Error Band is the only parameter in this

dialog that can be changed after the profile has started. Next is a section where XY Orientation can be specified for use with Interface Analysis. Below this is where the user selects the desired data Output Path, which is also listed, for reference, at the bottom of the Phase/Displacement Pane. At the bottom, thermocouples can be turned on and off depending on which ones are actually attached and measuring a sample. A Monitor... button brings up the Thermocouple Monitor (see **Figure 2.20**). This window allows the user to see, in real time, what the thermocouples are reading.

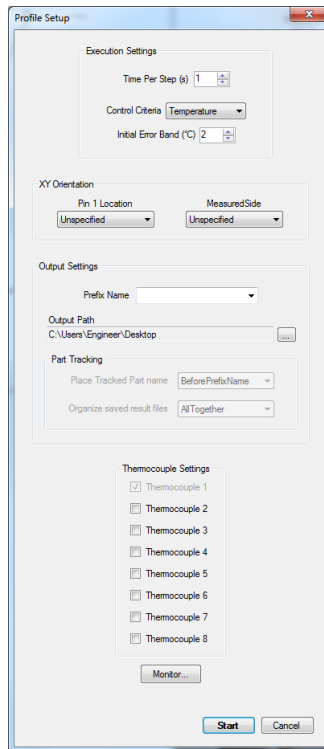


Figure 2.19 Profile Setup Dialog

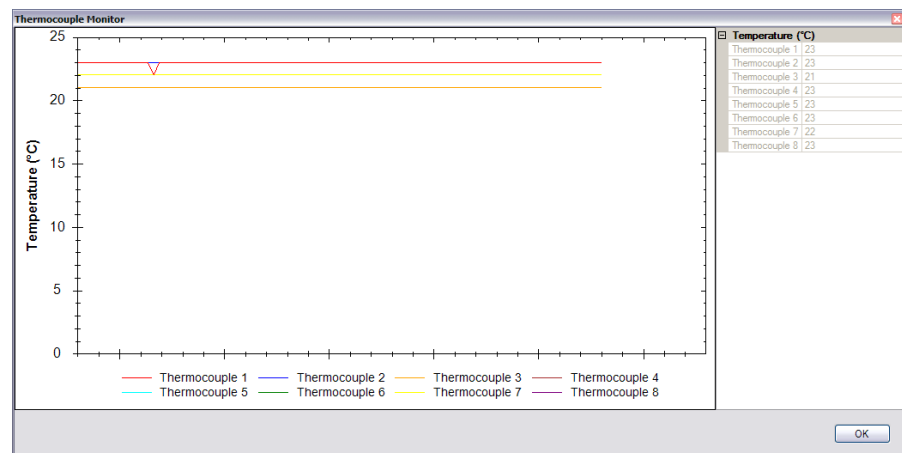


Figure 2.20 Thermocouple Monitor

Once all these parameters have been set up, the user can press Start. The profile will run automatically, regulating temperature via the temperature controller and capturing data using the system cameras. The user can stop the profile at any time by right-clicking on the profile graph or table and selecting Stop. Pressing the system E-Stop button will also end the profile.

Regardless of the method of stoppage, at the conclusion of the profile, the application will prompt the user to save both the graph and table view data. The Prefix Name will be used for these files as well.

2.6 DFP/DIC Modes

2.6.1 DFP

When Surface Measurement is in DFP mode, the Thermal Profiler application will also be in DFP mode. However, for all intents and purposes, the user will not notice this

change. All program functions will be identical to that of regular shadow moiré measurements.

2.6.2 DIC

There will be some slight changes to Thermal Profiler while in DIC mode. Because there is no DIC analysis built into the Surface Measurement application, no graph will show up when DIC images are capture. Instead, all the user will see is the captured images in a tabbed format (see **Figure 2.21**).

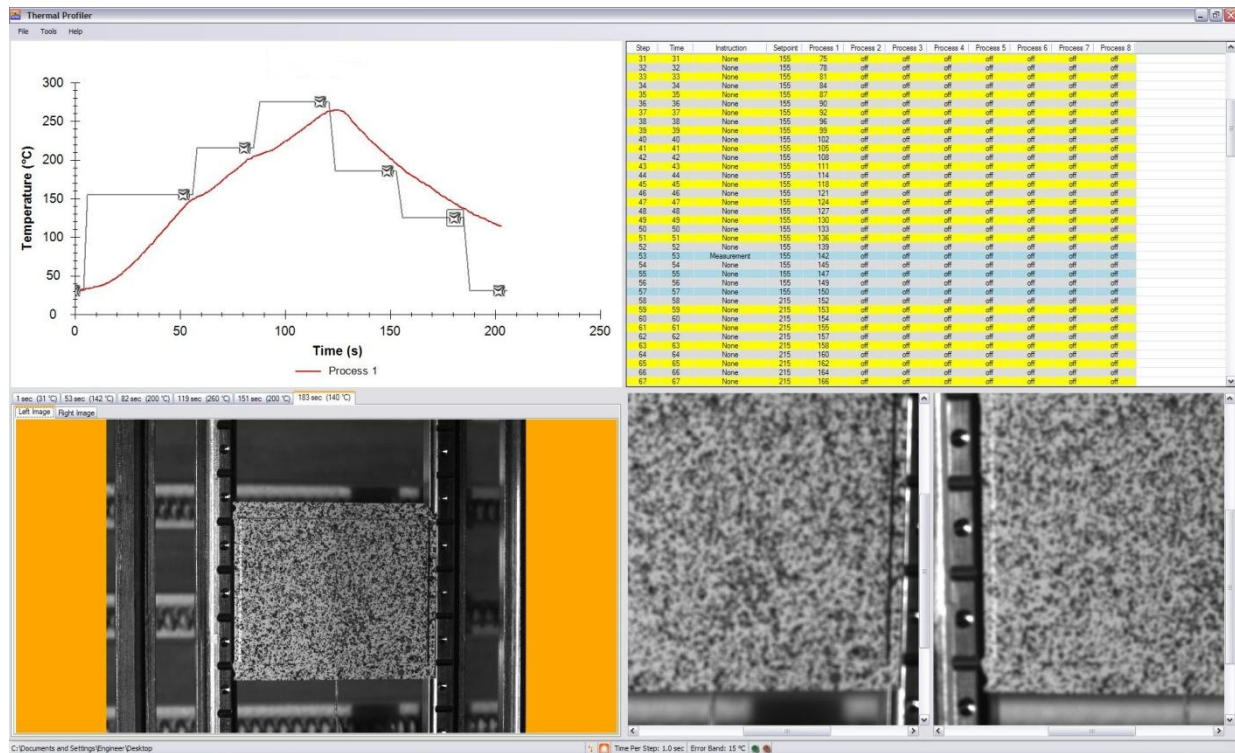


Figure 2.21 Thermal Profiler in DIC mode

2.7 Part Tracking Mode

When Part Tracking is Enabled in Surface Measurement, several GUI changes arise to accommodate the additional program functionality in Thermal Profiler. The Camera Window Pane ROI box is removed and there are two new options in the Profile Setup screen detailing how part results will be organized.

Before a thermal profile is run with Part Tracking enabled, an initial part track operation is performed to establish a base line for how many parts the software should expect to find. If a part happens to not be found during any subsequent measurements, the remaining parts will still be numbered appropriately. A Baseline Arrangement confirmation dialog (**Figure 2.23**) will pop up stating the number of parts found and asks the user to confirm that this is the desired number of parts. While a profile is running with the new Thermal Profiler Part Tracking interface enabled, parts will be tracked and ROI selection annotations will be placed on the Camera Window Pane over the location

where the parts were found. A green annotation box indicates the actively shown ROI data in the bottom left Phase/Displacement Pane.

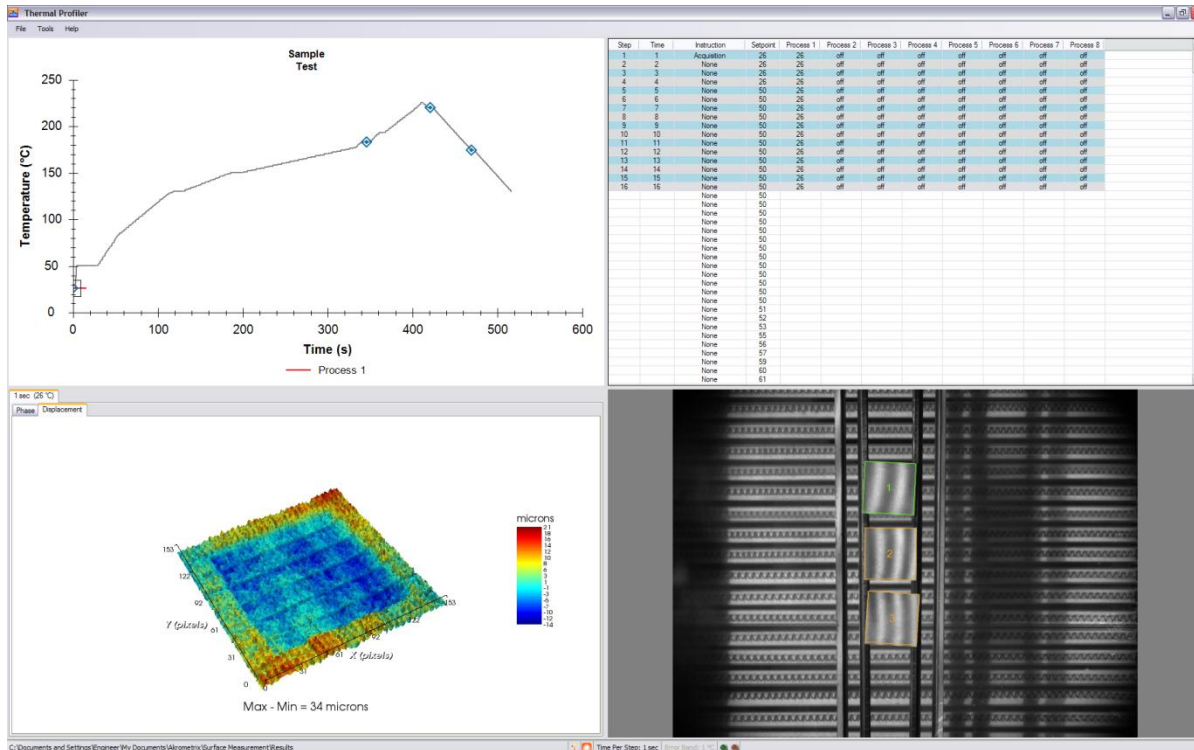


Figure 2.22 Thermal Profiler in Part Tracking Mode

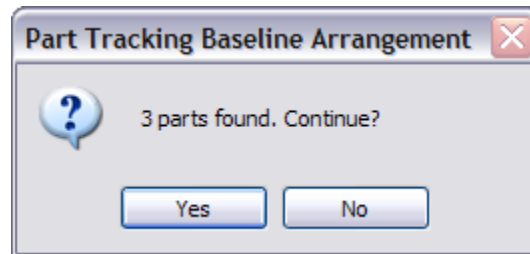


Figure 2.23 Baseline Arrangement Confirmation

2.7.1 Profile Setup – Organization and Naming Options

There are two new options in the Profile Setup window for organizing and naming Part Tracking results. These two options are shown below in **Figure 2.24** and **Figure 2.25**.

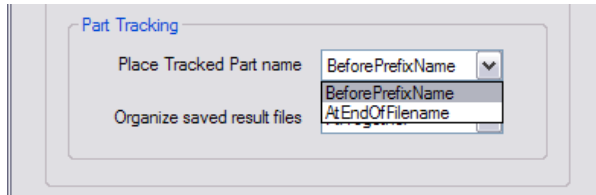


Figure 2.24 Place Tracked Part Name Option

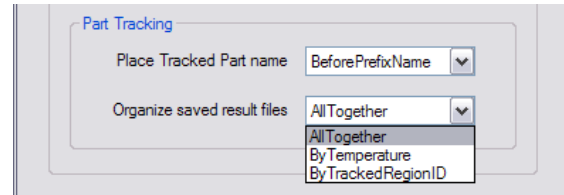


Figure 2.25 Organize Saved Result Files Option

The Place Tracked Part Name option describes where in each filename the tracked part name is placed. The Organize Saved Result Files option determines how the resulting phase images are organized.

Appendix A - Miscellaneous Information

A.1 File Formats

Input files for the Thermal Profiler application consist of only one type, files with the extension .akx_profile. For more information on this file format and its construction please see the Profile Generator User Manual.

Output files consist of .txt, .jpg, .akx, and, while in DIC mode, .tif files.

A.2 Keyboard Shortcuts

There are currently no keyboard shortcuts in the Thermal Profiler application.