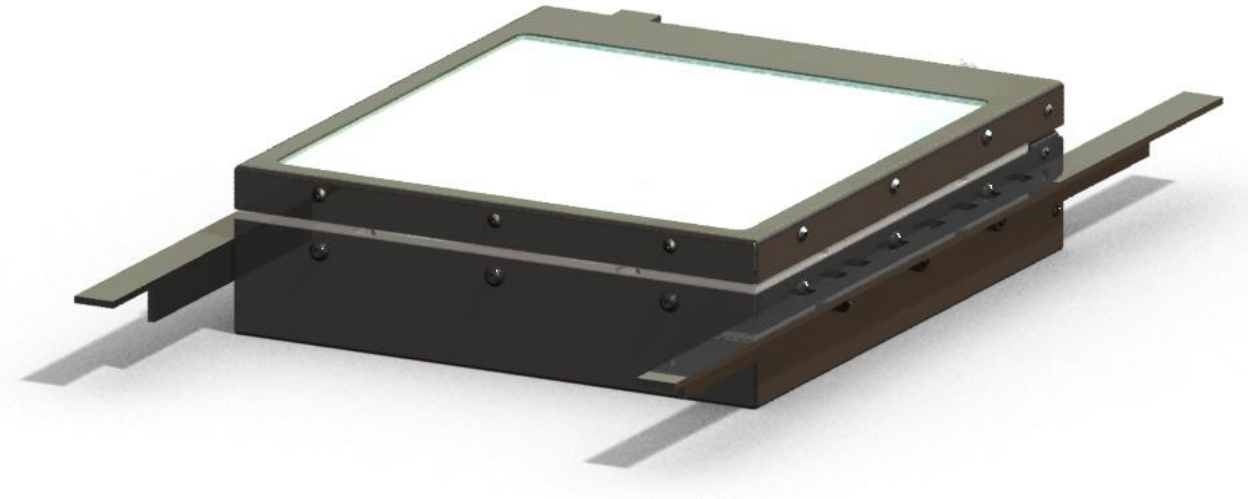
akrometrix

Sub Room Temperature Module



User Manual

Akrometrix Proprietary Information

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Contents

1 Introduction

1.1 Overview

The Akrometrix Sub Room Temperature Module is an add-on component for the TherMoiré warpage measurement system that allows samples to be heated and cooled convectively from -50 to 300 °C. It is designed to work with the TherMoiré PS400 or AXP.

This manual describes the Sub Room Temperature Module system hardware and sample set-up, as well as some data acquisition software features. It is assumed that the user is already familiar with the operation of the TherMoiré measurement system; a user unfamiliar with shadow moiré or the TherMoiré system is advised to first read the TherMoiré User Manual in order to make best use of the system.

Before operating the Sub Room Temperature Module, the user should carefully read **Section 1.2**, which describes health and safety hazards associated with the system. The Sub Room Temperature Module makes use of an air chiller, an air heater, and electrical and high-pressure gas systems, all with the potential to injure if used or maintained carelessly. **Section 1.3** identifies system components and controls.

Chapter 2 describes basic procedures for system setup, operation and shutdown. **Chapter 3** describes the data acquisition process for the Sub Room Temperature Module system and focuses on how data acquisition differs between the TherMoiré and the Sub Room Temperature Module. **Chapter 4** explains how to troubleshoot the Sub Room Temperature Module in order to make best use of the system.

Appendix A describes recommended procedures for maintenance and transport of the system. This section also contains equipment ratings and technical support material.

1.2 Warnings and Precautions

1.2.1 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.

1.2.2 Heating and Cooling Temperatures

The Sub Room Temperature Module combines a 2-stage refrigeration system with a downstream tube heater to provide nozzle temperatures ranging from -80°C to 500°C. These temperatures are measured at the end of the chiller system's nozzle, which is

different than the temperatures that are applied to the sample from the chamber nozzle. During CM operation, the sample temperature is controlled by a separate temperature controller than that of the base TherMoiré system. A master thermocouple is attached to the sample under test and the controller adjusts heater power to minimize the difference between sample and setpoint temperatures. The controller can be operated manually by the front panel controls (**Section 3.2**) or automatically by the Thermal Profiler software (see the Thermal Profiler User Manual for instructions on its use).

1.2.3 Pressurized Air

Pressurized dry air is required to run the system with incoming pressures above 520 KPa [75 psi] to the chiller system. Caution should be observed whenever connecting or disconnecting the air lines.

The air must be dry gas, either air or nitrogen, with operating flow rates from 28.3 to 169.9 lpm [1.0 to 6 scfm] as measured from the incoming air to the chiller. SCFM is Cubic Feet per Minute of air at Standard temperature and pressure. The volumetric flow rate applied to the sample can be greater than or less than the scfm flow rate according to the ideal gas law.

1.2.4 Lid Defrost

Extended operation at sub-room temperatures can cause fogging of the sample enclosure lid due to condensation from ambient humid air. The lid defrost circuitry runs a low voltage current through a transparent conductive coating on the outer surface of the double pane window. Heating of this surface above the room's dew point prevents condensation and will drive off any moisture on the surface. It is controlled manually through a front panel button on the Sub Room Temperature Module electrical cabinet.

Proper lid defrost control must be determined by the user. Because it adds heat to the system, it can slow down sample cooling and even limit the lowest achievable temperature. Normal practice is to turn it on as necessary, typically when condensation first appears at the edges of the window. Under very high ambient humidity, it may be necessary to use it frequently or even continuously.

1.2.5 Health and Safety Hazards

- The Sub Room Temperature Module system has been designed to minimize the potential for user injury. Safety systems should not be tampered with, circumvented, or left in a permanent over-ride state. Settings on the over-temperature controller should not be changed without the approval of Akrometrix.
- Surfaces both inside and outside the sample enclosure chamber can reach extreme temperatures, both hot and cold, during system operation and can harm the user without proper precautions. Care should be taken in opening the oven after a temperature cycle. The user should only touch the sample enclosure after the sample has been held at room temperature for at least 10 minutes. Internal surfaces can remain at extreme temperatures even after the sample reaches room temperature. The user should exercise care before touching the sample, sample supports, or other internal surfaces after a temperature cycle.

- The system should not be used with samples that are combustible or emit toxic gases at high temperatures.
- External electrical and compressed air connections must be installed safely and meet all relevant requirements and building codes.
- Special care should be used when operating the system manually or using specialized diagnostic programs. Temperatures or motions outside the normal range of operation may be possible under these conditions and the system should be monitored carefully.

1.2.6 System Operating Precautions

- The Sub Room Temperature Module should be operated with an emergency-stop cable (or E-Stop cable) that connects the chiller system to the TherMoiré system. If the TherMoiré system goes into E-Stop mode it will turn off the Sub Room Temperature Module's heating system.
- Do not install additional software on the TherMoiré 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 sample enclosure with care. Make sure there is adequate clearance between sample enclosure and grating before closing the oven lid. If the sample enclosure lid is discolored by outgassing products, clean the lid using rubbing alcohol or glass cleaner before performing another temperature cycle.

Warning: Do not home the motor stage when using the CM200 sample chamber if it has been installed before running Surface Measurement. Doing so will damage the sample chamber and sample support structure.

1.3 System Configuration

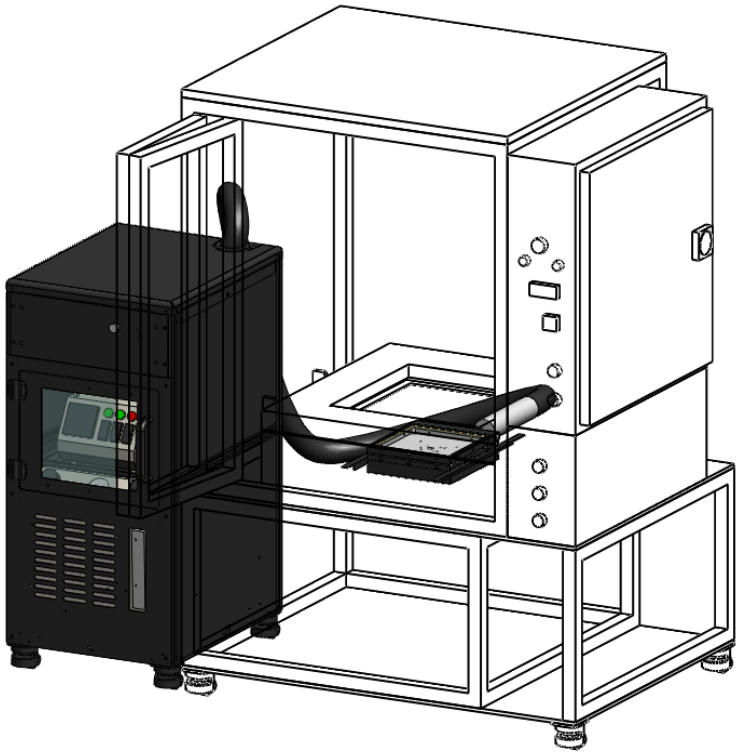

Figure 1.3 CM200 Install Diagram

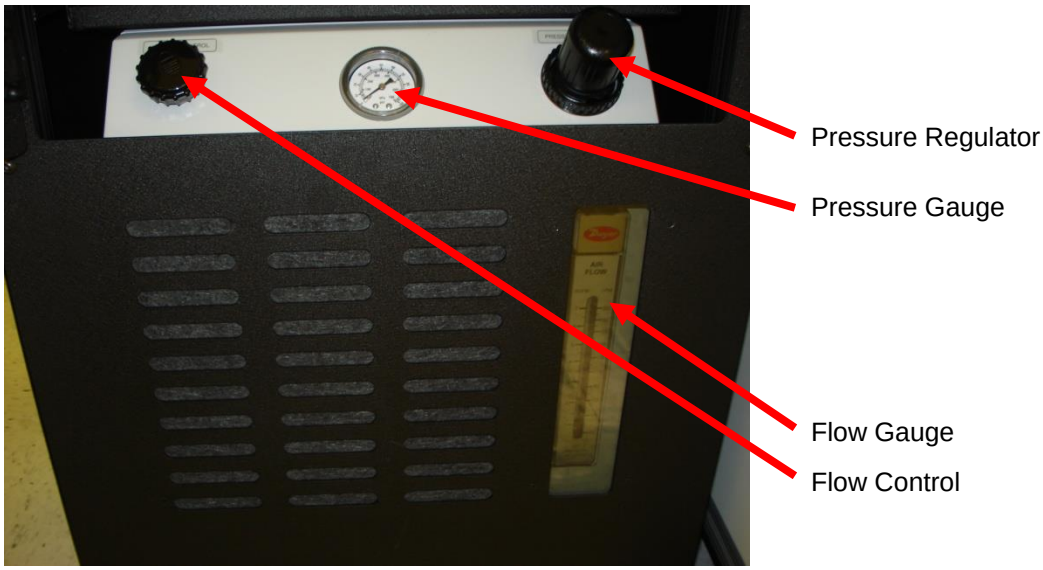

Figure 1.4 Air Chiller Front Panel Controls

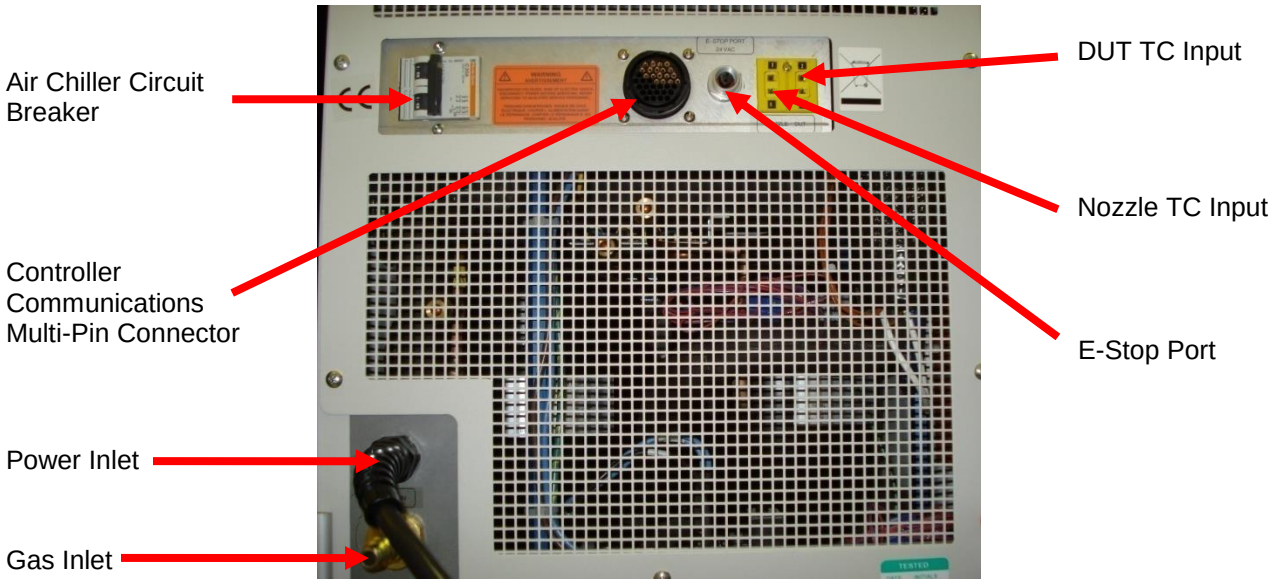

Figure 1.5 Air Chiller Back Panel Connections

Figure 1.6 Temperature Controller Front Panel Controls

Figure 1.7 Temperature Controller Back Panel Connections

1.3.1 Nozzles

Each Sub Room Temperature Module comes with 3 aluminum nozzles that mount inside the sample chamber. The purpose of these nozzles is to distribute the incoming air evenly across the sample. Achieving the best heating rates and sample temperature uniformity requires choosing a nozzle matched to the sample size. The sample edges should be at least 5 mm from the perimeter of nozzle mesh. See **Figure 1.8** for a picture of the available nozzles and their sizes.

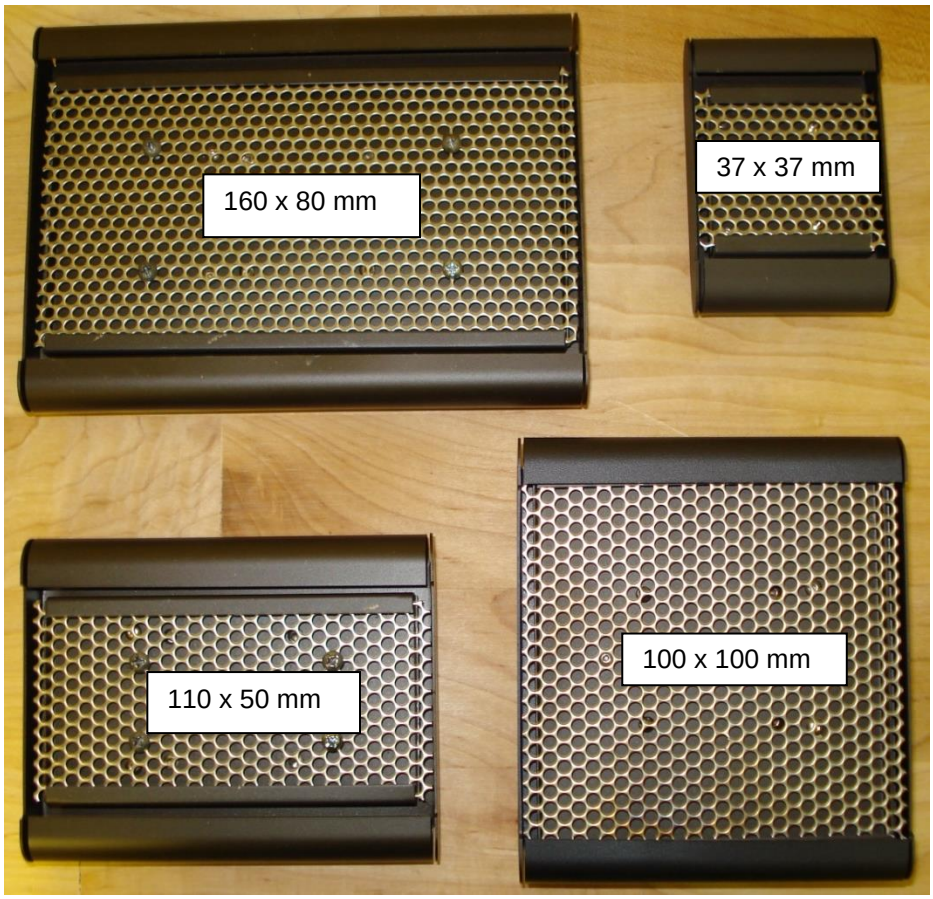

Figure 1.8 Nozzle Size Options

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 System Set-up

2.1 System Set-up

2.1.1 Common Installation Instructions

1. Place the Sub Room Temperature Module console to the left of the TherMoiré unit as shown in **Figure 1.3**.

2. Connect the Emergency-Stop cable from the E-Stop connector port at the back of the TherMoiré electrical cabinet to the E-Stop connector port at the back of the Sub Room Temperature Module air chiller.

3. Connect the serial cable from the Sub Room Temperature Module temperature controller to the S3 serial port coming from the back of the computer.

4. Disconnect the infrared (IR) oven power connector from the side of the TherMoiré IR oven.

Warning: Sample enclosure damage can occur if the TherMoiré IR oven is active when the sample enclosure is installed in the oven. Although there are software protections to prevent this, we recommend disconnecting the IR oven power cable, located on the right hand side of the oven, during the Set-up procedure.

5. Connect Sub Room Temperature Module power and gas connections to the building utilities. See Appendix A for requirements.

6. Apply power to the TherMoiré (as described in the TherMoiré User Manual). Press the green Reset button so that the system is in operating condition.

7. Apply power to the Sub Room Temperature Module unit by pulling up on the black power button at the top of the temperature controller. All front switches (airflow, refrigeration, and heater) should be in the off position (see **Figure 1.6**).

8. Start the TherMoiré data acquisition program and allow the sample support stage to go through its normal homing cycle to the bottom of stage travel (as described in the TherMoiré user manual).

9. Using the Adjust Height control, lower the sample support stage so that its absolute height value is around 1500 mils.

10. Remove the rear reflector of the TherMoiré sample support by removing the three screws connecting it to the back sample support. Route the flexible hose metal

end through the nozzle support bracket at the rear of the machine and into the back of the oven. Once fully inserted the knurled nut at the end of the metal nozzle should poke through the back inner wall of the oven.

Warning: The user should not force the black insulated flexible hose to make tight-radius bends during installation and especially during operation. Doing so can damage internal cooling and air lines.

11. Route the female thermocouple connector through the back of the machine around the nozzle support bracket and to the right of the oven (left side of oven while facing the front of the machine).

12. Tighten the set screws on the nozzle support bracket to hold it in place.

13. Open the oven lid and place the Sub Room Temperature Module inside the sample support frame as shown in **Figure 2.1**.

Warning: The CM200 must not be installed in the oven chamber during the stage home sequence.

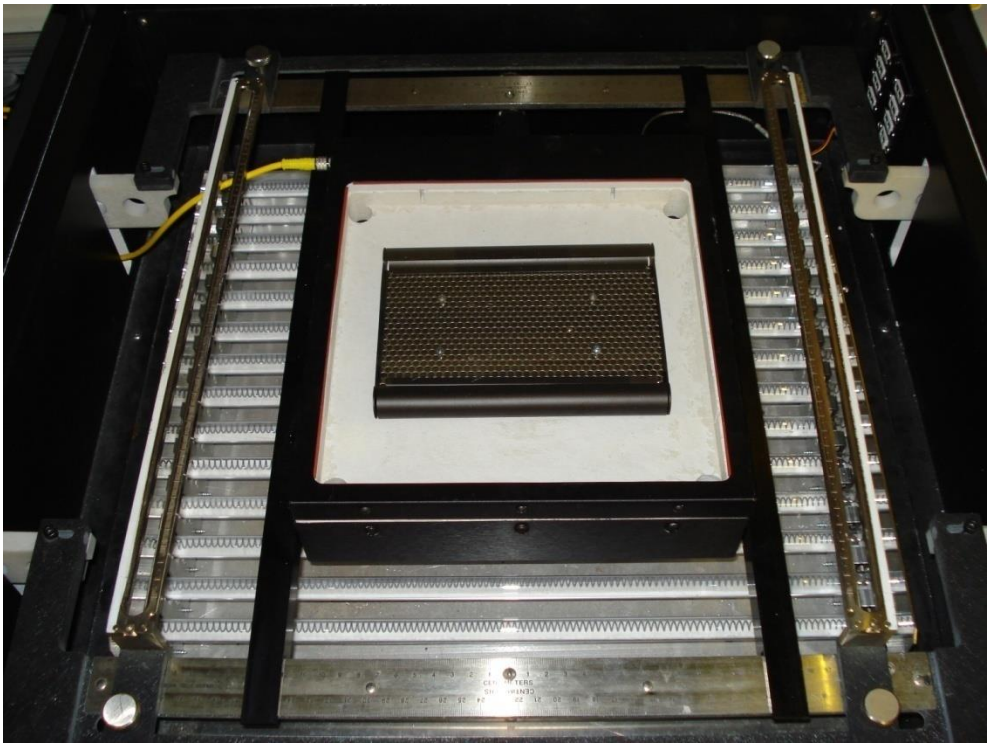

Figure 2.1 CM200 Sample Chamber installed in PS400

14. Connect the knurled Swagelok nut at the end of the chiller nozzle to the threads on the end of the black insulated air pipe. Tighten it by hand or lightly with a wrench.

15. If sub-room temperature testing will be performed, connect the Lid Defrost Power Cable to the Lid Defrost Power Connector through the gap beneath the left rear oven support arm (see **Figure 2.1**).

16. Connect a male K-type thermocouple to the female DUT thermocouple connector that exits the end of the chiller nozzle.

17. Remove the Sub Room Temperature Module lid and place the selected nozzle inside the recessed holes. Tighten the screws with the supplied 3/32” ball hex driver with no more than 4 turns per screw until the nozzle is fully seated.

18. Attach the K-type DUT thermocouple to the sample. Typically, a 36awg Teflon-coated thermocouple with a bare junction is attached to the underside of the sample using Kapton tape. Thermal grease can be applied for operations above room temperature to achieve better thermal contact and more accurate temperature measurements.

19. [Optional] Additional K-type thermocouple(s) can be attached to another point on the sample or to another sample. This thermocouple reading can be recorded during the sample run, but does not play a role in temperature control. The PS400 and AXP can accommodate additional 7 additional thermocouples.

20. Route the thermocouple wires through the slots on the chamber base.

21. Place the sample enclosure lid on the sample chamber, taking care not to crimp or break the thermocouple wires. Special slots are arranged around the perimeter of the box to allow easy routing of thermocouple wires under the enclosure lid.

22. Close the oven lid and press Reset to remove the emergency stop condition. The system is now ready to begin operation.

2.2 System Operation

1. Turn the Airflow switch on the Sub Room Temperature Module temperature controller to the On position. The light above the switch is illuminated.

2. Adjust the air pressure on the Sub Room Temperature Module chiller unit to 520 KPa [75 psi] and the airflow to 56.6 lpm [2 scfm].

3. Manually set the setpoint of the Sub Room Temperature Module temperature controller to 25°C (this should be default condition on powering up the system).

4. Turn the Refrigeration switch on the Sub Room Temperature Module temperature controller to the On position. The chiller requires approximately 15-20 minutes to begin cooling. The light above the switch is illuminated when the second stage compressor is activated and cooling begins.

5. Monitor the nozzle temperature (Input 1 field) on the front of the Watlow series F4 temperature controller. When the nozzle temperature reads -75°C or below, the system is ready for operation.
   a. If the system is having problems reaching low temperatures, the airflow can be decreased to 42.5 lpm [1.5 scfm] until low temperatures are reached, then increased back to 56.6 lpm [2.0 scfm].

6. Turn the Heater switch on the Sub Room Temperature Module temperature controller to the On position. The light above the switch is illuminated only when the heater in the nozzle is in an over-temp condition. This rarely occurs during normal operation.

The system is now ready to begin manual or automated temperature control (See Section 3).

2.3 System Shutdown

1. To shutdown the Sub Room Temperature Module system when testing is complete, turn off the Heater and Refrigeration switches on the Sub Room Temperature Module temperature controller.

2. Turn the Airflow switch on the Sub Room Temperature Module temperature controller off after the nozzle temperature (Input 1 field on the Watlow series F4 temperature controller) rises above 15°C.

Warning: Turning off the airflow before the nozzle temperature has returned to room temperature may cause freezing within the air line, which will require that the entire system return to room temperature, with a longer delay before system operation can resume.

3. When the sample has returned to room temperature, open the TherMoiré oven and sample enclosure and remove the sample.

Warning: The Sub Room Temperature Module sample chamber takes time to return to safe-handling temperatures. Use extreme caution in handling the sample chamber as it can retain significant heat or cold long after the thermal cycle is complete. The temperature controller displays the *sample temperature*, which may not be an accurate indicator of the temperature of other oven components.

4. Continue the TherMoiré shutdown procedure as described in the TherMoiré user guide.

2.4 Removing the Sub Room Temperature Module Sample Enclosure

Removing the Sub Room Temperature Module sample chamber is simply a reversal of the installation instructions. Disconnect all cables and tubes from the sample enclosure. Remove the lid defrost cable from the oven by pulling it through the slots in the oven. Remove the sample enclosure from the oven. Remember to reconnect the oven power cable for normal TherMoiré IR heating.

3 Data Acquisition

3.1 Warpage Measurement Set-Up

Sample set-up is identical to normal practice for the TherMoiré systems, as described in the TherMoiré User Manual. The primary difficulty lies in getting adequate fringe contrast because the sample chamber windows require a greater working distance between the sample and grating. Setting up the measurement can normally be done while waiting for the Sub Room Temperature Module chiller to achieve normal operating conditions (see **Section 2.2**, steps 4 and 5).

Warning: The Sub Room Temperature Module is only designed to work with 100 lines per inch or lower frequency gratings.

Warning: The Sub Room Temperature Module works best with light colored samples or samples that have been painted with a high temperature white paint because of the greater optical contrast.

1. Adjust the sample chamber height as described in the TherMoiré User Manual.
2. Raise the sample enclosure until it barely touches the bottom of the grating.
3. Lower the sample enclosure until it no longer touches the grating (i.e., about 10 to 20 mils).
4. Readjust the camera lens (zoom, iris and focus), and ROI as described in the TherMoiré User Manual

Warning: Sub Room Temperature Module Chamber or grating damage can occur if the sample chamber is not lowered below grating height when the oven lid is closed.

5. Manual or automated data acquisition can now be performed as described in the TherMoiré User Manual

3.2 Data Acquisition with Manual Temperature Control

Set the desired setpoint temperature manually on the Sub Room Temperature Module temperature controller (**Figure 1.6**) by:

1. On the Main Page display (default display), move the triangular cursor next to the label SP1 by using the up and down arrow buttons on the face of the temperature controller.
2. Push the right arrow once.

3. Use the up and down arrow buttons to adjust the setpoint to the desired value.

4. Push the right arrow once more.

See the Watlow F4 manual for more extensive details on functionality.

The sample temperature is displayed in red numerals on the top display of the temperature controller. When the sample temperature has stabilized at the desired temperature, image acquisition can occur as described in the TherMoiré User Manual. If a measurement needs to be made at a different temperature, repeat Steps 1 – 4.

When the temperature run is complete, the user must reset the set point temperature to room temperature (26°C).

Warning: Upon completion of a manually controlled temperature profile, the user *must reset the setpoint temperature to room temperature*. Failure to do so may cause the oven to system to continue heating and/or cooling.

3.3 Software Temperature Control

The Sub Room Temperature Module uses the same Thermal Profiler software as the IR oven. Please see the Thermal Profiling Manual for a description of its procedures and usage.

Note: The TherMoiré oven exhaust and blower fans are still operational and can be turned on and off automatically using the Thermal Profiler software. However, these have very little impact inside the Sub Room Temperature Module Sample Chamber.

Warning: The user must manually switch the Thermal Profiler software to Sub Room Temperature mode. If the sample chamber is in the oven and the software is not in Sub Room Temperature mode, it may sustain damage when a temperature profile is initiated. For safest operation, disconnect the power cable from the right side of the IR oven.

3.4 Removing and Changing Samples

1. Allow the sample enclosure to heat or cool until internal temperatures (as measured on both temperature controllers) are safe for handling. Airflow through the Sub Room Temperature Module system may continue while the sample is being changed.

Warning: The Sub Room Temperature Module sample chamber takes time to return to safe-handling temperatures. Use extreme caution in handling the sample chamber as it can retain significant heat or cold long after the thermal cycle is complete. The temperature controller displays the *sample temperature*, which may not be an accurate indicator of the temperature of other oven components.

2. Open the lid while pressing the Oven Lid Release button.

3. Remove the sample enclosure lid.

4. Remove the tested sample carefully. Detach the thermocouple by removing the Kapton tape. Do not remove the thermocouple by pulling on the thermocouple wire, which may damage the wire.

5. Set up the new sample as described in **Section 2.1.1**, Steps 18-22.

Warning: Before closing the lid, check that clearance between the sample enclosure and grating will be maintained after closing. Lower the sample chamber height before closing, if necessary. Sample chamber-grating contact may damage the grating.

4 Troubleshooting

4.1 Troubleshooting Data Acquisition

Many of the issues that arise when making measurements with the Sub Room Temperature Module system are similar to those the user may encounter with the TherMoiré. Please review the TherMoiré User Guide for a discussion of these issues. Still, there are issues that are specific to the Sub Room Temperature Module system. Those issues are discussed in the following sections.

4.1.1 Failure to Obtain Quality Phase Information

Phase data is obtained for each pixel in an image by combining four digitized images on a pixel-by-pixel basis. In general, quality phase data can be obtained anywhere good fringe contrast is observed in the raw video image. Frequently, good phase data can be calculated even where the human eye cannot resolve fringes; for example, against a permanent background pattern such as circuit traces. However, there are situations where quality fringes cannot be obtained:

Symptoms:

- An extremely noisy grayscale signal appears in the phase image. (**Figure 4.1**)
- A banding pattern of grayscale values appears in the phase image.(**Figure 4.2**)

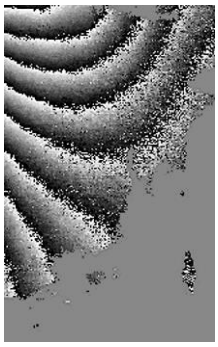

Figure 4.1 Noisy Phase Image

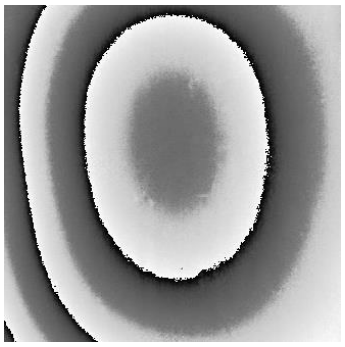

Figure 4.2 Banded Phase Image

Cause: Sample-Grating Distance

A noisy grayscale signal in a phase image generated by the Sub Room Temperature Module system usually occurs because the sample is too far away from the grating. A fringe pattern is not visible when the distance between the sample surface and the grating is too large. There is an effective working distance below the grating within which fringes on the sample surface can be observed. The shadow of the grating loses sharpness as the distance from the grating increases due to diffraction effects and finite thickness of the light source. The distance between the sample and the grating is difficult to determine in the Sub Room Temperature Module because the sample enclosure lid is placed between them.

Solution:

a. Raise the TherMoiré sample support as high as possible without touching the grating.
b. Paint the sample with white paint. This will provide a much sharper contrast to the shadows cast by the grating.
c. Ensure the lid is tightly attached to the chamber base and no thermocouples are caught between the lid.

Cause: Condensation on Glass

A noisy grayscale signal in a phase image generated by the Sub Room Temperature Module system can also occur when there is fogging or frosting of the glass in the sample enclosure lid. The extreme low temperatures generated by the Sub Room Temperature Module can cause water vapor from the air to condense onto the glass of the sample enclosure lid and freeze, obstructing the camera's view of the fringe pattern.

Solution:

Turn on the lid defrost power using the switch on the front of the Sub Room Temperature Module electrical interface. The outer surface of the glass in the sample enclosure lid is coated with a thin resistive film called Indium Tin Oxide (ITO). Turning on the lid defrost allows low voltage to flow through the resistive film and heat the outer surface, which will evaporate any condensation.

Cause: Incorrect Phase Step Distance

Banding of the phase image occurs when there is an incorrect phase step distance, resulting in the incorrect calculation of phases. This is due to incorrect software grating selection, incorrect calibration values, or physical contact between the sample and the grating. This may happen in the Sub Room Temperature Module system when the sample enclosure is touching the grating, or if there is interference from the air tube (i.e., the tube getting wedged between the sample support arms and the side of the slot in the back of the oven).

Solution:

a. Lower the sample enclosure so that it is not touching the grating.
b. Make sure that the Sub Room Temperature Module air tube is not interfering with motor travel.

4.2 Troubleshooting Heating/Cooling

4.2.1 Difficulty Reaching High Temperatures

Symptoms:

Sample does not reach maximum operating temperatures or takes a very long time to reach a desired temperature. Again, heating rates and thermal conductivity are specific to each type of sample; there are operational situations that may prevent the Sub Room Temperature Module from producing the highest possible sample temperature.

Cause: Low Flow Rates

Adjusting the flow rate may improve sample heating rates. Typically, gas flow may be run higher (85 – 169.9 lpm [3-6 scfm]) during heating than cooling to achieve optimal heating. However, at higher flow rates, sample temperature uniformity will decrease.

Cause: Incorrect Nozzle Choice

The nozzle chosen should be the smallest size compatible with the sample(s) to be measured. Smaller nozzles have less thermal mass and more efficiently concentrate the air flow on the sample surfaces.

Cause: Poor Sample Fixturing

Check that the method used to hold the sample does not block the airflow around the sample or cause heat transfer between the sample and a more massive object. Check also that the sample is not in contact with the inner surface of the chamber window.

Cause: Frozen Chiller Line

Extended use of the Sub Room Temperature Module with the chiller refrigeration in the **On** position can cause freezing in the line if moisture gets into the dry air system. Note that this can occur even during heating. If this occurs, the system should be run with the refrigeration off until the line appears clear of freezing or moisture, and then run for an additional 15-30 minutes at 85 – 169.9 lpm [3-6 scfm].

4.2.2 Difficulty Reaching Low Temperatures

Symptoms:

While cooling rates and thermal conductivity are specific to each type of sample, there are operational situations that may prevent the Sub Room Temperature Module from producing the lowest possible sample temperature:

Cause: High flow rates

Starting the air chiller at a flow rate higher than 56.6 lpm [2 scfm] can prevent the chiller from reaching the minimum air/gas temperature because the refrigeration system runs inefficiently.

Solution:

Akrometrix suggests starting the air chiller at 42.5 – 56.6 lpm [1.5 – 2 scfm] and allowing it to run at that flow rate for 15 to 20 minutes to allow chiller to reach the minimum temperature. The flow rate can then be increased to up to 70.8 lpm [2.5 scfm] to improve the cooling rate. Increasing the flow rate after the chiller has reached the minimum temperature should not cause the temperature to increase. Decrease airflow if nozzle temperatures begin to drop.

Cause: Lid defrost

Turning on the lid defrost causes the top surface of the glass in the sample enclosure lid to heat up. The heat from this surface can then be conducted to the sample, counteracting the air/gas cooling.

Solution:

Akrometrix suggests using the lid defrost only when necessary to minimize this effect.

Cause: 'Wet' Gas

If the gas being used is not at or below a dew point of –100°C, the chiller will not reach the minimum temperature.

Solution:

Use a dry gas source (such as nitrogen) or use an air dryer to prevent this issue. A desiccant air dryer is insufficient to achieve a dew point of -100°C.

Cause: Frozen Chiller Line

Extended use of the Sub Room Temperature Module with the chiller refrigeration in the 'On' position can cause freezing in the line if moisture gets into the dry air system.

Solution:

If this occurs the system should be run with the refrigeration off until the line appears clear of freezing or moisture, and then run for an additional 15-30 minutes at 85 – 169.9 lpm [3-6 scfm].

Cause: Sample Thermal Mass too Great

A sample with too great of a thermal mass may not achieve a desired temperature even after extended operation at the minimum temperature. Because of the heat transfer to and from the sample the convective cooling may not be enough to counteract the heat gain from radiation and conduction on the top surface of the sample.

Solution:

Change the minimum temperature of the profile to a value that can be achieved in a reasonable time.

Cause: Chiller malfunction

a. To determine if there is a malfunction, lower the set point to -100°C and allow the chiller to run for about 30 minutes. The nozzle temperature (as displayed on the Watlow F4 main screen) should reach approximately -75°C running at 42.5 – 56.6 lpm [1.5 – 2 scfm].

b. Heavy buildup of frost between the flexible hose and the aluminum cylinder at its end may also indicate a broken gas or refrigerant line requiring factory repair.

Solution:

If the temperature is more than a few degrees higher than -75°C or if there is a buildup of frost between the flexible hose and chiller nozzle, contact Akrometrix.

4.2.3 Difficulty Matching a Profile

Symptom:

Output profile deviates from input profile drastically, or oscillates wildly.

Cause: PID Settings Not Optimized for Sample/Nozzle

Solution:

Restore the PID setting of the Watlow controller to the original shipped values (see **Table 4.1**). Retest at these values. If resetting the PID parameters does not rectify the problem then try extending the total profile time. Modifying of the inner loop PID parameters is usually not necessary, but the integral value (I) of the outer loop can be reduced to make the temperature more quickly match the profile. Also, the proportional value (P) of the outer loop can be reduced as long as the system is not exhibiting oscillatory behavior. The Watlow controller's user manual describes some of these procedures. If this still does not work, please contact Akrometrix customer support.

Table 4.1 Default Sub Room Temperature Module PID Settings

	Inner Loop (Chiller Control)	**Outer Loop (Sample Control)**
Proportional Band (°C)	100	70
Integral Term (°C/s)	0.20	3.0
Derivative Term (°C s)	0	0

Appendix A - Miscellaneous Information

A.1 Equipment Ratings

Physical Characteristics	
Chiller Tower Size	520 mm x 640 mm x 1100 mm
Chiller Tower Weight	80 kg [180 lbs]
Required Services	
Electrical	220 VAC, 50/60 Hz, single phase, 20 Amps
Air	clean dry air at 520 KPa [75 psi], 169.9 lpm [6 scfm], dew point ≤ -80°C

A.2 Installation and Assembly

A qualified Akrometrix representative should perform the initial installation. However, if it is necessary to disconnect the system components for transport or maintenance, please reconnect the system as described below:

A.2.1 Connect the Dry Gas Delivery Line

The Sub Room Temperature Module requires a source of dry gas with a dew point below –80°C at a pressure of 520 KPA [75 psi] and flow rate of up to 169.9 lpm [6 scfm]. This may be air or nitrogen.

Connect the dry gas supply to the inlet at the rear of the Sub Room Temperature Module air chiller (see **Figure 1.5**).

A.2.2 Reconnect Cables and Wires

1. Connect the serial cable to the back of the temperature controller (see **Figure 1.7**). Connect the other end of the serial cable into the serial to USB adapter that is connected to the TherMoiré computer.
2. Connect the E-stop cable from the back of the Sub Room Temperature Module chiller unit to the back of the TherMoiré electrical cabinet.

A.3 Transport

When transporting the Sub Room Temperature Module system to a new location, Akrometrix recommends that the components be removed from the system and packed and moved separately. Components requiring special care include:

- Sample enclosure lid
- Air chiller (keep upright and observe minimum bend radius of black insulated air hose)

Warning: The user should not force the black insulated flexible hose to make tight-radius bends during installation and especially during operation. Doing so can damage internal cooling and air lines.

A.4 Disassembly

Contact Akrometrix for safe disassembly and disposal instructions.

A.5 Ventilation

The Sub Room Temperature Module requires no specialized ventilation. Normal use of the equipment should take place in a clean, well-ventilated area. Any gases produced can be vented using the TherMoiré system's exhaust.

A.6 Maintenance

A.6.1 Gas Line Maintenance

Periodically inspect all hose connections for leaks or other wear. Tighten connections when necessary.

A.6.2 Lid Defrost and Glass

Both surfaces of the sample enclosure lid glass should be cleaned periodically with commercial glass cleaner and a soft cloth.