H1000

THERMAL CHUCK SYSTEM OPERATIONS MANUAL

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TRADEMARKS

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CAUTION: CAUTION statements identify conditions or practices that could result in damage to this product or other property.

NOTES

SECTION 1.0
INTRODUCTION

1.1 HOW TO USE THIS MANUAL

Read Section 1.0 for general information regarding the **H1000 THERMAL CHUCK SYSTEM™** For unpacking and setup information and equipment familiarization, read Section 2.0. For information regarding how to operate this equipment and instructions that will serve to introduce several equipment familiarization procedures, read Section 3.0. Section 4.0 provides the PRINCIPLES OF OPERATION for the system. Sections 5.0 covers the 0° cooling option. Section 6.0 provides maintenance and repair methods and recommended spare parts.

1.2 SYSTEM OVERVIEW

The **H1000 THERMAL CHUCK SYSTEM™** (Ref. Fig. 1-1) is a modular approach to providing customized temperature controlled platforms for testing wafers. The various modules are the Heat Control Module, Cooling Module, Thermal Chuck Assembly, and optional Linear DC Power Supply.

The most BASIC SYSTEM consists of a HEAT CONTROLLER and THERMAL CHUCK for the appropriate wafer prober. This would provide a low cost Heat only Thermal Chuck testing system. This system would allow operation from ambient to 400° C. This system can be expanded by adding one or more options to it. For example, by inserting a COOLING MODULE into the space provided in the original Heat Controller and plumbing in the Cooling module accessories, the Thermal Chuck can be cooled more rapidly when required. When the correct Cooling Option is selected, the Thermal Chuck can even be cooled below ambient. A Linear DC Power Source can also be added for those who require the Thermal Chuck to be electrically "quiet". These options can be added together or separately to provide the desired end configuration.

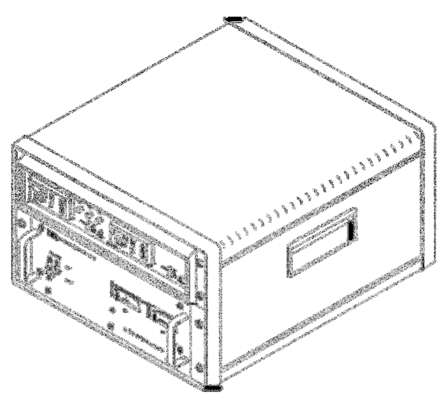


FIGURE 1-1. H1000 THERMAL CHUCK SYSTEM
(SHOWN WITH DC POWER SOURCE)

1.3 GENERAL DESCRIPTION

The most Basic system consists of a Heat Controller and Thermal Chuck system which would allow operation from ambient to 400º C. Some form of coolant must be circulated through the radiators of the Thermal Chuck during normal operation. Two hoses are provided with each system for connection to and from the radiators. These hoses are connected to the assembly with quick connect couplings that have internal shut off inside of them.

The most basic Heat Controller (H1000) (Ref. Fig. 2) would use AC power to drive the thermal chuck. A special "burst firing" control of the AC provides a low noise AC drive to the Thermal Chuck. The H1000 Heat Controller is designed to work in conjunction with the DC100 power source that drives the thermal chuck with an extremely "clean" DC Power. PID temperature control is provided with both the AC and DC power.

The Heat Controller is packaged in a 19" rack mountable 5 1/4" high by 13 1/2" deep enclosure. Power and actuation control for a cooling option is integrated into the heat module. All manual controls governing actuation and temperature set point control are located on the Heat Controller's front panel.

FIGURE 1-2. HEAT CONTROLLER

The Heat Controller's rear panel serves as the central connection point for all options. Located on the rear panel are the, AC power inlet, two Voltage Selector switches, appropriate circuit breakers (two for AC power chucks), a T/C connector, a CHUCK connector an INTERFACE connector, a COMPUTER INTERFACE connector, a red LIMIT indicator, and a RESET switch.

The Heat Controller provides two connection points to the Thermal Chuck; the T/C (temperature control sensors) and the CHUCK (electrical heater drive). See block diagram.

The INTERFACE connector provides the interconnection of other options such as the Cool Module and/or the DC power source. The COMPUTER INTERFACE connector is a seven position Viking connector wired to provide access for 422 serial control of the module.

1.4 OPTIONS

The H1000 Thermal Chuck System has several options which can be added to the basic heat-only system. Each of these options are discussed in brief in this section. Detailed information can be found in the appropriate section for the particular option.

1.4.1 Cooling options

The H1000 Thermal Chuck System has three different cooling options to choose from. The H1000 Thermal Chuck System can be purchased with one of these options or upgraded at a later time.

AMBIENT COOLING OPTION (C1000-V0-H)

This cooling option provides the capability to cool the thermal chuck to the temperature of water supplied by the user. The user must also supply a drain for the cooling water. The system automatically purges the cooling water from the chuck after the 'cold' temperature set point is reached. The 'cold' temperature is not controlled by this cooling option. Temperature stability is maintained using the heat controller. The C1000-V0-H cooling option provides the necessary plumbing to provide continuous water cooling for the radiator portion of the thermal chuck.

This system includes the cooling module, service module (SRV1) (Ref. Fig. 1-3), tubing and interconnecting cables.

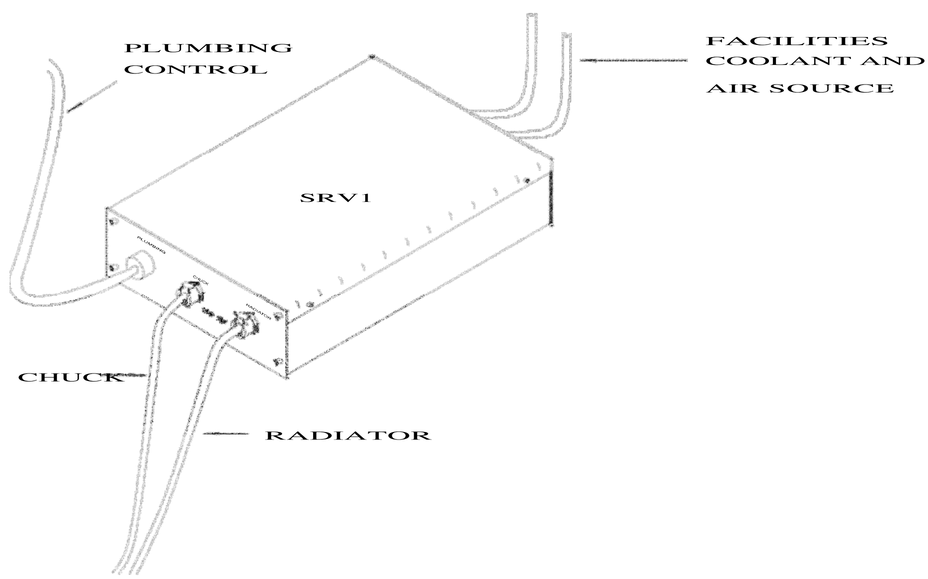


FIGURE 1-3. SERVICE MODULE (SRV1)

AMBIENT COOLING OPTION (C1000-V1-HE and C1000-V2-HE)

This cooling option provides the capability to cool the thermal chuck to the temperature of the ambient air. This cooling option includes an external self-contained heat exchanger which circulates a cooling fluid (usually DI water or water/glycol mixture) to cool both the chuck radiator and chuck surface as required. The system is equipped with an initial supply of cooling fluid. The fluid level is maintained by the user as evaporation occurs. The 'cold' temperature is not controlled by this cooling option. Temperature stability is maintained using the heat controller. This cooling option includes the cooling controller, heat exchanger, tubing and interconnecting cables. The heat exchanger may be ordered with a 19" rack mount kit which occupies 6U (10.5") of rack space.

ZERO ºC COOLING OPTION (C1000-V1-C-0 and C1000-V2-C-0)

This cooling option provides the capability to cool the thermal chuck to 0ºC. This cooling option includes an external refrigeration unit which chills a cooling fluid that flows through the chuck radiator and body as required. The cooling fluid is a mixture of water and glycol. The 'cold' temperature is controlled by the cooling controller which controls the flow of the cooling fluid through the chuck. This cooling option includes the cooling controller, service module (SRV1), refrigeration unit, tubing and interconnecting cables.

1.4.2 Linear DC Power Source (DC-100)

The most basic H1000 heat controller is equipped to supply AC power to heat the thermal chuck. Some thermal chuck applications require the use of "clean" DC power (Ref. Fig. 1-4) to eliminate electric fields created when AC power is used. The H1000 Thermal Chuck System can be configured to supply DC heating power to chuck. AC powered systems can be upgraded to use DC power.

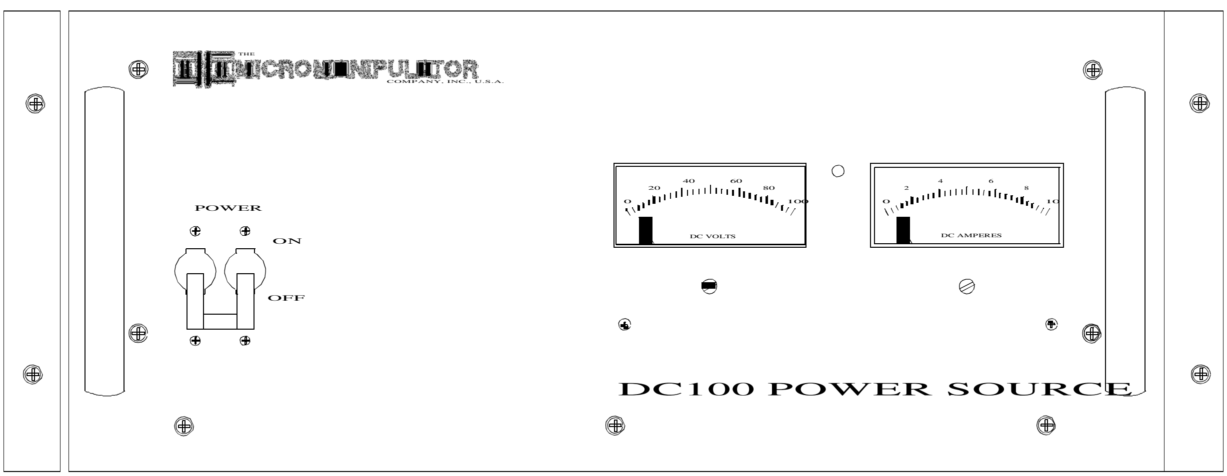


FIGURE 1-4. DC POWER SOURCE (DC-100)

1.4.3 Computer Interface Options (Ref. Fig. 1-5)

In addition to front panel control, the H1000 Thermal Chuck System can be controlled by a computer. There are three interface options available.

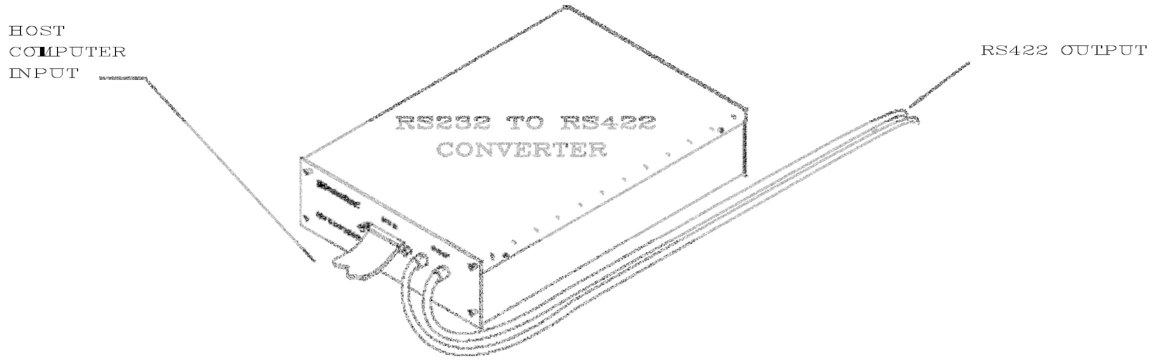


FIGURE 1-5. COMPUTER INTERFACE

RS-232 INTERFACE (H1000-RS-232)

The "native" communications method designed into the H1000 controllers is RS-422. The H1000-RS-232 option allows a remote controller to communicate with the H1000 controllers via RS-232. The command reference for the H1000 temperature controllers can be found in Appendix A of this manual.

GPIB INTERFACE (H1000-IEEE)

This communications option allows a remote controller to communicate with the H100 controllers via a standard IEEE (488) interface. The command reference for the H1000 temperature controllers can be found in Appendix B of this manual.

RS-422 INTERFACE (H1000-RS-422)

This interface option provides the necessary hardware to connect the H1000 controllers to a RS-422 interface, 25 pin connector. The command reference for the H1000 temperature controllers can be found in Appendix C of this manual.

1.5 SPECIFICATIONS

<u>THERMAL CHUCK:</u>

SURFACE PREPARATION:	Platinum sputtered surface.
SURFACE FLATNESS:	50 um (ambient to 300º C) or better.
HEIGHT:	1.85" when equipped with mounting for **MICROMANIPULATOR** probe stations.
SURFACE PLANARITY:	Planarizable at factory or field.
ELECTRICAL ISOLATION:	
COAXIAL:	Surface to ground @25º C, 500 VDC > 100 Gohm
	Surface to ground @400º C, 500 VDC > 1 Gohm
ADVANCED COAXIAL:	Surface to ground @25º C, 500 VDC > 5 Tohm
	Surface to ground @400º C, 500 VDC > 5 Gohm
TRIAXIAL:	Surface to ground @25º C, 500 VDC > 10 Tohm
	Surface to guard @25º C, 500 VDC > 5 Tohm
	Surface to ground @400º C, 500 VDC > 10 Gohm
	Surface to guard @400º C, 500 VDC > 5 Gohm
CAPACITANCE	
COAXIAL:	4" Surface to ground < 200 pF
	6" Surface to ground < 300 pF
	8" Surface to ground < 400 pF
TRIAXIAL:	4" Surface to ground < 150 pF
	6" Surface to ground < 250 pF
	8" Surface to ground < 400 pF
CAPACITANCE VARIATION:	< 3 fF
VERTICAL EXPANSION:	< 10um per 100º C
DIAMETER:	Available in 4", 6", and 8" Consult factory for other configurations.
TEMPERATURE CAPABILITY:	-65º C to +400º C
FACILITY REQUIREMENTS:	Vacuum 25" Hg nominal

HEAT CONTROLLER:
(H1000-AC1-V1, H100-AC1-V2, H1000-DC1-V1, H1000-DC1-V2)

CONTROL METHOD:	PID control
POWER OUTPUT:	
H1000-AC1-V1, H1000-AC1-V2	AC, 1200 watts
H1000-DC1-V1, H1000-DC1-V2	DC, 1000 watts
TEMPERATURE RANGE:	to 400° C 300° C 300mm Chuck H1000-DC1-V1-12
TEMPERATURE ACCURACY:	+/- 0.1% of span, +/-1 LSD, (25°C +/- 3°) ambient at rated line voltage (100 - 240 VAC) +/- 10%
TEMPERATURE STABILITY:	0.1°C per 1°C change in ambient
TEMPERATURE RESOLUTION:	0.1° C
CYCLE TIME PERFORMANCE:	Ambient to 300° C ≤ 12 min. Ambient to 400° C ≤ 30 min. Ambient to 300° C ≤ 45 min. (300mm Chuck).
AMBIENT OPERATING TEMPERATURE:	10 to 40° C.
OVER TEMPERATURE PROTECTION AT:	425° C.
TEMPERATURE DISPLAY:	Green LED chuck temperature; red LED set point temperature.
STATUS INDICATORS:	Heating, fault, % deviation of set point, % power being delivered.
COMPUTER CONTROL:	Optional interfaces available for: RS-422, RS-232 or GPIB(IEEE)

FACILITY REQUIREMENTS:

H1000-AC1-V1, H1000-DC1-V1	120 VAC, 60Hz, 20A, 1 phase
H1000-AC1-V2, H1000-DC1-V2	220 VAC, 50Hz, 10A, 1 phase
H1000-AC1-V1, H1000-DC1-V1-12	120 VAC, 60Hz, 20A, 1 phase
H1000-AC1-V2, H1000-DC1-V2-12	220 VAC, 50Hz, 10A, 1 phase

To meet S2 Certification:
Supply full Thermal Chuck Control and Probing System to GFI Breaker Controlled Power Circuit.

AMBIENT COOLING OPTION (C1000-V0-H):

CONTROL METHOD: PID

TEMPERATURE RANGE: Cools to temperature of user supplied water

TEMPERATURE RESOLUTION: Not applicable

TEMPERATURE STABILITY: Not applicable

CYCLE TIME PERFORMANCE: 400º C to 100º C <6 min.
400º C to 40º C < 9 min with 10º C cooling water
300º C to 40º C < 9 min (300mm Chucks)

TEMPERATURE DISPLAY: Green LED chuck temperature; red LED set point temperature.

STATUS INDICATORS: Cooling, fault, % deviation of set point, % power being delivered.

COMPUTER CONTROL: Optional interfaces available for:
RS-422, RS-232 or GPIB(IEEE)

FACILITY REQUIREMENTS: Shop air @ 20 - 65 Psig
Cooling water @ 20 - 65 Psig @ 20 gal/hr
Water drain

To meet S2 Certification:
Supply full Thermal Chuck Control and Probing System to GFI Breaker Controlled Power Circuit.

AMBIENT COOLING OPTION (C1000-V1-HE, C1000-V2-HE):

CONTROL METHOD: PID

TEMPERATURE RANGE: Cools to ambient air temperature

TEMPERATURE RESOLUTION: Not applicable

TEMPERATURE STABILITY: Not applicable

CYCLE TIME PERFORMANCE: 400º C to 100º C <7 min.
400º C to 40º C < 15 min.
300º C to 40º C < 21 min. with 300mm Chucks.

TEMPERATURE DISPLAY: Green LED chuck temperature; red LED set point temperature.

STATUS INDICATORS: Cooling, fault, % deviation of set point, % power being delivered.

COMPUTER CONTROL: Optional interfaces available for: RS-422, RS-232 or GPIB(IEEE)

COOLING FLUID: De-ionized water or water/glycol mixture

RESERVOIR CAPACITY: 2.5 gallons

FACILITY REQUIREMENTS: C1000-V1-HE: 115 VAC, 60 Hz @ 2A
C1000-V2-HE: 220 VAC, 50 Hz, @ 2A
Shop air @ 20 - 65 Psig

To meet S2 Certification:
Supply full Thermal Chuck Control and Probing System to GFI Breaker Controlled Power Circuit.
When GFI protection is not provided Micromanipulator recommends the use of Optional S2 Certified Hose assemblies for use with Heat Exchangers. They can be ordered using Micromanipulator Part Number S2-HOSE . Contact factory for price and delivery.

ZERO ºC COOLING OPTION (C1000-V1-C-0, C1000-V2-C-0):

CONTROL METHOD: PID

TEMPERATURE RANGE: Cools to 0º C, within 8ºC of chiller temperature

TEMPERATURE RESOLUTION: +/- 0.1º C

TEMPERATURE STABILITY: +/- 1º C

CYCLE TIME PERFORMANCE: TBD

TEMPERATURE DISPLAY: Green LED chuck temperature; red LED set point temperature.

STATUS INDICATORS: Cooling, fault, % deviation of set point, % power being delivered.

COMPUTER CONTROL: Optional interfaces available for: RS-422, RS-232 or GPIB(IEEE)

COOLING FLUID: Water/glycol mixture (60 % water/40% glycol)

RESERVOIR CAPACITY: 0.53 gallons (2 liters)

FACILITY REQUIREMENTS: C1000-V1-C-0: 120 VAC, 60 Hz @ 8A
C1000-V2-C-0: 220 VAC, 50 Hz, @ 5A
Shop air @ 20 - 65 Psig

To meet S2 Certification:
Supply full Thermal Chuck Control and Probing System to GFI Breaker Controlled Power Circuit.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

NOTES

SECTION 2.0
INSTALLATION AND SETUP PROCEDURES

2.1 PRE-INSTALLATION PROCEDURES

2.1.1 Shipping Carton Inspection

Carefully check the packing materials for signs of visible damage when they are received. If any damage is noted, photograph the damage carton(s) immediately and contact the shipping company to report the damage and to obtain a damage claim form. Notify **The MICROMANIPULATOR Co., Inc.** Service Department.

2.1.2 Instrument Removal

While removing the test station from the carton(s), check all components for shipping damage. If possible, photograph any damage for use when claims are submitted to the shipping company. Notify the shipping company and **The MICROMANIPULATOR Co., Inc.** immediately. We will not be responsible for shortages unless they are reported at the time of receipt. Include the following on all claim reports:

INSTRUMENT MODEL NUMBER
INSTRUMENT SERIAL NUMBER
YOUR PURCHASE ORDER NUMBER
YOUR LIST OF THE SHORTED MATERIALS

2.1.3 Instrument Inspection

All instruments should be thoroughly inspected upon receipt. If the contents are damaged, or the instrument fails to operate properly, the carrier and **The MICROMANIPULATOR Co. Inc,** must be notified at once. The following documents are required to support claim:

ORIGINAL FREIGHT BILL AND BILL OF LADING ORIGINAL
INVOICE OR PHOTOCOPY OF ORIGINAL INVOICE COPY OF
PACKING LIST
PHOTOGRAPHS OF THE DAMAGED EQUIPMENT AND CONTAINER(S)

Should any damage be noted, contact **The MICROMANIPULATOR Co., Inc.,** Customer Service Department. The telephone numbers are listed in the "i" pages at the front of this manual. The company will aid in getting your instrument up and running as soon as possible.

2.2 INSTALLATION AND SETUP (Ref. Fig. 2-1)

2.2.1 Thermal Chuck

The THERMAL CHUCK (Ref. Fig. 2-1 & 2) is connected to a prober via **one** electrical connector, **one red** silicone hose for vacuum, **two white** silicone hoses with male quick connects for radiator cooling, and **two red** hoses with female quick connects for chuck cooling. The prober will be internally plumbed to accept the thermal chuck. To connect the thermal chuck to the prober, first connect the thermal chuck's vacuum hose to the wafer chuck vacuum nipple on the prober. Then connect all electrical connectors and plumbing quick connects to their mating counterparts on the prober. The CHUCK POTENTIAL electronic connector is a single UMC coaxial connector mounted on a four inch piece of coaxial cable attached to the bottom side of the chuck. This UMC connector mates directing with the signal cable which is a part of the probe station plumbing. If the prober is equipped with Kelvin connections to the chuck, a Model 45-2F can be employed to connect both of the Chuck signal cables to the THERMAL CHUCK assembly. The Model 45-2F allows the dual cabling to be attached at the chuck thus allowing the HP 4284 style LCR instrument to correct for the added inductance of the probe station's internal cabling to minimize errors. This significantly reduces the error compared to "teeing" the instrument cabling outside of the prober.

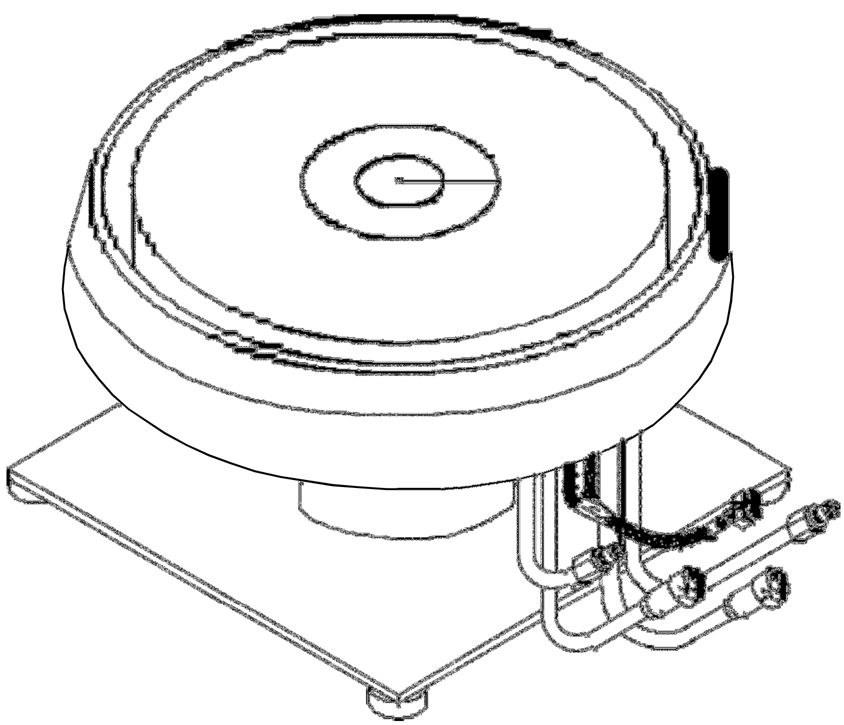


FIGURE 2-1. THERMAL CHUCK (TOP VIEW)

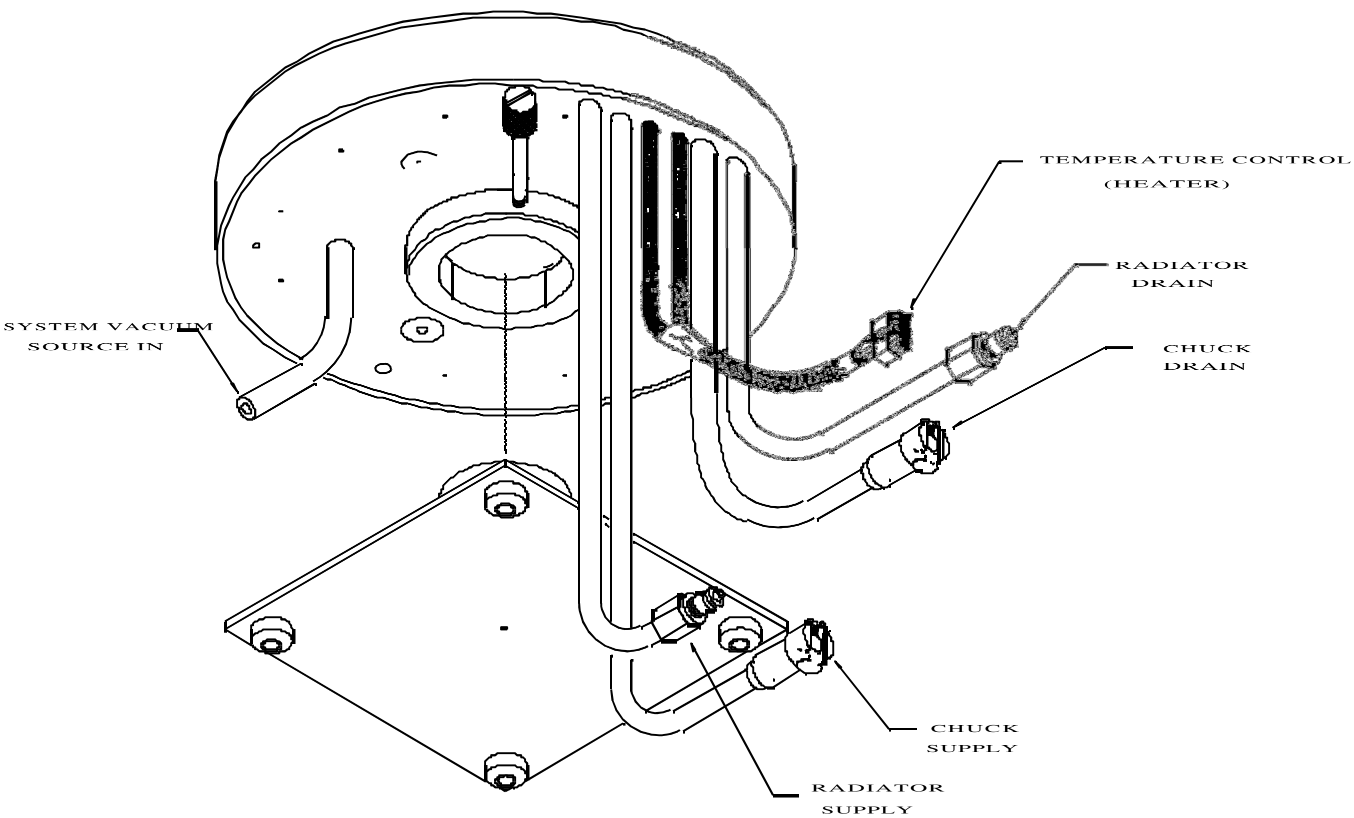


FIGURE 2-2. THERMAL CHUCK (BOTTOM VIEW)

The chuck has four hoses which connect to the four fittings on the probe station. Figure 2-2 identifies the hoses as:

- Radiator supply
- Radiator return
- Chuck supply
- Chuck return

Figure 2-3 identifies the four fittings on the probe station with the same nomenclature. Be sure to connect the four hoses to the correct fittings in the probe station. Incorrect hose connections can adversely affect thermal chuck performance.

Cooling fluid that flows through the radiator portion of the chuck is at the temperature of the chiller reservoir. Condensation will form on the outside of the radiator when operating the chiller at temperatures below the dew point of the air surrounding the chuck. It is highly recommended to maintain the environment around the chuck at a dew point at least 10º C below the temperature of the chiller setting. To ensure that water formed by condensation does not drip into the probe and cause malfunctions, a tube of Dielectric Silicone Compound is supplied with the thermal chuck. Be sure to spread a film of the compound around the rectangular connector under the chuck to prevent damage due to

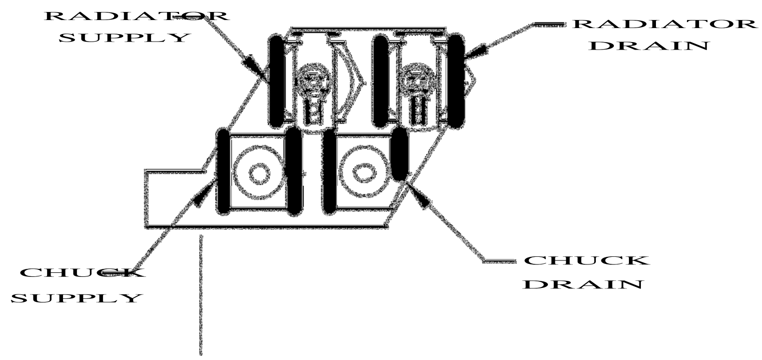


FIGURE 2-3.
COOLING FLUID FITTINGS FOR 8000 SERIES PROBE STATION

2.2.2 <u>Heat Controller</u> (H1000-AC1-V1, H1000-AC1-V2, H1000-DC1-V1, H1000-DC1-V2)

Once the thermal chuck is installed on the prober, the HEAT CONTROLLER should be connected to the prober (Ref. Fig. 2-3 for unit panel locations). The prober has a panel mounted on the rear of the station that provides a convenient interface of the prober (Ref. Fig. 2-4 for electrical hookup) to the various components of the H1000 Thermal Chuck System. On this panel are two electrical connectors and 5 plumbing (quick connects) connectors. The two electrical connectors are connected to the identically labeled connectors on the rear of the HEAT CONTROLLER with the supplied extension cables.

2.2.3 <u>Ambient Cooling Option (</u>C1000-V0-H)

<u>HOOKUP</u>:

The C1000-V0-H cooling option requires user supplied air, water and water drain. The Cool Module is factory installed in the cabinet with the heat controller. The interface connection between the heat and cool controllers should also have been made at the factory. The user setup requires the hookup of the Service Module (SRV1) to the water and air supply, the probe station and to the Cool Module.

There are six hoses supplied with the C1000-V0-H cooling option. Refer to Figure 2-5 for system hose hookups. The yellow polyethylene hose is used to connect the SRV1 Chuck Assembly Supply to the Chuck Supply on the rear of the probe station. The blue polyethylene hose is used to connect the SRV1 Radiator Supply to the Radiator Supply on the rear of the probe station.

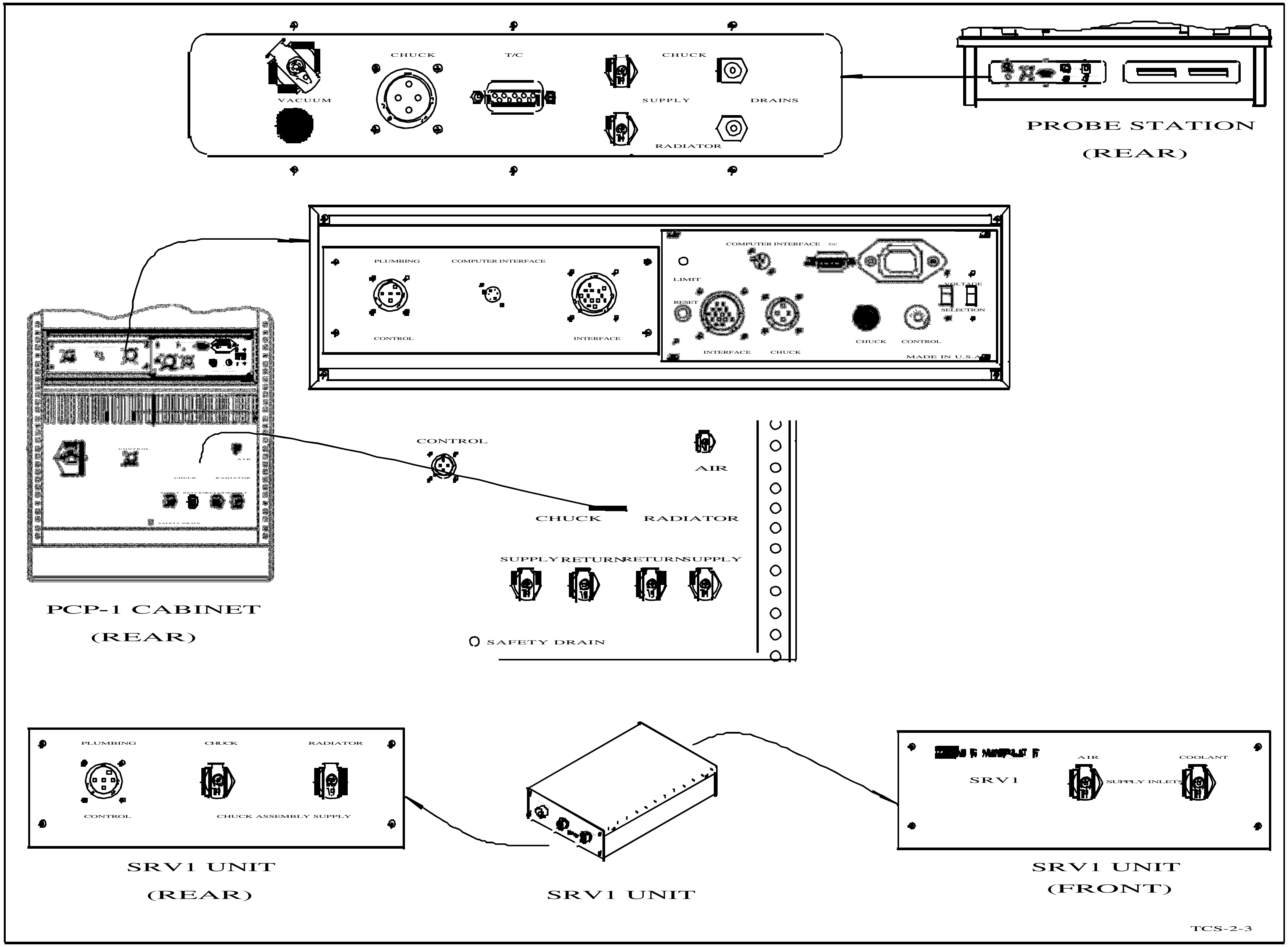
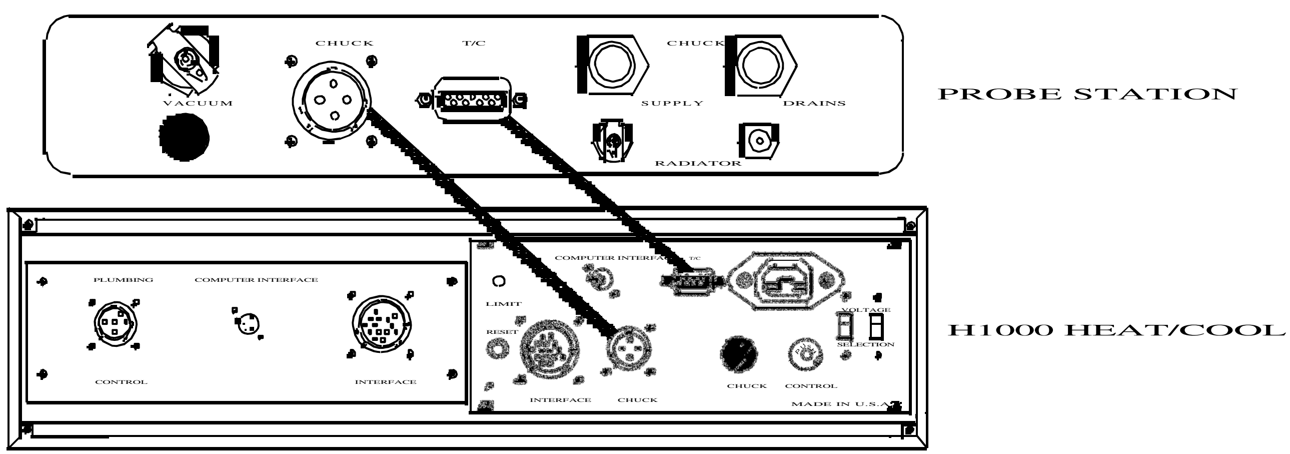


FIGURE 2-4. AMBIENT COOLING UNIT PANEL LOCATIONS



TCS-2-4

FIGURE 2-5. HEAT CONTROL MODULE HOOKUP

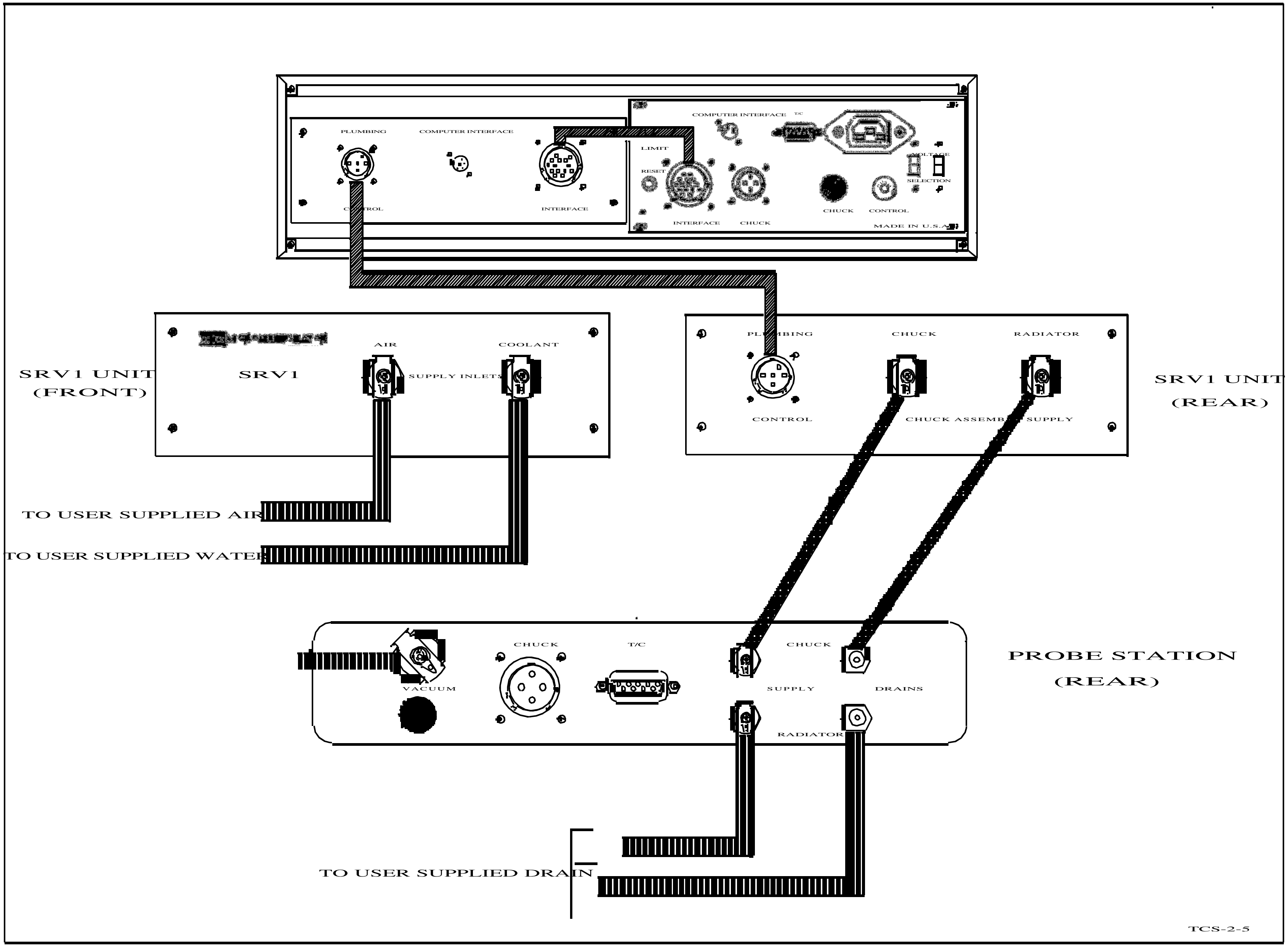


FIGURE 2-6. AMBIENT COOLING HOOKUP WITHOUT HEAT EXCHANGER

(C1000-V0-H)

The two red silicone hoses are used to connect the Chuck and Radiator drains from the probe station to the user supplied drain. The red polyethylene hose is use to connect the user supplied water to the water inlet on the SRV1. The clear polyethylene hose is use to connect the user supplied air to the air inlet on the SRV1. The connector on the SRV1 labeled Plumbing Control is connected to the Plumbing Control connector on the rear of the Cool Module using the extension cable provided.

2.2.4 Ambient Cooling Option (C1000-V1-HE, C1000-V2-HE)

PREPARATION:

The Heat Exchanger is shipped empty and must be filled with either de-ionized or a mixture of glycol and water to become serviceable. A gallon of commercial grade anti-freeze is included with the heat exchanger. Using only one cup of anti-freeze and add water to fill the reservoir will result in an appropriate water/glycol mixture for corrosion resistance. The fill port is located on the top of the unit under the sliding cover. In most cases, the Heat Exchanger will have to be 'burped' to remove any air trapped in the internal hoses and/or pump. To do this, use the yellow polyethylene hose to connect the Radiator Supply to the Radiator Return on the rear of the Heat Exchanger. Turn the system on and off using the power switch on the rear of the Heat Exchanger until the system is free of air and pumping properly. Wait 15-20 seconds before turning power back on or off. It may be necessary to tilt up the left side and/or front of the heat exchanger to allow any trapped air in the system to escape.

HOOKUP:

The C1000-V1-HE and C1000-V2-HE cooling options include a self-contained heat exchanger which eliminates the need for the user to supply water and an open drain for cooling purposes. The Cool Module is factory installed in the cabinet with the heat controller. The interface connection between the heat and cool controllers should also have been made at the factory. The user setup requires the hookup of the Heat Exchanger to the probe station and to the Cool Module.

There are five hoses supplied with the C1000-V1-HE and C1000-V2-HE cooling options. Refer to Figure 2-6 for hose hookups. The yellow polyethylene hose is used to connect the Heat Exchanger Chuck Supply to the Chuck Supply on the rear of the probe station. The blue polyethylene hose is used to connect the Heat Exchanger Radiator Supply to the Radiator Supply on the rear of the probe station. The two red silicone hoses are used to connect the Chuck and Radiator drains from the probe station to the Heat Exchanger Chuck and Radiator Returns. The clear polyethylene hose is use to connect the user supplied air to the air inlet on the Heat Exchanger. The connector on the Heat Exchanger labeled Control is connected to the Plumbing Control connector on the rear of the Cool Module using the extension cable provided.

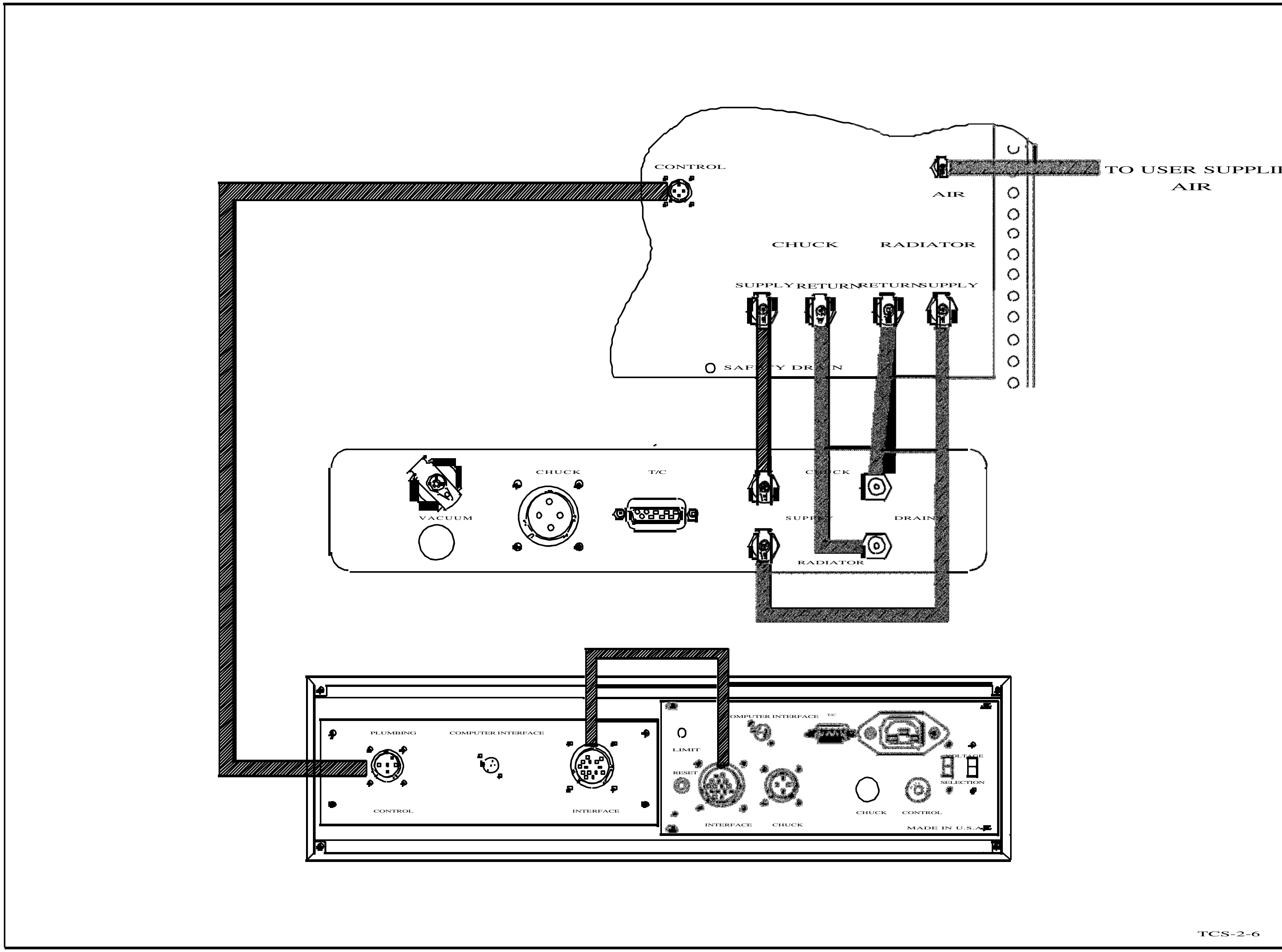


FIGURE 2-6. AMBIENT COOLING OPTION WITH HEAT EXCHANGER HOOKUP

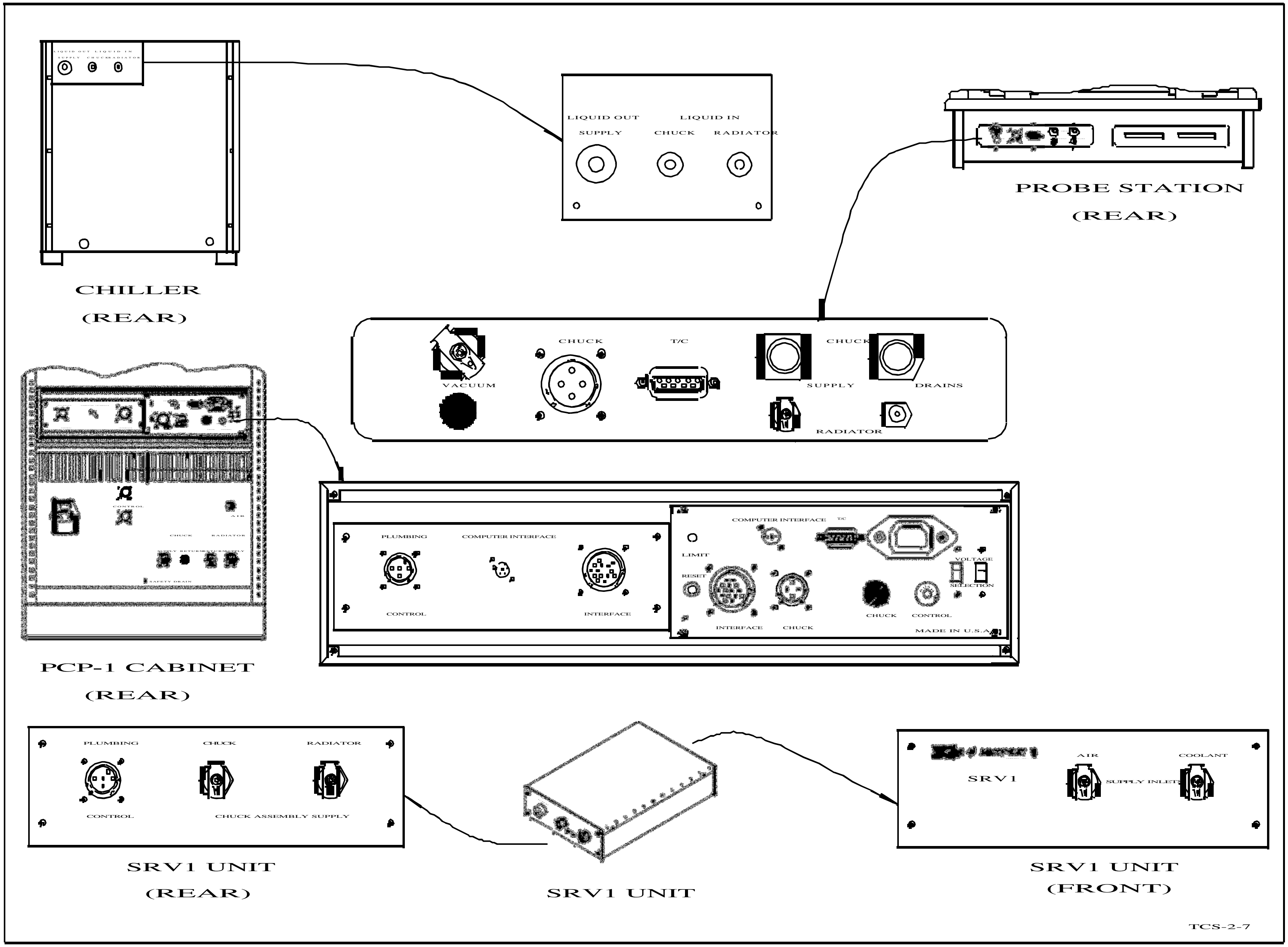


FIGURE 2-7. ZERO °C COOLING OPTION UNIT PANEL LOCATION

2.2.5 ZERO °C Cooling Option (C1000-V1-C-0, C1000-V2-C-0)

The C1000-V1-C-0 and C1000-V2-C-0 cooling options includes a Service Module (SRV1) and a self-contained chiller which provides a reservoir of cool liquid for use in cooling the chuck surface and radiator. The Cool Module is factory installed in the cabinet with the heat controller. The interface connection between the heat and cool controllers should also have been made at the factory. The user setup requires the hookup of the chiller and the SRV1 to the probe station and to the Cool Module.

PREPARATION:

The chiller supplied with the system is shipped empty and needs to be filled with a suitable cooling fluid. Make a mixture of 40% anti-freeze and 60% water. Fill the reservoir with this glycol/water mixture. The fill port is located on the top of the chiller. Remove the clear plastic cover to fill the reservoir.

HOOKUP: (Ref. Fig. 2-7 for Unit Panel Locations)

There are six hoses supplied with the C1000-V1-C-0 and C1000-V2-C-0 cooling options. Refer to Figure 2-8 for system hookups. The yellow polyethylene hose is used to connect the SRV1 Chuck Assembly Supply to the Chuck Supply on the rear of the probe station. The blue polyethylene hose is used to connect the SRV1 Radiator Supply to the Radiator Supply on the rear of the probe station. The two red silicone hoses are used to connect the Chuck and Radiator drains from the probe station to the two drain connections on the rear of the chiller. The red polyethylene hose is use to connect the chiller supply to the water inlet on the SRV1. The clear polyethylene hose is use to connect the user supplied air to the air inlet on the SRV1. The connector on the SRV1 labeled Plumbing Control is connected to the Plumbing Control connector on the rear of the Cool Module using the extension cable provided.

2.2.6 Linear DC Power Source (DC-100)

The linear DC power Source (DC-100) is included with H1000-DC1-V1 and H1000-DC1-V2 H1000 Thermal Chuck Systems. The DC-100 is integrated with the heat controller at the factory during assembly. Please contact the factory for upgrade information if DC chuck power is desired.

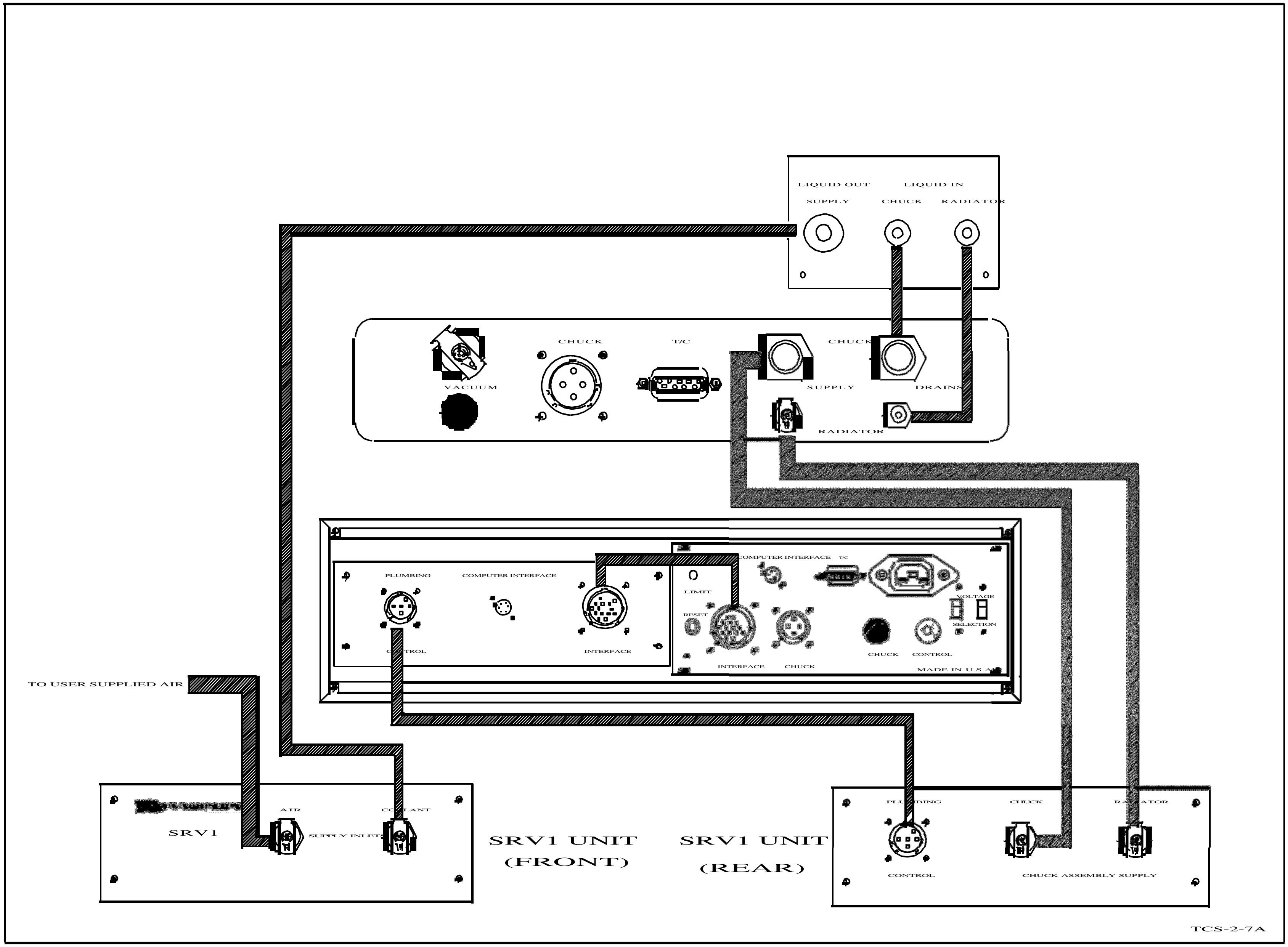


FIGURE 2-8. ZERO °C COOLING OPTION HOOKUP

2.2.7 <u>Computer Interfaces</u> (H1000-RS-232, H1000-IEEE, H1000-RS-422)

Each of the three computer interface options are connected to the H1000 heat and cool controllers via the two 7 position Viking connectors on the rear of each controller. The H1000-RS-232 and H1000-IEEE are each packaged in the same size chassis with the appropriate connectors mounted on the front panel. Each of the three interface options includes two 10 ft cables with Viking plug connectors on each end.

NOTES

SECTION 3.0
OPERATING INSTRUCTIONS

3.1 INTRODUCTION

This section will be dedicated to the explanation and description of the controls and indicators associated with the HEAT CONTROLLER, COOL MODULE, CHILLER, and the DC100 POWER SUPPLY. It will also carry the user through a complete power up sequence.

3.2 HEAT CONTROLLER OPERATING MODES

There are two type of operating modes - MANUAL and COMPUTER control. Manual control is performed by the operator utilizing the controls on the front panel of the HEAT CONTROLLER. Computer control is performed by the HOST COMPUTER via a COMPUTER INTERFACE option.

3.3 POWER UP SEQUENCE

CAUTION: ***Ensure that the Thermal Chuck is fully connected to system prior energizing, and conversely ensure that the Controller is turned off prior to disconnecting the Thermal Chuck assembly from system.***

To turn on the HEAT CONTROLLER, actuate the large square button labeled **POWER**. If the system includes a **DC100** option, turn this unit on also by placing its **POWER** switch to the **ON** position. When the HEAT CONTROLLER is switched on, the white **POWER ON** indicator (within the switch) should illuminate and the green **STOP** indicator should also be lit. If a COOL MODULE is part of the system, you will also see the green **PURGE** indicator (within the switch) light. A thirty (30) second purge will be initiated whenever the HEAT CONTROLLER is energized. Both the HEAT CONTROLLER and the COOL MODULE temperature displays should illuminate within five (5) seconds after the units are turned **ON**. The HEAT CONTROLLER will be in the **STOP** or idle mode.

********* IMPORTANT - PLEASE READ *********

Operation of the H1000 Thermal Chuck system under remote (computer) control can result in Heat or Cool operation when the system is turned on. In this case, the STOP indicator will illuminate, but the system will be in either Heat or Cool operation as indicated by the ACTIVE indictor flashing on either one of the controllers. Please refer to section 3.7 for a complete explanation of remote control operation.

3.4 HEAT CONTROLLER - CONTROLS AND INDICATORS

The HEAT CONTROLLER front panel (Ref. Fig. 3-1) is designed into two sections. These two sections are the actuation controls section (on the right side of the panel) and the temperature displays section (on the left side [raised area] of the panel)

3.4.1 Heat Controller Actuation Controls and Indicators Section

The actuation control switches that initiate all actions of the controller in the manual mode and indicators operate as follows:

POWER: The **POWER SWITCH** applies or removes all power to the HEAT CONTROLLER. If you have a cooling option, this switch also enables all power to the COOL MODULE through the INTERFACE connector. To turn on the HEAT CONTROLLER actuate the large square button labeled POWER. If the system includes a DC100 option then turn this unit on also by placing its **POWER** switch to the **ON** position. When the heat controller is switched on the white **POWER** (switch) light should illuminate and the green STOP indicator should also light. If the system is equipped with a cooling option then you will also see the green **PURGE** (switch) light illuminate on the COOL MODULE. A thirty (30) second purge will be initiated whenever the controller is energized. The controller temperature displays should illuminate with in five seconds after the controllers are turned on.

STOP: Depressing the **STOP** switch places the controller in an idle state. If the controller was in a **HEAT** operation, depressing the STOP switch disconnects the Thermal chuck from the power supply driving its heating elements and the **ACTIVE** light will stop flashing. The temperature displays will continue to operate normally. If the controller was in a **COOL** operation, depressing the **STOP** switch disconnects the Thermal chuck cooling coils form the coolant being supplied. A thirty second PURGE will be automatically initiated to remove the coolant from the THERMAL CHUCK assembly. The **ACTIVE** light on the COOL MODULE stop flashing.

HEAT: Depressing the **HEAT** switch initiates the "heat" of operation which controls the THERMAL CHUCK temperature above ambient. The green HEAT indicator will illuminate and the controller will begin delivering and controlling power to the THERMAL CHUCK. The **"1" (ACTIVE)** and **"3" (OUTPUT)** indicators on the associated display and setpoint control section temperature should begin flashing and the Chuck temperature display (red display) should also exit an increasing temperature until the setpoint temperature is reached. As the controller converges upon the setpoint the rate of **ACTIVE** flashes will diminish. If the system includes a DC100 option then its front panel meters will display the power that the system is delivering to the Thermal chuck.

The controller will stay in this "heat" mode until either the **COOL** or **STOP** switch is depressed.

COOL: Depressing the **COOL** switch causes the **COOL** light to energize. If the controller was in the **STOP** mode, depressing the **COOL** switch causes the **STOP** light to extinguish and the **COOL** light to energize. The **COOL** operation is the same as the **STOP** mode control if no COOL MODULE is present. If a COOL MODULE is installed depressing the **COOL** switch also initiates the Cool module controller functions. The COOL MODULE will begin controlling coolant flow to the THERMAL CHUCK to lower its temperature to its setpoint. The **ACTIVE ("1")** and **OUTPUT ("3")** lights will begin flashing on the COOL MODULES display face. Once the COOL MODULE setpoint is reached the controller stops the flow of coolant, and a thirty second **PURGE** is initiated to remove the coolant from the THERMAL CHUCK assembly. The **ACTIVE** light on the COOL MODULES temperature display face will stop flashing.

If the controller was in **HEAT** control, depressing the **COOL** switch disconnects the Thermal chuck from the power supply driving its heating elements. The **HEAT** light will extinguish and the HEAT CONTROLLER **ACTIVE** light will stop flashing.

NOTE

If your system does not have a COOL MODULE, pressing the COOL switch or pressing the STOP switch will discontinue the HEAT operation.

When a Cool module is present, depressing the **COOL** switch causes the **COOL** light to energize and initiates the Cool module controller functions. The COOL MODULE will begin controlling coolant flow to the THERMAL CHUCK to lower its temperature to its setpoint. The **ACTIVE** light will begin flashing on the COOL MODULES display face. Once the COOL MODULE setpoint is reached the controller stops the flow of coolant, and a thirty second **PURGE** is initiated to remove the coolant from the THERMAL CHUCK assembly. The **ACTIVE** light on the COOL MODULES temperature display face will stop flashing. If the THERMAL CHUCK's temperature increases above the setpoint, the controller will reroute coolant to the THERMAL CHUCK until the setpoint is reached again and the same purging process will reoccur.

3.4.2 Temperature Display Section

The temperature display section is the raised face element of the front panels. The temperature display section of each controller module has two displays, a **RED** display which is the actual temperature currently being measured and a **GREEN** display that indicates the controller's current setpoint.

This section also contains control keys (buttons) for controlling the displays. These keys possess very good tactility for operator feedback when using them.

<u>Figure 3.1 Heat Module Controls</u>

The **SETPOINT** is adjusted by the two arrows on the right hand side of the panel of the controller. The arrow pointing upwards increases the temperature setpoint and the arrow pointing down lowers the temperature setpoint. Familiarize yourself with their operation by changing the setpoint to a variety of values. The longer the arrow is held depressed the faster the temperature settings will change. The display on the HEAT CONTROLLER is used for setting the high temperature or **HEAT** setpoint, and the display on the COOL MODULE is used for setting the low temperature or **COOL** setpoint.

Note: The HEAT or COOL buttons must be selected before setpoints can be adjusted.

The **"ADVANCE"** key when depressed cycles the controller between a series of modes. This key allows changing between temperature setpoint (Auto) mode and % output (Manual) mode. It is recommended that the modes not be altered. The % output mode will drive the chuck with the % output selected until the user presses the green "STOP" button. It does not control to a setpoint. The normal operation of the unit is in Auto Mode where a setpoint is entered and the controller drives the chuck to that setpoint. See the end of this manual for instructions on how to reset the controller to this mode should it be changed.

The **"INFINITY"** Key is used to back out of menus. Pressing the key twice in rapid succession or holding it for 3 seconds will return the display to the "Home" screen.

The **"EZ1"** and **"EZ2"** Keys are used to program special functions on the controller. The system does not include any such functions as configured at the factory so these keys are not used.

<u>Manual (% OUTPUT) mode:</u> These controllers can be set to allow the Chuck to be driven in a mode not dependent of a temperature setpoint. The % output mode will drive the chuck with the % output selected until the user presses the "STOP" button. It does not control to a setpoint. **CARE MUST BE TAKEN IN USING THIS MODE AS THE CHUCK WILL RUN IN TEMPERATURE**

UNLESS MANUALLY STOPPED WITH THE STOP BUTTON. See the end of this manual for instructions on how to reset the controller to Auto mode should it be changed to Manual (%).

3.5 COOLING OPTIONS

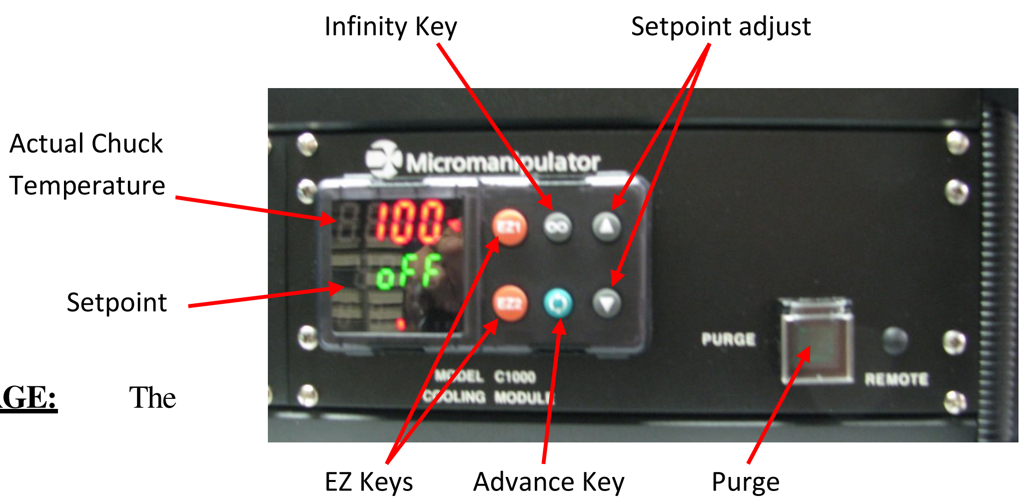
Each of the different cooling options includes a COOL MODULE. The COOL MODULE controls and indicators are the same for all cooling options.

The COOL MODULE front panel is the same as and operates in the same way as the HEAT MODULE does. See the above section and figure 3.2 for a description of the controls.

The only separate actuation control associated with the COOL MODULE is the **PURGE** switch. The **PURGE** switch is similar to the **POWER** switch on the HEAT CONTROLLER. It is a two position latching push-button switch. It is actuated by depressing it. If the switch is in the elevated position and depressed it latches in the depressed position. When the switch is depressed again the latch is released and the switch will return to its elevated position.

Each of the different cooling options performs automatic purging functions under specific conditions. The **PURGE** switch allows the user to perform a purge at any time by depressing the switch **PURGE** switch.

<u>Figure 3.2 Cool Module Controls</u>



<u>PURGE:</u> The

The **PURGE** switch is similar to the **POWER** switch on the Heat Controller. It is a two position latching push-button switch with a built in lamp. It is actuated by depressing it. If the switch is in the out (**OFF**) position and depressed, it latches in the in or depressed (**ON**) position and the lamp will light. When the switch is depressed again the latch is released and the switch will return to its out (**OFF**) position and the lamp will extinguish.

When the **PURGE** switch is turned on (latched in the in or depressed position) the PURGE (switch) light illuminates and the remote valve controlling the air delivery to the THERMAL CHUCK is energized. This condition is maintained until the **PURGE** switch is actuated back to its **OFF** (out) position (off). **PURGE** can be initiated regardless of what mode the controllers are in (**HEAT**, **COOL**, or **STOP**).

This is particularly useful when insuring that all coolant is removed from the chuck for greater isolation.

NOTE:

*The **PURGE** (switch) lamp will be lit anytime the switch is on, or that the Purge interval timer is energizing the remote valve controlling the air delivery to the THERMAL CHUCK.*

3.5.1 <u>TEMPERATURE DISPLAY SECTION:</u> Reference section 3.4.2 for description.

3.5.2 <u>ZERO °C Cooling Option</u> (C1000-V1-C-0, C1000-V2-C-0)

This cooling option includes a chiller to supply a cooling fluid to the thermal chuck system. The chiller power is turned on after the HEAT CONTROLLER is turned on. Turn the chiller power switch on. Verify that the amber indicator is ON.

For zero degree operation, it is suggested that the set point be adjusted to -10° C. For cooling to other temperatures between 32° C and 0° C, adjust the set point between 5 and 10 degrees below the desired cool temperature. The set point is adjusted by pressing and holding the up or down arrow button on the chiller top panel.

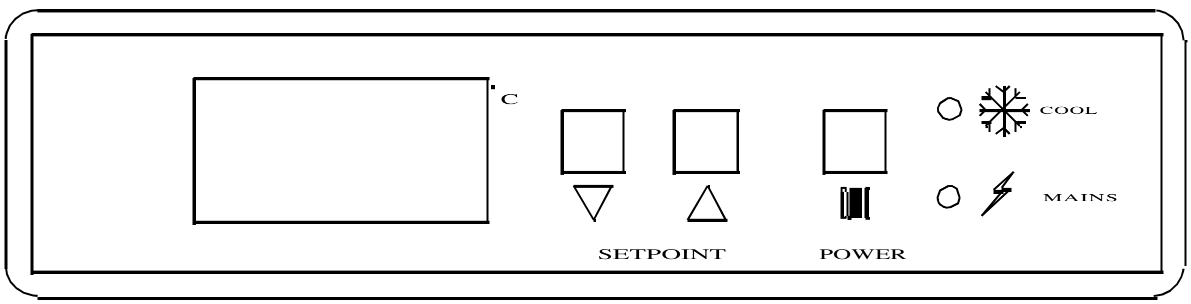


FIGURE 3-2 ZERO °C CHILLER FRONT PANEL

3.6 LINEAR DC POWER SOURCE (OPTIONAL)

The only user controls and indicators associated with the DC100 option (Ref. Fig. 3-3) is one **POWER** switch and two meters. The **POWER** switch is two 20 amp circuit breakers linked together on the front panel as one two position single throw switch. When placed in the up position labeled ON the power is turn on. When the switch is placed in the down position labeled **OFF** the power supply is turned off. The two front panel meters are one **DC VOLT** meter and one **DC AMPERES** meter. They are used to monitor the power supplied to the THERMAL CHUCK. When the power supply is turned on the user will be able to hear the sound of the cooling fans inside of the power supply. The HEAT CONTROLLER must be in the **HEAT** mode before any deflection of the panel meters will occur.

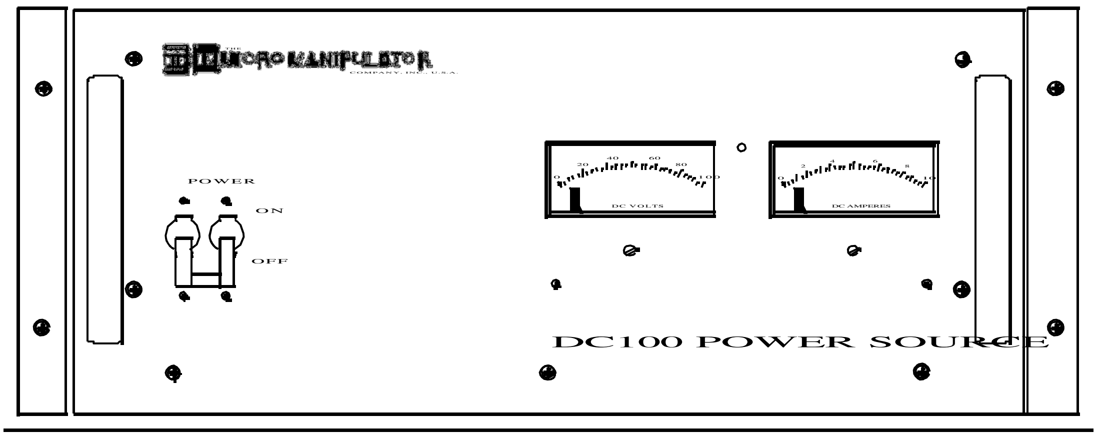


FIGURE 3-4. DC100 POWER SUPPLY FRONT PANEL

3.7 REMOTE CONTROL OPERATION

Both the Heat Control Module and the Cool Module have provisions for remote control via RS-422. Communications converters are available which will accept an RS-232 or GPIB (IEE-488) interface to the RS-422 ports.

The command set for the H1000 Thermal Chuck System can be found in Appendix A. Users may develop their own software to control the system. Micromanipulator has developed a software package called pcTC which provides both manual and sequential control of the H1000 Thermal Chuck System to include a DDE interface to other applications running such as pcProbe II and ICS.

When the Heat Control Module and Cool Module receive a communications instruction to perform a function (such as HEAT), the command is executed until a communications instruction is received to perform some other function, or the controller power is cycled off and on.

NOTE:

On units manufactured prior to 1997. The last instruction received by the Heat and/or Cool Module is "remembered" and will continue to be performed even after power is turned OFF and ON. This feature can be very cause system operation which may appear to be a malfunction. If the Heat or Cool Module is ACTIVE when power is applied, then the system is most likely responding to a previously sent command. The only way to correct this situation is to establish communications with the controller and send an instruction to STOP, and exit the program normally.

NOTE: The HEAT and COOL are operational even when the system is under computer control. Therefore, the system could be BOTH heating and cooling at the same time if the system received an instruction to COOL and the HEAT button was pressed. To avoid this condition from occurring, make sure that the STOP indicator is illuminated when the system is being controlled by through remote communications.

3.8 ERROR CODES AND INDICATIONS

When either the heat or cool controller senses an error or fault, the red temperature indicator will display **"- - - -"** 4 dashed lights, the green display will indicate 0. The most common error is a disconnected temperature sensor or thermocouple. Check the cable and connections to the chuck from the back of the controller to correct this.

The heat or cool controllers can also provide a series of "Attention" messages as follows:

Display	Parameter Name Description	Setting	Range	Default	Appears If
Attn	**Attention** An active message will cause the display to toggle between the normal settings and the active message in the upper display and Attn in the lower display. Your response will depend on the message and the controller settings. Some messages, such as Ramping and Tuning, indicate that a process is underway. If the message was generated by a latched alarm or limit condition, the message can be cleared when the condition no longer exists. If an alarm has silencing enabled, it can be silenced. Push the Advance Key to display iGnr in the upper display and the message source (such as L ih1) in the lower display. Use the Up and Down keys to scroll through possible responses, such as Clear CLr or Silence SiL. Then push the Advance or Infinity key to execute the action. Alternatively, rather than scrolling through all messages simply push the Infinity button to generate a clear.		AL.L1 AL.L2 AL.L3 AL.L4 Alarm Low 1 to 4 AL.h1 AL.h2 AL.h3 AL.h4 Alarm High 1 to 4 AL.E1 AL.E2 AL.E3 AL.E4 Alarm Error 1 to 4 Er.i1 Er.i2 Error Input 1 or 2 L iL1 Limit Low 1 L ih1 Limit High 1 L iE1 Limit Error 1 tUn1 tUn2 Tuning 1 or 2 rP1 rP2 Ramping 1 or 2 LP.o1 LP.o2 Loop Open Error 1 or 2 LP.r1 LP.r2 Loop Reversed Error 1 or 2 C.Er1 Current Error h.Er1 Heater Error		an alarm or error message is active.

SECTION 4.0
PRINCIPLES OF OPERATION

4.1 INTRODUCTION

This section will discuss the **PRINCIPLES OF OPERATION** of the individual components that comprise the **H1000 THERMAL CHUCK SYSTEM** as well as the overall operation when these components are working in concert.

The most basic H1000 Thermal Chuck System consists of two components; the **Thermal Chuck** and **Heat Control Module**. Optional equipment include one of three **Cooling Options**, one of three **Computer Interfaces**, and a **Linear DC Power Source**.

4.1.1 Thermal Chuck

The Thermal Chuck Assembly is divided into four elements:

1) the "**PUCK**" (Temperature controlled surface)
2) the radiator
3) the kinematic mounting of the "**PUCK**" in the assembly
4) the isolation surface (on XC and T models only)

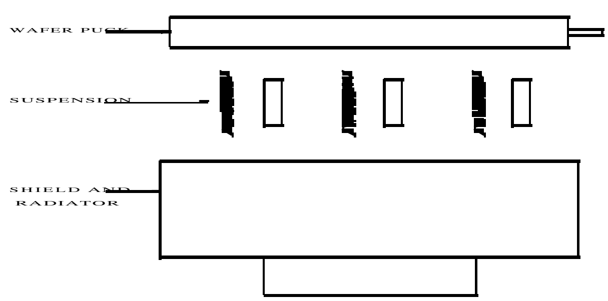


FIGURE 4-1. THERMAL CHUCK

4.1.2 Heat Control Module

The **Heat Control Module** is broken into six main elements or sub-systems:

1) the operator controls (front panel)
2) equipment interfaces (rear panel)
3) power on reset circuit
4) main temperature controller
5) second safety (back up) temperature controller
6) heater isolation relays

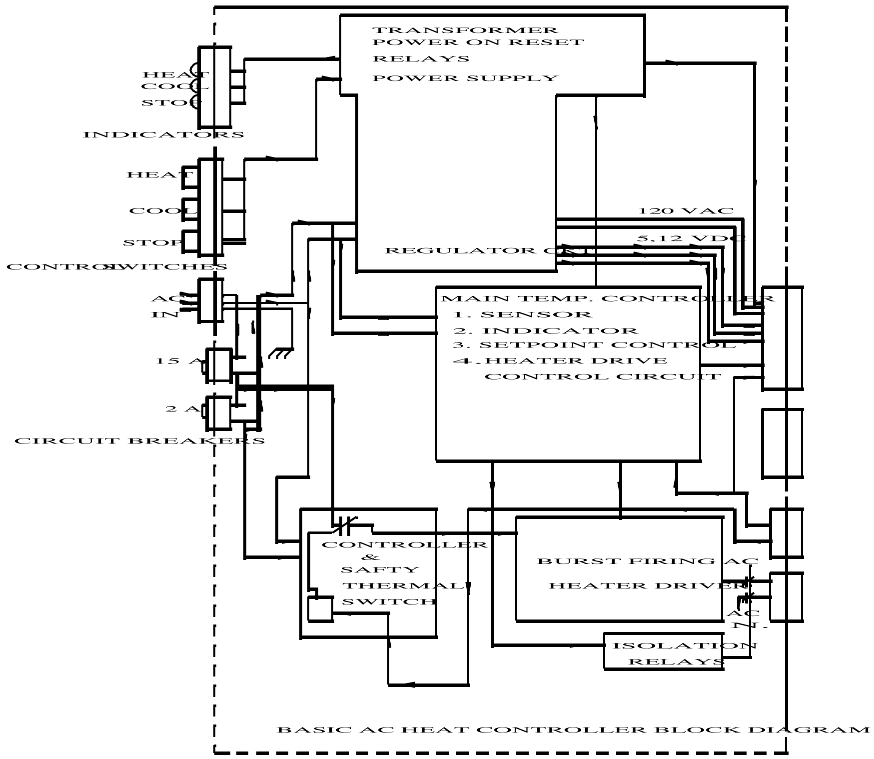


FIGURE 4-2. HEAT CONTROL MODULE BLOCK DIAGRAM

4.1.3 Linear DC Power Source (Optional)

The **Linear DC Power Source** (DC-100) consists of three main elements or sub-systems:

1) the AC input
2) the DC supply
3) the output control (and display) circuits

4.1.4 Cooling Options

Each of the different **Cooling Options** includes a **Cool Module** which is installed in the same chassis as the **Heat Control Module.** Refer to Figure 4-3 for a block diagram of the **Cool Module**.

AMBIENT COOLING OPTION (C1000-V0-H)

The elements of the C1000-V0-H COOLING OPTION are:

1) **Cool Module**
2) **Service Module** (SRV1)
3) Various hoses and interconnection cables

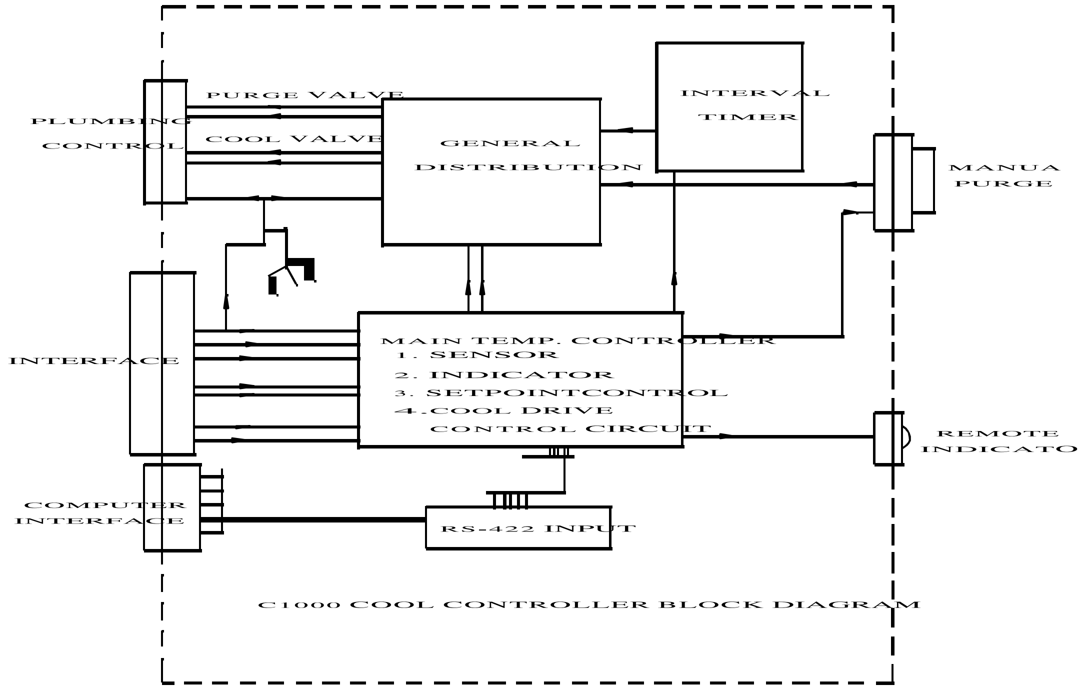


FIGURE 4-3. COOL MODULE BLOCK DIAGRAM

AMBIENT COOLING OPTION (C1000-V1-HE, C1000-V2-HE)

The elements of the C1000-V1-HE, C1000-V2-HE COOLING OPTIONS are:

1) **Cool Module**
2) **Heat Exchanger**
3) Various hoses and interconnection cables

ZERO DEGREE C COOLING OPTION (C1000-V1-C-0, C1000-V2-C-0)

The elements of the C1000-V1-C-0, C1000-V2-C-0 cooling options are:

1) **Cool Module**
2) **Zero Degree C Chiller**
3) Various hoses and interconnection cables

4.1.5 Computer Interfaces (Optional)

The **H1000 Thermal Chuck System** can be controlled using a remote computer via one of the three optional interface options.

<u>RS232 INTERFACE (H1000-RS-232)</u>

The H1000-RS-232 interface includes a converter module and cables which converts the native RS-422 interface for each of the controllers and accepts a RS-232 communications link using ANSI X3.28 protocol.

<u>IEEE-488 INTERFACE (H1000-IEEE)</u>

The H1000-IEEE interface includes a converter module and cables which converts the native RS-422 interface for each of the controllers and accepts an IEEE-488 (GPIB) communications link.

<u>RS-422 INTERFACE (H1000-RS-422)</u>

The H1000-RS-422 interface includes the necessary cables to interface the heat and cool modules to a RS-422 controller. The RS-422 communications protocol is native to the H1000 control modules.

4.2 THERMAL CHUCK

The H1000 THERMAL CHUCK has been specially designed and fabricated for high performance applications in probe stations.

4.2.1 Thermal Chuck Construction

The Thermal Chuck (PUCK) temperature controlled wafer surface is made from an aluminum casting. This part has isolated heater elements and cooling tubes cast directly in the PUCK in a proprietary pattern. This special casting insures rapid heating and cooling as well as extremely even temperature distribution.

The wafer surface is machined flat to .0002" and then sputtered coated with platinum. This process ensures an electrically conductive, chemically inert wafer interface that remains extremely flat even at highly elevated temperatures.

Several temperature sensing devices are imbedded into the PUCK to ensure accurate temperature measurements. These devices include:

1) 2ea 3-wire platinum resistance temperature sensing devices (RTD's)
2) 2ea type "K" thermocouples

The RTD's are used by the **Heat Control Module** and the **Cool Module** to monitor the temperature of the thermal chuck. One thermocouple is used to monitor temperature for the over temperature circuit and the other thermocouple is a spare device. Since the sensing device is inside the PUCK, the operator is sure of the actual temperature at the wafer (interface) surface.

Even though the heater elements and temperature sensors are imbedded in the cast PUCK, they are electrically isolated from the PUCK's surface. The PUCK is also electrically isolated from the rest of the assembly by a special kinematic suspension system. This suspension system minimizes the effects of thermal expansion and contraction of the PUCK's wafer surface while maintaining high electrical isolation by using either Pyrex or sapphire suspension rods and springs anchored in Teflon.

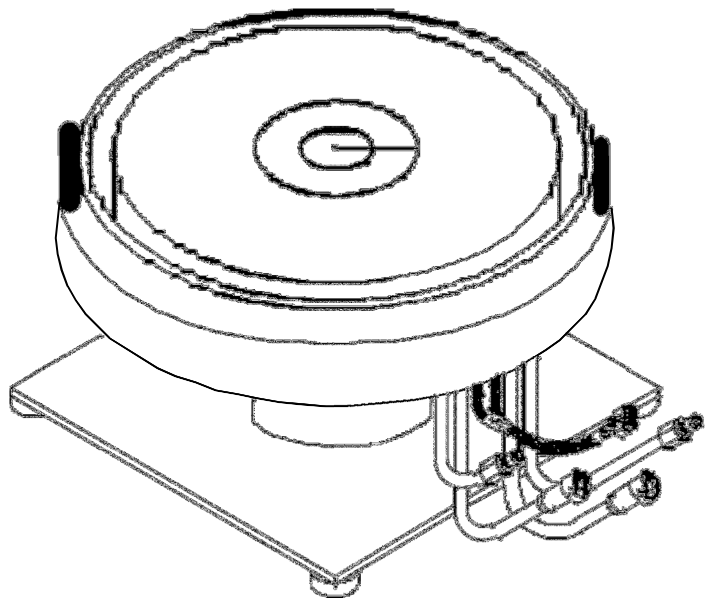


FIGURE 4-4 THERMAL CHUCK

The **Thermal Chuck** is equipped with an outer radiator which provides both an electrical and thermal shield. The cooling radiator serves two purposes:

1) to minimize the danger to personnel who might inadvertently come in contact with the outside of the THERMAL CHUCK assembly when it is at an elevated temperature

2) to prevent damage to the X - Y stage mechanism from heat radiated down into the probe station.

<u>NOTE</u>

Advanced Coaxial and Triaxial thermal chuck assemblies have removable circuit elements made from 99.5% pure alumina oxide (Al_2O_3). This material was selected for its excellent electrical isolation properties while providing very good heat transfer properties. The design for indexing these circuit elements to the heat and cooling engines (puck) of the chuck assembly must allow for the large differences in thermal expansion rates between these parts. Accordingly, these parts have manufacturing tolerances that allow for thermal motion differences while maintaining superb thermal conductivity. Inherent to this design are minuscule vacuum leakage paths. The Chuck assemblies are checked to ensure aberrant leakage does not exist and that wafers are adequately held down when vacuum is applied. The typical vacuum deviation for these assemblies is 2" to 4" of mercury when connected to a vacuum source with a minimum rating of 20" Hg@0.5 CFM.

4.2.2 Temperature Sensing

As mentioned previously, each **Thermal Chuck** has temperature sensing devices imbedded within the cast PUCK. Each PUCK has two **RTD** type temperature sensing devices along with a separate safety thermocouple that goes directly to a second safety thermocouple control circuit in the **Heat Control Module**. Each PUCK also contains a second spare type K thermocouple.

Each PUCK's temperature sensors are calibrated with the controllers at the factory to ensure good thermal stability throughout the PUCK as well as accurate control.

When the temperature sensors are inserted into the PUCK, they are potted in a proprietary fashion to ensure a high volume of resistivity of a teraohm or greater at ambient temperature. However, more importantly, at very high temperatures the isolation numbers also stay extremely high.

4.3 HEAT CONTROL MODULE

The **Heat Control Module** can be broken down into six (6) elements or sub-systems working independently and/or in concert to maintain a selected temperature for the THERMAL CHUCK assembly. These elements or sub-systems are:

1) operator control panel (Front Panel)
2) equipment interface (Rear Panel)
3) power on reset circuit
4) main temperature controller
5) safety temperature controller
6) heater isolation relays

4.3.1 <u>Heat Control Module Front Panel</u>

The function of the Heat Control Module (Ref. Fig. 4-2) is control the temperature of the Thermal Chuck when the H1000 system is in HEAT mode. The Heat Control Module has a dedicated front panel for operator control and input. The Heat Control Module front panel operation is described in Section 3.4 of this manual.

4.3.2 <u>Equipment Interface (Rear Panel)</u>

The **Equipment Interface** (Rear Panel) provides all necessary interface connections between the **Heat Control Module** and other modules in the **H1000 THERMAL CHUCK SYSTEM**. These connections include the **INTERFACE**, **COMPUTER INTERFACE**, **CHUCK** and **T/C** connectors.

<u>INTERFACE CONNECTOR</u>

The **Interface Connector** is used to connect the **Heat Control Module** directly to the **Cool Module** when there is no **Linear DC Power Source** connected to the system. When the **Linear DC Power Source** is connected to the system, the **Heat Control Module** is connected to it via a "Y" cable with one leg of the cable going over to the **Cool Module**.

<u>COMPUTER INTERFACE CONNECTOR</u>

This connection allows the **Heat Control Module** to be controlled by a host computer control. The native control communications is RS-485. Converters are available which will accept RS-485 or Ethernet communications. Check with the factory for current availability.

<u>CHUCK CONNECTOR</u>

This connector provides connection from the HEAT MODULE to the THERMAL CHUCK assembly via the connector on the rear of the probe station.

<u>T/C CONNECTOR</u>

This connector provides connection between the HEAT MODULE and the THERMAL CHUCK assembly's appropriate temperature sensing devices via the connector on the rear of the probe station.

4.3.3 <u>Power On Reset Circuits</u>

The HEAT CONTROLLER has three circuits which ensure that the controller is reset properly when power is cycled.

MANUAL CONTROL

These circuits are designed to ensure **Power On Reset** when the system experiences a loss of power. When power is re-applied to the system, the **Power On Reset** circuits brings the **Heat Control Module** back up to last operation it was performing. This condition is the **STOP** (or idle) state.

SPECIALIZED POWER SUPPLY

The **Heat Control Module** also houses a separate power supply used to control isolation relays and other special functions.

One if it's special functions is to control a TIMING RELAY for the isolation relays. This timing circuit allows the isolation relay to shut off when the system is placed in the HEAT mode prior to sending a control signal the **Linear DC Power Source**.

When the HEAT operation is halted, the timing circuit will operate to ensure that the relays are energized until after the control signal is removed from the **Linear DC Power Source**.

These functions have been designed to ensure that no large transient currents are operating through the relay contracts. By doing this, the life of the relay contacts will be prolonged. This will also minimize transient noise associated with the relays opening and closing with large currents going through them. This should not become a problem because the load is purely resistive; however, any such action across the relay contacts will cause noise spikes.

4.3.4 Main Temperature Controller

The MAIN TEMPERATURE CONTROLLER is part of the operator interface located on the front panel. This is a modular component that can be removed and replaced by service personnel at any time if it is damaged or fails.

This base system (under **PID** control) is designed to go from ambient to 400° C. The **PID** control has been optimized for operation between 50° and 300° C. If the end user knows of a specific temperature at which the system will be operating and that temperature is less than 300° C. , the **PID** controls can be reset. The factory can be contacted and service personnel can be sent to tune the system for a specific temperature.

4.3.5 Safety Temperature Controller

When a **H1000 Thermal Chuck System** is ordered, the specific operating temperature of the system is determined by its specifications. A second temperature limit is set into the system at the factory to ensure safe operation of the unit. The **Safety Temperature Controller** is designed to ensure that predetermined temperature is not exceeded.

This safety circuit is a second type of heat controller that acts as a backup safety temperature controller to the **Heat Control Module**. It monitors a separate temperature sensing device inside the PUCK that is set at a pre-determined temperature of approximately 25° C above the factory set temperature or setpoint for the specified **Heat Control Module**.

EXAMPLE:

> If the system's **Heat Control Module** operates at 210° C , the **Safety Temperature Controller** will be set at 235° C. If the **Heat Control Module** requirement is 400° C, the **Safety Temperature Controller** will be set at 425° C.

The **Safety Temperature Controller** is designed as a backup in the event of a sensor failure in the PUCK. If a thermocouple fails in the shorted condition, it appears as an ambient temperature to the **Heat Control Module**. Having two separate sensors monitored separately provides a redundant safety feature to protect the equipment as well as the end user.

On the rear panel of the **Heat Control Module** is a **RESET** switch with an indicator which allows the operator to determine if the **Safety Temperature Controller** has been activated due to a malfunction and needs to be reset.

NOTE

> Due to the **Power On Reset** circuit, it is not necessary to go to the rear panel of the **Heat Control Module** to reset the **Safety Temperature Controller** -- just turn the **Heat Control Module OFF/ON** and all conditions will be reset.

4.3.6 Isolation Relays

The **Isolation Relays** are a set of relays that are placed in series between the power source and the **Thermal Chuck**. These relays, two FORM A type, are rated to handle 16 amps with a breakdown voltage in excess of 1000 VRMS.

4.4 COOLING OPTIONS

4.4.1 Ambient Cooling Option (C100-V0-H)

The C1000-V0-H cooling option consists of three (3) elements or sub-systems. They are:

1) **Cool Module**
2) **Service Module** (SRV1)
3) Plumbing accessories (hose and tubing assemblies)

COOLING MODULE

The C1000-V0-H is the most basic cooling option (Ref. Fig. 4-7 & 8) available. It allows the Thermal chuck to be connected to a coolant and air supply for a more rapid cooling of the thermal chuck. Its intended operation would allow rapid cooling to ambient with a subsequent purge of air to remove the coolant from the **Thermal Chuck** assembly. Its temperature set point range is 400 to 10° C. The C1000-V0-H cooling option consists of a **Cooling Module,** the SRV1, plumbing accessories such as tubing and quick connects, the appropriate INTERFACE cable and SRV1's plumbing control interconnecting cable.

The **Cooling Module** is designed to slide into the right hand side of the Heat Controller. On the front panel are the manual temperature set point controls, Chuck temperature display, and a manual PURGE control. The module has three rear panel connectors labeled: INTERFACE, COMPUTER INTERFACE, and PLUMBING CONTROL. The INTERFACE connector supplies the necessary power and control signals for the Cooling Module to be operated from the host Heat Controller. The PLUMBING CONTROL connector supplies the necessary control signals to the **Plumbing Service Module** (SRV1). The COMPUTER INTERFACE connector is a seven position Viking connector wired to provide access for 485 serial control of the module or using RS-232, IEEE-488 with an appropriate interface option.

Operation instructions for the Cooling Module can be found in section 3.4 of this manual.

FIGURE 4-5. COOL MODULE (FRONT VIEW)

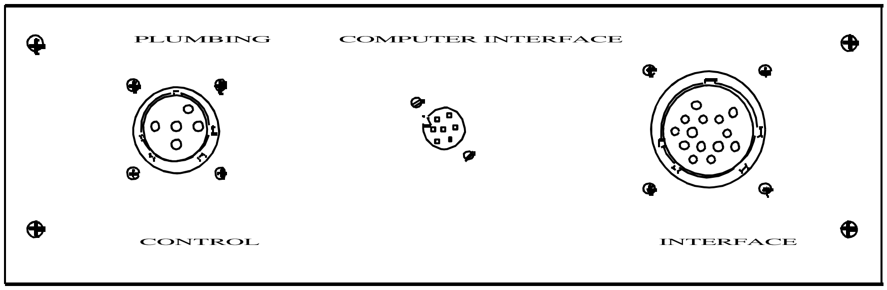


FIGURE 4-6. COOL MODULE (REAR VIEW)

THEORY OF OPERATION FOR A COOLING OPTION

When the COOL BUTTON is depressed on the **Heat Control Module**, a control signal is then transmitted to the **Cooling Module** which will begin a cool cycle to the preset temperature. The **Cooling Module** then sends a signal to the SRV1 MODULE to control and direct coolant to the **Thermal Chuck** assembly. It will continue to send coolant to the **Thermal Chuck** assembly until the temperature that was preset is obtained.

In ambient cooling option, it will discontinue the direction of the coolant flow and start a preset thirty second PURGE operation to remove the coolant from the **Thermal Chuck** in preparation for the next heat cycle.

In the Zero Degree C cooling option, coolant continues to flow and control the temperature of the thermal chuck to the set point on the Cooling Module. A PURGE operation will automatically be initiated only when the thermal chuck temperature transitions 1.5^{o} C over the set point on the Cool Module. If the user has any doubt if there is liquid in the chuck, a manual PURGE can be done using the PURGE button on the Cooling Module front panel.

The PURGE cycle is designed to remove the coolant from the PUCK to not only facilitate the next HEAT CYCLE but to also increase the electrical isolation of the **Thermal Chuck** assembly.

PLUMBING SERVICE MODULE (SRV1)

The **Service Module** (SRV1) is designed to allow for various types of cooling operations to service the **Thermal Chuck**. The SRV1 consists of a couple of control valves that direct coolant and air as necessary to allow the basic COOL operation. It directs a constant flow of coolant through the **Thermal Chuck** assembly radiator at all times. During the COOL operation, it also directs coolant through the **Thermal Chuck** PUCK.

At the end of a COOL cycle in ambient cooling options, it discontinues the coolant flow through the PUCK and replaces it with air, for thirty seconds, to remove any excess coolant remaining in the PUCK. The SRV1 is connected to the **Cooling Module**, via an interface cable, to transmit the control signal from the **Cooling Module** to the SRV1.

Zero Degree C cooling options maintain coolant flow in the thermal chuck to maintain the set point in the Cooling Module.

PLUMBING ACCESSORIES (Hose and Tubing Assemblies)

The hose assemblies are used to handle the higher temperature drain lines that exit the **Thermal Chuck** assembly. Special hoses and fittings are used that can handle these excess temperatures. The tubing assemblies are used to supply coolant to the **Thermal Chuck** assembly. The supply temperature will seldom, if ever, get above ambient.

Other plumbing accessories supplied are two ten foot lengths of tubing affixed with male quick connects on each end for interconnection of the SRV1 to the Prober. Also supplied are two fifteen foot lengths of 1/4" OD semi-rigid tubing, each with one quick connect, for connection of the SUPPLY INLETS of the SRV1 to the appropriate services. All plumbing quick connect fittings have internal shut of valves. The connection of tubing/hose to the SRV1 and the **Thermal Chuck** is fairly straight forward. The SRV1 module will have a plumbing diagram (Ref. Fig 4-7 & 8) of the hose assembly affixed to the top of the module cabinet for reference to make all of the proper connections.

4.4.2 Ambient Cooling Option (C1000-V1-HE, C1000-V2-HE)

The C1000-V1-HE and the C1000-V2-HE cooling options consist of three (3) elements or sub-systems. They are:

1) **Cooling Module**
2) **Heat Exchanger**
3) Plumbing Accessories (hose and tubing assemblies)

The **Cooling Module** for this cooling option is the same as the **Cooling Module** for the C1000-V0-H cooling option as described earlier in this section.

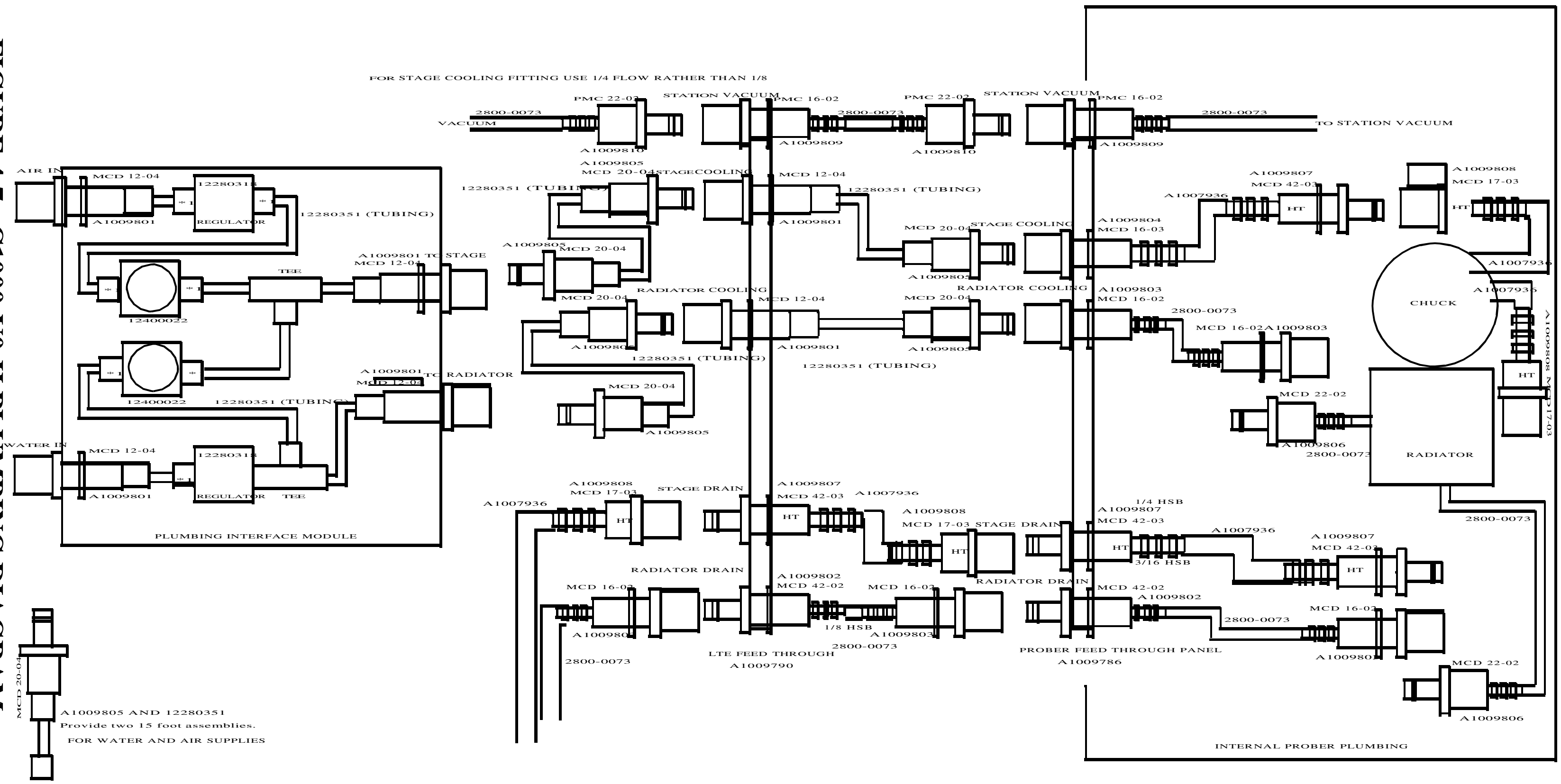


FIGURE 4-7. C1000-V0-H PLUMBING DIAGRAM

HEAT EXCHANGER

The **Heat Exchanger** is a self-contained unit which maintains the output cooling fluid at the same temperature as the ambient air. Liquid and air enter the exchanger at different temperatures and exit with shared temperatures. The resultant heat transfer is used to cool the liquid to a temperature that match the incoming air. The closed loop liquid cooling system is used to cool water or a water/glycol mixture as the coolant , heat is transferred from the system chuck cooling fluid through the exchanger where it is transferred to the air. The constant circulation removes the heat and rapidly cools the fluid to the 'Ambient' or incoming air temperature. Refer to Figure 4-9 for a flow diagram.

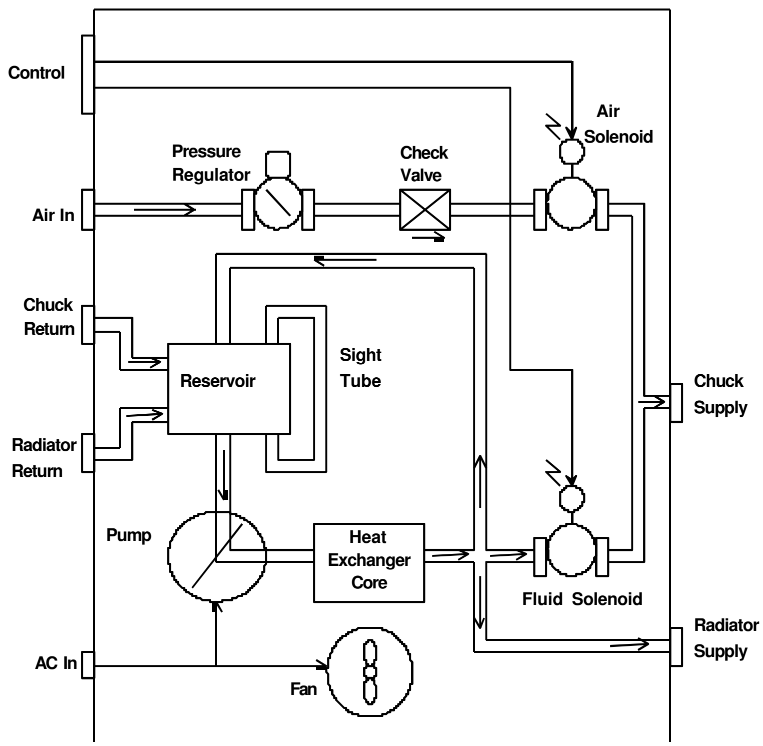


FIGURE 4-8. HEAT EXCHANGER FLOW DIAGRAM

4.4.3 Zero Degree C Cooling Option (C1000-V1-C-0, C1000-V2-C-0)

The C1000-V1-C-0 and the C1000-V2-C-0 cooling options consist of three (3) elements or sub-systems. They are:

1) **Cooling Module**
2) **Zero Degree C Chiller**
3) **Service Module** (SRV1)
4) Plumbing Accessories (hose and tubing assemblies)

The **Cooling Module** for this cooling option operates very similar to that used in the C1000-V0-H cooling option. The subtle difference between the two modules is in the way the PURGE operates. The Zero Degree Cooling Module automatically initiates a PURGE only when the thermal chuck temperature rises 1.5° C above the set point on the Cooling Module. The user should initiate a manual PURGE using the PURGE button on the Cooling Module front panel if here is any doubt whether the thermal chuck has liquid in it.

The SRV1 used in the Zero Degree Cooling Option is slightly different than the SRV1 used in the ambient cooling option. The zero degree SRV1 does not regulate the pressure to the chuck cooling, but does regulate the coolant pressure supplied to the radiator.

ZERO DEGREE C CHILLER

The **Zero Degree C Chiller** contains a refrigeration unit which maintains a reservoir of cooling fluid (normally water/glycol mixture) at a specific temperature set using the front panel. The SRV1 controls the flow of cooling fluid through the **Thermal Chuck** radiator ring and the PUCK for cooling the chuck surface. The PUCK is purged of the cooling fluid whenever the controller switches out of the cooling mode.

4.5 LINEAR DC POWER SOURCE (DC-100)

The **Linear DC Power Source** is capable of delivering a linear 100 VDC, with less than 25 mV of ripple when delivering 10A. This is the DC power supplied to the THERMAL CHUCK assembly to heat the PUCK surface to the selected temperature designated by the **Heat Control Module.** Its output control signal is received via the interconnect cable from the **Heat Control Module.** The front panel meters allow the operator to observe the power being supplied to the **Thermal Chuck** assembly at any given time.

EXAMPLE:

Operating at approximately 350° C, the operator will note that the supply is delivering between 60 to 70 volts DC and 5 to 6 amps DC to maintain the selected temperature. On the approach to the selected setting from ambient to 350° C, you will notice that the DC volt will equal 100 and the amps will equal 8 to 9 1/2 amps depending upon the THERMAL CHUCK assembly.

Observing the actual power out meters on the front panel allows the operator to see that the system is operating properly.

The **Linear DC Power Source** is a convertible power supply that can be switched from 120 VAC to 220 VAC operation by qualified service personnel. It has a large internal transformer with jumpers that need to be switched when converting. When a **Linear DC Power Source** is ordered, the required voltage setting must appear on the Sales Order in the form of either option V1 (120VAC) or V2 (220VAC) so that the jumpers can be switched at the factory for proper testing.

CAUTION: ***Power Supply jumpers may be changed in the field. However, they must be changed by factory authorized personnel.***

SECTION 5.0
ZERO °C COOLING OPTION

5.1 INTRODUCTION

The **ZERO °C COOLING OPTION** is incorporated as a part of the **H-1000 THERMAL CHUCK SYSTEM®.**

A recirculating cooler or chiller is a device which controls the temperature of a process by heating or removing heat from a process by circulating a fluid. The circulated fluid flows from the cooler to the process and back in a closed loop.

The zero degree cooling option includes the required equipment for control of the fluid include a pump, reservoir, heat rejection method, and a temperature controller.

5.1.1 The Reservoir

The RESERVOIR is required for the following two (2) reasons:

1. Fluid Expansion and Contraction

   When the temperature of fluid is changed, a change in volume occurs. As temperatures decrease the volume decreases, and vice-versa. The reservoir must be large enough to accommodate the expansion and contraction of the fluid.

2. System Initial Fill

   The reservoir is initially filled prior to start up. If the process is not precharged, there must be sufficient fluid in the reservoir to fill the process which still having a sufficient volume to prevent pump cavitation.

5.1.2 Heat Transfer

A RECIRCULATING cooler is considered a forced convection heat transfer device. The mass flow of liquid flowing through the process heat exchanger allows temperature control by adding or removing heat as required. Heat transfer is affected by many different fluid characteristics which include:

DENSITY **VISCOSITY** **FLOW RATE**
SPECIFIC HEAT **TEMPERATURE DIFFERENTIAL**

To calculate heat removal, the temperature of the fluid entering the process and exiting the process must be measured. The mass flow rate of liquid and its specific heat are required .

<u>FORMULA</u> Q

= M Cp dT

Q = Heat Removal (BTU/HR)
M = Mass Flow (LB/HR)
Cp = Specific Heat (BTU/LB/F)
dT = Temp Differential (F)

For water flowing at **2 gallons per minute** with an inlet **temperature of 72º F** and outlet **temperature of 80º** we can calculate the heat removal:

Q = (2 GPM * 8 lb/gl * 60 min/hr) * 1 BTU/LB/F * 8 F

Q = 7680 BTU/HR = 2250 Watts

The VISCOSITY of the liquid is very important when deciding on what fluid to use for the application. At no time should the fluid viscosity be above **20 CENTISTOKES**. Viscosities higher than 20 centistokes will result in decreasing heat transfer.

5.2 SYSTEM DESCRIPTION

This system is designed to operate on a continuous basis with minimal interruption for maintenance and service. The system uses a single compressor to chill the cooling fluid.

RECIRCULATING coolers include a mechanically refrigerated heat exchanger, a fluid reservoir, a pump and a temperature controller as standard features.

The fluid flows from the reservoir through the pump and is pushed through the internal heat exchanger. The process equipment is attached between its outlet and return.

5.2.1 Pump

The zero degree system uses a high pressure positive displacement pump.

<u>High Pressure Pumps</u>

HPP-2	Procon #1304 w/strainer
HPP-4	Procon #2507 w/o strainer

Type: Positive displacement, rotary-vane type pumps

Pump housing is brass, and internal metal parts are stainless steel or brass. Internal bearings, vanes, and liner are made from a special carbon graphite material which is selflubricating, heat-resistance, chemically and mechanically inert, and harder than many steels.

HPP-2

Body Material	Brass
Capacity	15 to 100 GPH
Pressure	25 PSI at 100 GPH
	150 PSI at 95 GPH
Normal Speed	1725 RPM (60 Hz)
Max. Discharge	200 PSI
Rotation	CW (from nameplate view)

The chiller has external plumbing installed to provide a bypass for operation where the coolant is not flowing.

5.2.2 Safeties

To prevent damage to the devices under test, several safeties are built into the system.

5.3 HEAT REMOVAL

The mechanical refrigeration system has a single stage refrigeration system. The refrigerant is expanded in the heat exchanger to provide cooling. A solenoid valve is used to control the flow of refrigerant to the heat exchanger for precise cooling control. The solenoid valve is normally **OPEN** to provide maximum cooling should the controller not be powered.

The heat exchanger is a stainless steel brazed plate unit. Air cooled mechanically refrigerated units depend on the ambient air to be drawn across the condensing fins. The cool air cools the hot gas inside the condenser which allows the gas to liquefy.

The air cooling process is critical. If the flow is blocked or the temperature of the air is too high, the gas is not cooled into a liquid and the result is loss of cooling in the heat exchanger.

Always be alert that the air flow can be blocked by dust in the condenser fins. Check the room temperature. Temperature above 72° F will reduce the specified heat removal.

BTU PER HR/WATTS	0	10	20
RS33	1706/500	2730/800	3750/1100

TABLE 5-1

The heat removal specifications for the unit are specified for an ambient temperature of 72º F which does not change. The fluid used for testing is **Glycol/water 40/60**.

5.4 SYSTEM SET-UP

The Recirculator is designed for operation in a normal environment. Air cooled systems require the room ambient temperature to be 72º F (25º) with up to 50% humidity.

ELECTRICAL REQUIREMENTS

RS33 120V, 60 Hz, 8A
AMBIENT: 72º F, 50% HUMIDITY

NOTE

All recirculators provide maximum cooling at temperatures below 72º F. Higher temperatures will degrade heat removal. DO NOT operate the systems in an ambient above 90º F.

SYSTEM PREPARATION FOR START-UP

STEP 1. Check wall voltage. Does it match the system electrical requirements?

STEP 2. Place all control switches in the **OFF** position.

STEP 3. Attach SHORT CIRCUIT hoses to fluid I/O for testing.

STEP 4. Fill reservoir with fluid. Make sure the freezing point of the fluid is well below the systems maximum low temperature. **Use either a Glycol/water mix of 50/50** (or when using the supplied Sierra antifreeze) **Sierra/water mix 40/60. DO NOT** use water below 8º C.

STEP 5. Check for leaks. Placing a piece of clean card board under the system will allow easy leak detection.

STEP 6. Attach AC power. The AC power amber indicator will illuminate.

STEP 7. Depress the **O/I** button (top most button) - controller will now turn **ON**.

STEP 8. Adjust SET POINT to 0° .

STEP 9. Turn REFRIGERATION **ON**.

5.5 MAINTENANCE

It is the operator's responsibility to periodically check the system for proper operation. These operational checks must be performed on a weekly basis.

Periodic Maintenance: Weekly (154 hours)

5.5.1 Reservoir fluid level

Insure adequate supply of fluid in reservoir. Minimum half full.

Periodic Maintenance: 3 months (2000 hours)

NOTE

Power temperature controller and cooling devices should be off. Disconnect all power sources from line connections prior to performing maintenance or servicing the chilling unit or heat exchanger. Disconnect controller and heat exchanger power cords from the respective rear panels when available. Reference the safety section on electrical hazards for details. Service should be performed by Micromanipulator authorized technician. Contact the Micromanipulator service department when a problem occurs.

5.5.2 Refrigeration Condenser

For the mechanical refrigeration system to operate efficiently the condenser must be dust free. Over a period of time, dust will build up on the condenser which will decrease system performance. This dust must be vacuumed off. The condenser is located in the front of the system. The front of the system is removable for periodic maintenance.

NOTE

The rear and side panels must first be removed in order to clean the condenser.

5.5.3 HHP-2 Strainer

A strainer is provided as part of the pump head assembly on the HHP-2 series of pumps. The strainer should be periodically cleaned to prevent fluid flow reduction.

The symptoms of a clogged strainer are a noisy pump, decreased fluid flow, and / or reduced heat removal capacity.
The Strainer requires more regular maintenance when anti-freeze is substituted for use of pure Glycol.

Periodic Maintenance: 12 months (8000 hours)

5.5.4 HEAT TRANSFER FLUID

Drain chiller, clean HHP-2 strainer, and replace fluid. **Use either a Glycol/water mix of 40/50** (or when using the supplied Sierra antifreeze). **DO NOT** use water below 8º C.

5.6 DO'S AND DON'TS

DO

- Provide adequate ventilation for refrigeration condenser
- Operate in an ambient of 72º F
- Use glycol/water below 8º C
- Perform periodic maintenance every 3-6 months
- Leave at least 6" on each side of the unit for proper air flow

DON'T

- Use water below 8º C
- Operate the high pressure pump without fluid or with fluid flow impeded
- Operate the equipment in an ambient above 90º F
- Block the condenser fins
- Operate at low voltage level
- Use flammable fluids for recirculation
- Push any side of the unit against the wall
- Operate with fluids with a pH of less than 5 or greater than 9
- Operate the system in a closet

5.7 FLUIDS IN RECIRCULATING SYSTEMS

Choosing the proper fluid for use in a recirculating system is the single most important decision to be made. Improper fluid can result in damage to the process and equipment.

5.7.1 Boiling Point

Fluids should be operated at temperatures no closer than 15º C to their boiling point. As the temperatures approach the boiling point, the pump will tend to cavitate (i.e. If a fluid boils at 100º C, it should not be used above 85º C

5.7.2 Glycol/Water : Glycol - Ethylene Glycol, Industrial Grade

When glycol and water are mixed they create a mixture which can be used at lower temperatures than either of the two individually. The ideal mixture for glycol/water is 40% glycol and 60% water.

Glycol is available in pure form or in anti-freeze form. Pure glycol is almost clear. Anti-freeze is green and includes additives which inhibit scaling, corrosion, and bacterial growth. The use of anti-freeze may cause the internal strainers to be cleaned more often. Pure glycol is recommended.

SIERRA ANTIFREEZE is shipped with each unit. If you determine that you would prefer to use this verses pure glycol, the ideal mixture would be for Sierra/water is 40% Sierra and 60% water.

Freezing Points of Common Mixtures

The following are common fluid mixtures and their resulting freezing points. Note that the viscosity is NOT linear and therefore the freezing point and pumpability are NOT directly related. The intent of the charts is to provide the use with the optimum mixtures.

ETHYLENE GLYCOL/WATER

% VOLUMN	FREEZE Pt (F)
35	-4
40	-12.5
45	-22
50	-32.5 (*)

(*) Not Pumpable Below -22°F (-30° C)

TABLE 5-2

PROPYLENE GLYCOL/WATER

% VOLUMN	FREEZE Pt (F)
40	-5.5
45	-15
50	-25.5 (*)
55	-39.5
59	-57

(*) Not Pumpable Below -15 deg F (-25 deg C)

TABLE 5-3

5.8 TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	SOLUTIONS
UNIT WILL NOT START	1. Power is not connected properly.	1. Have electrician check power connections.
	2. Breaker at the wall is in the OFF position.	2. Turn breaker ON.
PUMP WILL NOT START	1. Power is not connected properly.	1. Have electrician check power connections.
	2. Breaker at the wall is in the OFF position.	2. Turn breaker ON.
	3. Impeller jammed.	3. Verify that motor is getting voltage and that the voltage is correct.
	4. Pump motor has overheated	4. The pump motor is provided with a thermal overload protection. If it overheats, the pump will shut down. This is usually a result of the pump being overworked. Check solutions under FLUID FLOW IS INADEQUATE.
	5. Pump motor has burned out.	5. If all reasons listed above are not the cause and the pump has voltage to it, the pump motor is no good. Contact factory for new pump motor.
UNIT NOT COOLING PROPERLY	1. Temperature setting above fluid temperature	1. Adjust temperature setting to the proper setting
	2. Viscosity of fluid is too high for intended temperature range.	2. Change fluid.

PROBLEM	POSSIBLE CAUSE	SOLUTIONS
UNIT NOT COOLING PROPERLY (continued)	3. Ambient temperature too high.	3. To meet specifications, the room air temperature must be 72° F. The capacity of the cooling system and the maximum low temperature will degrade as the temperature increases.
	4. Plumbing incorrectly connected to process.	4. Check that LIQUID OUT port of system is connected to inlet of system to be cooled, and that LIQUID IN is connected to outlet of system to be cooled.
	5. Heat load is above unit's capacity.	5. Check to see that all lines have adequate insulation and that there are no local sources of heat which may be contributing to the load.
	6. Cooling water is inadequate or restricted.	6. A water cooled unit requires cooling water to be provided to the water cooled condenser. Check to see that cooling water supply is adequate.
	7. Cooling water is turned off.	7. Turn on cooling water. See UNIT CUTTING OUT ON HIGH PRESSURE.
	8. Refrigerant leak.	8. Connect gauges and check static charge. If this confirms a leak, have the system leak checked, repair leak, and recharge system to proper level.
	9. Ball valve is closed.	9. Open ball valve.
	10. Fluid flow is inadequate	10. See FLUID FLOW IS INADEQUATE.

PROBLEM	POSSIBLE CAUSE	SOLUTIONS
UNIT NOT COOLING PROPERLY (continued)	11. Cooling valve is sticking.	11. Adjust temperature set point to cycle the cool indicator ON/OFF. This should result in a "clicking" sound from inside the machine.
TEMPERATURE CONTROLLER WILL NOT CONTROL TEMPERATURE	1. Open sensor	1. Measure resistance of sensor. It should be approximately 100 ohms. If it is not, a new sensor is needed. Contact Service Dept. for new sensor.
	2. Connection on controller has come loose.	2. Check all connections on controller inside the unit. If any are loose or disconnected, reconnect them.
	3. Low voltage to solenoid valves.	3. The controller is operating properly but because of inadequate voltage to solenoid valve, the valves are not opening and closing as needed. Correct voltage supplied to the unit.
	4. Defective solenoid valve.	4. The controller operating properly, but the solenoid valve is not responding because of a defect.
LOW FLUID FLOW	1. Viscosity of fluid is too high for intended temperature range	1. Change fluid to a fluid with lower viscosity.
	2. Pump screen blocked, if using a high pressure pump such as HPP2 or HPP 4.	2. The inlet to the pump has a screen filter which is accessed by removing the insulation from the pump and removing the large nut on the pump housing.

PROBLEM	POSSIBLE CAUSE	SOLUTIONS
LOW FLUID FLOW (continued)	3. Ball valve is closed.	3. Open ball valve.
	4. Plumbing lines have become restricted or broken.	4. Check plumbing lines and repair as necessary.
	5. Restrictions in the system will not allow needed flow with supplied pump.	5. Use larger line sizes. Replace pump with pump capable of supplying needed flow with the given plumbing restrictions. Check with factory for warranty implications.
	6. Impeller or pump has been damaged.	6. Remove pump and chick impeller, contact factory for replace pump or impeller. Determine cause of damage and correct cause to prevent future damage.
	7. Pump motor has overheated.	7. The pump motor is provided with a thermal overload protection. If it overheats, the pump will shut down and it will restart when the motor has cooled down. This is usually a result of the pump being overworked. Check the above items to see if they are causing the motor to overheat.
	8. Pump motor has burned out.	8. Contact service department for new pump motor.
REFRIGERATION WILL NOT START	1. Pump switch is not ON.	1. Turn unit ON.
	2. Low/High Pressure (Ranco) Cut-out contacts are OPEN.	2. Press reset button on RANCO. If unit does not start, short contacts. If this does not start the unit, then this device is not the cause. If it does start, check refrigerant stats.

PROBLEM	POSSIBLE CAUSE	SOLUTIONS
REFRIGERATION WILL NOT START (continued)	3. Voltage is inadequate.	3. The compressor must have adequate voltage to start. Check voltage when power is applied to the system. If voltage is not within $\pm$ 5% of the system rated voltage, contact the electrical department to have the voltage corrected.
UNIT CUTTING OUT ON HIGH PRESSURE	1. Ambient too warm.	2. The unit is designed for operation in an ambient environment of 72º F. Temperatures over 80º F may cause the compressor to overheat.
	2. Fan not working.	3. Check the fan for rotation. If the fan is not rotating check: AC supply to fan For blockage Excessive dirt/dust
	3. Condenser blocked.	4. The finned condenser requires adequate air flow to provide cooling. Make sure that the finned surface is 6" away from the wall and not clogged with dust.
	4. High pressure cut-out has been moved, and it is adjusted too low.	5. Apply refrigeration gauges, and check where the system is cutting out. Compare this to the settings listed in the QC sheets. Adjust to proper setting.
UNIT IS CUTTING OUT ON LOW PRESSURE	1. Low pressure cut-out has been moved, and is adjusted too high.	1. Remove filter screen by cutting back insulation and removing large nut on pump housing.

PROBLEM	POSSIBLE CAUSE	SOLUTIONS
PUMP MAKING LOUD NOISE	1. Blocked filter screen, if using HPP2 or HPP4.	1. Remove filter screen by cutting back insulation and removing large nut on pump housing.
	2. Fluid freezing or icing.	2. Make sure that there is no ice in the fluid. Straight water should not be used below 5º C. For lower temperature operation, mix with glycol.

SECTION 6.0
MAINTENANCE AND TROUBLE SHOOTING

6.0 INTRODUCTION

This maintenance section is broken into two separate sections which are BASIC SYSTEM MAINTENANCE REQUIREMENTS and TROUBLE SHOOTING.

The first section will be the BASIC SYSTEM MAINTENANCE REQUIREMENTS which will be comprised of visual checks for good connections and general condition. Each of the topics in this section will have a recommended time period for the event to occur.

Power temperature controller and cooling devices off. Disconnect all power sources form line connections prior to performing maintenance or servicing the chilling unit or heat exchanger except when performing procedures detailed in sections **6.1.1** through **6.1.3**. Disconnect controller and heat exchanger power cords from the respective rear panels when available. Reference the safety section on electrical hazards for details. Service should be performed by Micromanipulator authorized technician. Contact the Micromanipulator service department when a problem occurs.

The second section will be the TROUBLE SHOOTING section which consists of a trouble shooting chart listing symptoms, cure and reference documents.

Appendix A (TEST PROCEDURES AND CHECKOUT SHEETS) and Appendix B (BILLS OF MATERIALS and ASSEMBLY DRAWINGS) are designed to work in conjunction with this maintenance section.

6.1 BASIC SYSTEM MAINTENANCE

6.1.1 <u>Heat Controllers (Recommended Every Six Months)</u>

A. AC and DC HEAT CONTROLLER OVERTEMP AND ISOLATION RELAYS CHECK

1. Turn **ON** the controller and ensure that it is in the **STOP** mode. Disconnect the **T/C** cable from either the rear of the TEMPERATURE CONTROLLER or the PROBE STATION.

2. The front panel temperature displays should show **4 DASHES**. The red **LIMIT** LED (on the rear panel of the controller) should light within 25 seconds. After the **LIMIT** LED has lit, reconnect the **T/C** cable.

3. Once the temperature displays resume normal indication, set the **HEAT SETPOINT** to any temperature that is 10 degrees higher than the indicated **THERMAL CHUCK** temperature. The **CHUCK** temperature should not increase (**ISOLATION RELAYS** need to be replaced if controller heats in this mode). Place **HEAT CONTROLLER** in **HEAT** mode. The **THERMAL CHUCK** should now begin heating.

6.1.2 <u>Cool Modules (Recommended Every Six Months)</u>

A. AMBIENT COOL OPTION CONTROL MODULE

1. PURGE TIMER CHECK (60 SECONDS)

Turn the controller **ON** and ensure that it is in the **STOP** mode. Check that an **AIR PURGE** is initiated (**PURGE** light lit and air blowing through cooling tubes of the **THERMAL CHUCK**). This could last from 60 to 90 seconds and then go **IDLE**. If **NO PURGE** occurs, initiate **MANUAL PURGE** using the **PURGE SWITCH** (this verifies control cables are connected to the **SRV** module or **HEAT EXCHANGER**). If **PURGE** occurs manually but not automatically, then interval in **COOL** module needs to be reset or replaced. The **INTERVAL TIMER** is mounted inside the **COOL** module. The timer has a scaled face for adjusting the time. The timer is typically set to 60 seconds but should be adjusted to ensure adequate time to remove water or coolant from the **THERMAL CHUCKS** cooling tubes.

6.1.3 <u>Service Modules (Recommended Every Six Months and / or Year)</u>

A. **SRV1** modules regulator settings and flow checks - refer to A1010812 Test and Check Out Sheet. <u>**Every Six Months**</u>

B. HEAT EXCHANGERS regulator settings and flow check, refer to A1011113 Test and Check Out Sheet (**Every Six Months**) .
Replace FLUID **Yearly.** Use either a Glycol/water mix or an anti-freeze/water mix. Mix 1 to 2 cups glycol or anti-freeze to 2 gallons of water.

6.1.4 Small Chillers

A. Clean **CONDENSER** weekly (Reference Section 5.5.1)

B. Clean **STRAINERS** every six months (Reference Section 5.5.2).

C. Replace **FLUID** yearly (Reference Section 5.5.3) **Use either a Glycol/water mix of 40/50, or supplied antifreeze /water mix 40/60. DO NOT** use water below 8^{o} C.

6.1.5 Thermal Chucks. (Recommended Every Three Months)

Visual check for GOOD connections and general condition.

6.2 TROUBLE SHOOTING

The following table is a compiled list of probable symptoms, cures and reference documents to help in repairing malfunctions that may occur during a chiller systems operation.

TROUBLE SHOOTING TABLE

HEAT SYMPTOMS	CURE	REF. DOC.
SYSTEM DOES NOT HEAT	1. EMO switch is OFF position. Check switch. 2. Open Chuck connections from controller to chuck. Check light on controller rear panel Check Heater power cable attached. Check all connections 3. Open heater in chuck assembly. Check heater resistance (Pins 1 & 4 heater power cable) 4. Isolation relays open. Check Over temperature controller operation. Isolation relays or Over temperature controller failed. Replace failed components.	Test sheets: A1011416 A1011024 Assembly prints: A1010509-A AC controllers; A1009795 for DC controllers A1010968, A1010967 A1010594, A1010825 CHK880-6C, CHK8800-8T, A1011467
SYSTEM HEATS SLOWLY	1. Improper voltage power to chuck; 100 to 130 Volts required for standard chucks and 210 to 250 volts required for "V2" chuck assemblies. Check heater power and chuck assembly rating. 2. PIDs set incorrectly. Check PID settings. 3. Controller configured for "RAMP" operations is with slow ramp rate. "RAMP" operations is an advanced usage. Consult factory.	Test sheets: A1011416, A1011024 Assembly prints: CHK8800-6C CHK8800-8T A1011467

HEAT SYMPTOMS	CURE	REF. DOC.
SYSTEM OVERSHOOTS WHEN HEATING	Standard PIDs can cause small Overshoots when heating. These are normally within the stability and uniformity specifications of the thermal chuck. 1. PIDs set incorrectly. Check settings. 2. Improper voltage power to chuck; 100 to 130 Volts required for standard chuck and 210 to 250 volts required for "V2" chuck assemblies. Excessive voltage causes Overshooting. Check heater power and Chuck assembly rating 3. Controller configured for "RAMP" operation. "RAMP" operation is an advanced usage. Consult factory	Test sheets: A1011416, A1011024 Assembly prints: CHK8800-6C CHK8800-8T, A1011467
ERRATIC TEMPERATURE DISPLAY ON HEAT CONTROLLER	1. Bad RTD connections. Check connector and T/C cable assemblies. Check thermal chuck assembly connections	Assembly prints: A1010509-A/B A1009795, A1010568, A1010895, A1010968, A1010967, A1010594, A1010825, CHK8800-6C, CHK8800-8T, A1011467
ERRATIC TEMPERATURE CONTROL IN **HEAT** MODE	1. Bad RTD connection. Check connector and T/C cable assemblies. Check thermal chuck assembly connections. 2. Bad Heater power connections. Check heater power cable connections from controller to chuck. 3. PIDs set incorrectly. Check PID settings. 4. Controller configured for "RAMP" operations. "RAMP" operations is an advanced usage. Consult factory 5. Define erratic behavior. Consult factory.	Test sheets: A1011416 Assembly prints: A1010509-A/B, A1009795, A1010568, A1010895, A1010968, A1010967, A1010594, A1010825, CHK8800-6C, CHK8800-8T, A1011467, A1009857

HEAT SYMPTOMS	CURE	REF. DOC.
SYSTEM IS IN **HEAT** MODE WHEN THE POWER IS TURNED **ON**	1. Voltage spike caused Power ON Reset PCB assembly malfunction. Cycle Power ON controller. If problem persists, replace A1009794	Assembly prints: A1010509-A AC controllers: A1009795 for DC controllers: A1010967
SYSTEM IS IN **HEAT** MODE AND **COOL** MODE SIMULTANEOUSLY	1. Voltage spike caused Power ON Reset PCB assembly malfunction. Cycle Power ON controller. If problem persists, replace A1009794.	Assembly prints: A1010509-A, A1009795, A1010967
DASHED TEMPERATURE DISPLAY ON HEAT CONTROLLER	1. Open RTD connections. Check connector and T/C cable assemblies from controller to probe station. 2. Chuck not connected. Check Chuck connections.	Assembly prints: A1010509-A/B, A1009795, A1010568, A1010895, A1010968, A1010967, A1010594, A1010825, CHKK8800-6C, CHK8800-8T, A1011467
NO TEMPERATURE DISPLAY ON HEAT CONTROLLER	1. No power. Check power cable plugged in. Check circuit breakers on controller rear panel	Visual - N/A
COOL SYMPTOMS	**CURE**	**REF. DOC.**
SYSTEM DOES NOT COOL	1. System not connected properly. Check electrical connections from COOL MODULE to SRV or HEAT EXCHANGER. Check all plumbing connections in system. Coolant source disabled. Verify coolant source active. 2. Failed coolant valve in SRV or HEAT EXCHANGER. Check and replace if necessary. 3. Failed coolant regulator in SRV. Check and reset if necessary. 4. Cooling module controller failed. Check operation.	User Manual for system interconnect. Test sheets: A1010813, A1011213, A1010812, A1011113 Assembly prints: A1010600, A1010760, A1010601, A1010775-A

COOL SYMPTOMS	CURE	REF. DOC.
SYSTEM COOLS SLOWLY	1. High coolant temperature. Check coolant temperature. 2. Low flow. Check coolant source to SRV1 module. Check flow rate to chuck cooling tubes. Check flow rate through chuck cooling tubes. 3. Controller configured for "RAMP" operations. "RAMP" operation is an advanced usage. Consult factory.	User Manual for systems interconnect. Test sheets: A1010812, A1011113 Assembly prints: A1010601, A1010775-A
ERRATIC TEMPERATURE DISPLAY ON **COOL MODULE**	1. Bad RTD connections. Check connector and T/C cable assemblies. Check thermal chuck assembly connections.	Assembly prints: A1010509-A/B, A1009795, A1010568, A1010895, A1010968, A1010967, A1010600, A1010760, A1010594, A1010825, CHK8800-6C, CHK8800-8T, A1011467
ERRATIC TEMPERATURE CONTROL IN **COOL** MODE	1. Bad RTD connections. Check connector and T/C cable assemblies. Check thermal chuck assembly connections. 2. PIDs set incorrectly. Check PID settings. 3. Controller configured for "RAMP" operations "RAMP" operations is an advanced usage. Consult factory. 4. Define erratic behavior. Consult factory.	Test sheets: A1010812, A101113 Assembly prints: A1010509-A/B, A1009795, A1010568, A1010895, A1010968, A1010967, A1010600, A1010760, A1010594, A1010825, CHK8800-6C, CHK8800-8T, A1011467
SYSTEM IS IN **COOL** WHEN THE POWER IS TURNED ON	1. Voltage spike causes Power ON Reset PCB assembly malfunction. Cycle power on controller. If problem persists replace A1009794	Assembly prints: A1010509-A AC controllers: A1009795 for DC controllers, A1010967

COOL SYMPTOMS	CURE	REF. DOC.
SYSTEM IS IN **HEAT** MODE AND **COOL** MODE SIMULTANEOUSLY	1. Voltage spike causes Power ON Reset PCB assembly malfunction. Cycle power on controller. If problem persists replace A1009794	Assembly prints: A1010509-A, A1009795, A1010967
NO TEMPERATURE DISPLAY ON COOL MODULE	1. No Power Check interface cable connected between COOLING MODULE and HEAT controller	User Manual for system interconnect.
PURGE SYMPTOMS	**CURE**	**REF. DOC.**
SYSTEM DOES NOT PURGE	1. Air not connected. Check air supply to system is connected. 2. Interval timer failed. Initiate manual purge. Check that manual purge works. If manual purge works, replace Interval timer. 3. Air valve in SRV or Heat exchanger failed. Initiate manual purge to check valve operation. 4. Air regulator in SRV or Heat exchanger needs to be reset. Initiate manual purge to adjust regulator.	User Manual for system interconnect. Test sheets: A1010812, A1011113, A1010813, A1011213 Assembly prints: A1010600, A1010760
PURGE TIME VERY SHORT	1. Internal timer needs to be reset	Test sheets: A1010813, A1011213 Assembly prints: A1010600, A1010760
PURGE TIME VERY LONG	1. Interval timer needs to be reset	Test sheets: A1010813, A1011213 Assembly prints: A1010600, A1010760

PURGE SYMPTOMS	CURE	REF. DOC.
PURGE INDICATOR DOES NOT ILLUMINATE	1. Lamp out. Replace lamp.	Assembly prints: A1010600, A1010760
PURGE INDICATOR DOES NOT TURN OFF	1. PURGE switch latched in "ON" position. Press and release PURGE switch. 2. Interval Timer failed ON. Replace timer.	Assembly prints: A1010600, A1010760

INDICATOR SYMPTOMS	CURE	REF. DOC.
RESET INDICATOR ON REAR OF HEAT CONTROLLER IS ON	1. Press and release RESET button or cycle Controller power off and then back on	User Manual
RESET INDICATOR ON REAR OF HEAT CONTROLLER WILL TURN OFF	1. Open thermocouple in Chuck. Check all T/C connections. Measure continuity of thermocouple in thermal chuck assembly. Wire in spare thermocouple if necessary 2. Over temperature controller failed. Check operation and replace if necessary.	Test sheets: A1011416, A1011024 Assembly prints: A1010509, A1009795, A1010968, A1010967, A1010594, A1010825, A1010467, CHK8800-6C, CHK8800-8T

ZERO DEGREE CHILLER SYMPTOMS	CURE	REF. DOC.
LA INDICATOR ON ZERO DEGREE CHILLER IS ON	1. low Alarm: If the process temperature falls below this value, the LA alarm prompt is added to the process display. System menus were altered. Check menus. 2. Temp sensor failed	FTS RS33A001 manual

ZERO DEGREE CHILLER SYMPTOMS	CURE	REF. DOC.
HA INDICATOR ON ZERO DEGREE CHILLER IS ON	1. High Alarm: The temperature which, it exceeded by the process temperature, causes application of the HA alarm message when the system is running. This operation may be normal. The temperature of the reservoir may exceed the HA setpoint when cooling the chuck from elevated temperatures. Press the UP arrow on the chiller to reset the HA indicator. Check System menus. Reset if necessary. 2. Temp sensor failed.	FTS RS33A001 manual
ZERO DEGREE CHILLER RESERVOIR OVERFLOWS DURING PURGE	1. Reservoir is overfilled or purge pressure is too great. Check fluid level. Adjust air regulator in SRV module as necessary to stop overflow.	Assembly print: A1010601
CHUCK SYMPTOMS	**CURE**	**REF. DOC.**
RADIATOR IS HOT WHEN CHUCK IS HOT	1. No or low radiator cooling flow. Check that there is flow to radiator. Check that there is flow through the radiator.	User Manual. The radiator should always be connected to a cooling system regardless of whether a cooling option is purchased.
RADIATOR HAS CONDENSATION OR **SWEATS**	1. Temperature of the radiator is lower than dew point of air in surrounding environment. Check dew point of air.	
CHUCK HAS CONDENSATION OR FROST	1. Temperature of the chuck is lower than dew point of air in surrounding environment. Check dew point of air	

Troubleshooting Alarms, Errors and Control Issues

Indication	Description	Possible Cause(s)	Corrective Action
Alarm won't clear or reset	Alarm will not clear or reset with keypad or digital input	• Alarm latching is active • Alarm set to incorrect output • Alarm is set to incorrect source • Sensor input is out of alarm set point range • Alarm set point is incorrect • Alarm is set to incorrect type • Digital input function is incorrect	• Reset alarm when process is within range or disable latching • Set output to correct alarm source instance • Set alarm source to correct input instance • Correct cause of sensor input out of alarm range • Set alarm set point to correct trip point • Set alarm to correct type: process, deviation or power • Set digital input function and source instance
Alarm won't occur	Alarm will not activate output	• Alarm silencing is active • Alarm blocking is active • Alarm is set to incorrect output • Alarm is set to incorrect source • Alarm set point is incorrect • Alarm is set to incorrect type	• Disable alarm silencing, if required • Disable alarm blocking, if required • Set output to correct alarm source instance • Set alarm source to correct input instance • Set alarm set point to correct trip point • Set alarm to correct type: process, deviation or power
ALE1 Alarm Error ALE2 ALE3 ALE4	Alarm state cannot be determined due to lack of sensor input	• Sensor improperly wired or open • Incorrect setting of sensor type • Calibration corrupt	• Correct wiring or replace sensor • Match setting to sensor used • Check calibration of controller
ALL1 Alarm Low ALL2 ALL3 ALL4	Sensor input below low alarm set point	• Temperature is less than alarm set point • Alarm is set to latching and an alarm occurred in the past • Incorrect alarm set point • Incorrect alarm source	• Check cause of under temperature • Clear latched alarm • Establish correct alarm set point • Set alarm source to proper setting
ALh1 Alarm High ALh2 ALh3 ALh4	Sensor input above high alarm set point	• Temperature is greater than alarm set point • Alarm is set to latching and an alarm occurred in the past • Incorrect alarm set point • Incorrect alarm source	• Check cause of over temperature • Clear latched alarm • Establish correct alarm set point • Set alarm source to proper setting
Er.i1 Error Input Er.i2	Sensor does not provide a valid signal to controller	• Sensor improperly wired or open • Incorrect setting of sensor type • Calibration corrupt	• Correct wiring or replace sensor • Match setting to sensor used • Check calibration of controller
Limit won't clear or reset	Limit will not clear or reset with keypad or digital input	• Sensor input is out of limit set point range • Limit set point is incorrect • Digital input function is incorrect	• Correct cause of sensor input out of limit range • Set limit set point to correct trip point • Set digital input function and source instance
LiE1 Limit Error	Limit state cannot be determined due to lack of sensor input, limit will trip	• Sensor improperly wired or open • Incorrect setting of sensor type • Calibration corrupt	• Correct wiring or replace sensor • Match setting to sensor used • Check calibration of controller
LiL1 Limit Low	Sensor input below low limit set point	• Temperature is less than limit set point • Limit outputs latch and require reset • Incorrect alarm set point	• Check cause of under temperature • Clear limit • Establish correct limit set point

Indication	Description	Possible Cause(s)	Corrective Action
[L.h1] Limit High	Sensor input above high limit set point	• Temperature is greater than limit set point • Limit outputs latch and require reset • Incorrect alarm set point	• Check cause of over temperature • Clear limit • Establish correct limit set point
[LPo1] [LPo2] Loop Open Error	Open Loop Detect is active and the process value did not deviate by a user-selected value in a user specified period with PID power at 100%.	• Setting of Open Loop Detect Time incorrect • Setting of Open Loop Detect Deviation incorrect • Thermal loop is open • Open Loop Detect function not required but activated	• Set correct Open Loop Detect Time for application • Set correct Open Loop Deviation value for application • Determine cause of open thermal loop: misplaced sensors, load failure, loss of power to load, etc. • Deactivate Open Loop Detect feature
[LPr1] [LPr2] Loop Reversed Error	Open Loop Detect is active and the process value is headed in the wrong direction when the output is activated based on deviation value and user-selected value.	• Setting of Open Loop Detect Time incorrect • Setting of Open Loop Detect Deviation incorrect • Output programmed for incorrect function • Thermocouple sensor wired in reverse polarity	• Set correct Open Loop Detect Time for application • Set correct Open Loop Deviation value for application • Set output function correctly • Wire thermocouple correctly, (red wire is negative)
[rP1] Ramping 1 [rP2] Ramping 2	Controller is ramping to new set point	• Ramping feature is activated	• Disable ramping feature if not required
[tUn1] Autotuning 1 [tUn2] Autotuning 2	Controller is autotuning the control loop	• User started the autotune function • Digital input is set to start autotune	• Wait until autotune completes or disable autotune feature • Set digital input to function other than autotune, if desired
No heat/cool action	Output does not activate load	• Output function is incorrectly set • Control mode is incorrectly set • Output is incorrectly wired • Load, power or fuse is open • Control set point is incorrect • Incorrect controller model for application	• Set output function correctly • Set control mode appropriately (Open vs Closed Loop) • Correct output wiring • Correct fault in system • Set control set point in appropriate control mode and check source of set point: remote, idle, profile, closed loop, open loop • Obtain correct controller model for application
No Display	No display indication or LED illumination	• Power to controller is off • Fuse open • Breaker tripped • Safety interlock switch open • Separate system limit control activated • Wiring error • Incorrect voltage to controller	• Turn on power • Replace fuse • Reset breaker • Close interlock switch • Reset limit • Correct wiring issue • Apply correct voltage, check part number
No Serial Communication	Cannot establish serial communications with the controller	• Address parameter incorrect • Incorrect protocol selected • Baud rate incorrect • Parity incorrect • Wiring error • EIA-485 converter issue • Incorrect computer or PLC communications port • Incorrect software setup • Wires routed with power cables • Termination resistor may be required	• Set unique addresses on network • Match protocol between devices • Match baud rate between devices • Match parity between devices • Correct wiring issue • Check settings or replace converter • Set correct communication port • Correct software setup to match controller • Route communications wires away from power wires • Place 120 Ω resistor across EIA-485 on last controller

Indication	Description	Possible Cause(s)	Corrective Action
Process doesn't control to set point	Process is unstable or never reaches set point	• Controller not tuned correctly • Control mode is incorrectly set • Control set point is incorrect	• Perform autotune or manually tune system • Set control mode appropriately (Open vs Closed Loop) • Set control set point in appropriate control mode and check source of set point: remote, idle, profile, closed loop, open loop
Temperature runway	Process value continues to increase or decrease past set point.	• Controller output incorrectly programmed • Thermocouple reverse wired • Controller output wired incorrectly • Short in heater • Power controller connection to controller defective • Controller output defective	• Verify output function is correct (heat or cool) • Correct sensor wiring (red wire negative) • Verify and correct wiring • Replace heater • Replace or repair power controller • Replace or repair controller
[100] Device Error [rEtn]	Controller displays internal malfunction message at power up.	• Controller defective • Sensor input over driven	• Replace or repair controller
[h.Er] Heater Error	Heater Error	• Current through load is above current trip set point • Current through load is below current trip set point	• Check that the load current is proper. Correct cause of overcurrent and/or ensure current trip set point is correct. • Check that the load current is proper. Correct cause of undercurrent and/or ensure current trip set point is correct.
[C.Er] Current Error	Load current incorrect.	• Shorted solid-state or mechanical relay • Open solid-state or mechanical relay • Current transformer load wire associated to wrong output • Defective current transformer or controller • Noisy electrical lines	• Replace relay • Replace relay • Route load wire through current transformer from correct output, and go to the [C.S.i] Source Output Instance parameter (Setup Page, Current Menu) to select the output that is driving the load. • Replace or repair sensor or controller • Route wires appropriately, check for loose connections, add line filters
Menus inaccessible	Unable to access [SEt], [OPEr], [FCtY] or [ProF] menus or particular prompts in Home Page	• Security set to incorrect level • Digital input set to lockout keypad • Custom parameters incorrect	• Check [LoC] settings in Factory Page • Enter appropriate password in [ULoC] setting in Factory Page • Change state of digital input • Change custom parameters in Factory Page
EZ-Key/s don't work	EZ-Key/s does not activate required function	• EZ-Key function incorrect • EZ-Key function instance not incorrect • Keypad malfunction	• Verify EZ-Key function in Setup Menu • Check that the function instance is correct • Replace or repair controller

SECTION 7.0

SAFETY

7.1 INTRODUCTION

The H1000 Thermal Chuck System is labeled with the CE mark. This indicates that it meets all applicable requirements to be marketed in the European Community.

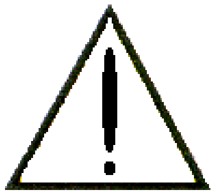
WARNING! Do not attempt to operate the H1000 Thermal Chuck System before reading this manual completely.

The Micromanipulator Co., Inc. appreciates your purchase of H1000 Thermal Chuck System. The thermal chucks were designed with precision temperature control as the goal. Used and maintained properly, your thermal chuck system will provide years of productive analytical probing performance.

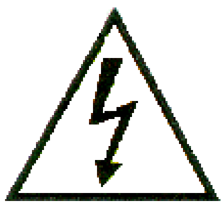
This manual provides you with all the information you will need to install, use and maintain you H1000 Thermal Chuck System. Please read this manual completely to become familiar with your temperature control system. In addition to your temperature control manual the probe station user's manuals serves as an aide to installation for your particular probing environment.

A maintenance section is included in this manual. It identifies steps required to insure specified performance. Be sure to disconnect all power cords before performing lubrication or repairs such as replacement of platen drive belts or illuminator bulb. Service should only be performed by an authorized Micromanipulator technician. Contact the Micromanipulator Co. service department when a problem occurs.

7.2 EXPLANATION OF SYMBOLS



DANGER ALERT symbol indicates the potential for injury or equipment damage. The hazard is described and directions are given to avoid the hazard.



HIGH VOLTAGE symbols indicate the presence of high voltage or current and potential for electrical shock causing injury or death.

HEATED SURFACE symbol indicates the presence of surfaces in excess of 60   C or below 10   C causing injury or burns.

NON-IONIZING RADIATION symbol indicates the presence of ultra-violet radiation causing eye injury when placed too close to source.

HAZARDOUS CHEMICAL symbol indicates burns or irritation may result if substance comes in contact with the skin.

7.3 HAZARD OUTLINE

The Micromanipulator Co. designs all of its temperature control products with safety of the operator, equipment and specimens foremost. Operation of the equipment for its intended purpose does not place the operator or equipment at inherent risk but hazards do exist. This section identifies the location of the possible hazards that are identified with the pictogram symbols as described in section 7.2.

7.3.1 Mechanical Hazards – Pinch Points

The Thermal Chuck System by itself does not present a mechanical hazard but is a component of a wafer testing system. Other components of the wafer test system may present a mechanical hazard. Reference user's manual of the other components of the wafer test system to determine whether mechanical hazards do exist.

7.3.2 Electrical Shock Hazard

The Thermal Chuck System may have as many as two AC line connections depending on the cooling option purchased with the system. The Thermal Chuck System may be integrated into a wafer probing system that has additional line connections. All additional controls should be powered off and power sources disconnected any time a component of the thermal chuck or wafer test system is to maintained or serviced except those detailed in sections **6.1.1** through **6.1.3** requiring power applied. The AC line connections are labeled with the high voltage symbol.

The H1000 temperature controller and cooling unit should be powered off and line cords should be disconnected from AC power and the rear panel when possible before performing maintenance or service.

7.3.3 Heated Surface Hazards

The H1000 thermal chuck system is capable of heating the thermal chuck surface above 60 C. The C1000-V1 or V2-C-0 cooling options can reduce the chuck surface temperature to 0 C. The chuck radiator is labeled caution hot and has the ISO pictogram for heated surface danger. The chuck surface should not be touched to prevent burns and also to prevent oily contamination of the surface. The 8000 series platen wedge is also labeled with ISO heated surface symbol so that when in place the chuck radiator labels may not be visible. The coolant supply and return connection on the rear panels of the test station and chilling units C1000-V1/2-C-0 can reach temperatures below 10 C and the panels near these connections are labeled with the ISO heated surface symbol.

7.3.4 Chemical Hazards

The coolant chemical recommended for use with the C1000-V1/2-HE and the C1000-V1/2-C-0 is a glycol and water mixture. The coolant provided with these products is Sierra antifreeze. Sierra antifreeze is not a hazardous chemical but the MSDS should be referenced for storage, handling and disposal recommendations. It is recommended that gloves be worn when handling any coolant fluids. It is recommended that when replacing fluid the removed fluid be recycled. The MSDS for the Sierra antifreeze is in Appendix E. If other coolants are to be used reference the MSDS for the chemical for handling, storage, ventilation and disposal recommendations.

7.3.5 Non-Ionizing Radiation Hazard

The H1000 thermal chuck system is not a source of non-ionizing radiation. Other components of the wafer test system may present a non-ionizing radiation hazard. Reference user's manual of the other components of the wafer test system to determine whether non-ionizing radiation hazards do exist.

7.4 OVER TEMERATURE PROTECTION & EMERGENCY STOP SWITCH

7.4.1 Standard 200 mm Product Description.

The over temperature protection in the H1000 series Thermal Chuck controllers is accomplished using the primary Thermal Chuck Temperature Controller and more importantly by the implementation of a second controller (a separate temperature controller) operating in the background. This second controller is called the **Safety Temperature Controlle**r. Both controllers are housed in the same chassis.

<u>HEATER ISOLATION RELAYS</u>

The **Heater Isolation Relays** are a set of relays that are placed in series between the power source and the **Thermal Chuck**. These relays are two FORM A type relays. They are rated to handle 16 amps with a breakdown voltage in excess of 1000 VRMS.

The primary temperature controllers monitor the chuck temperature via 3-wire platinum resistance temperature sensing devices (RTD's). The energy is directed to the chuck to maintain desired temperatures in the chuck by a closed loop temperature control that varies the firing of Triacs (for AC controllers) or SCRs (for DC controllers). These controllers are designed to stop firing the Triacs or SCRs as the temperature exceeds the setpoint or a sensor malfunction is determined. This power (AC or DC) is delivered to the chuck via a set of relays inside the chassis. These relays are called the **<u>HEATER ISOLATION RELAYS</u>**. These relays are two FORM A type relays. They are rated to handle 16 amps with a breakdown voltage in excess of 1000 VRMS.

The **Safety Temperature Controlle**r is second and entirely separate temperature controller that monitors the chuck temperature via type "K" thermocouples. The **Safety Temperature Controller** is designed to ensure that a predetermined temperature is not exceeded. Its set point is 25^{o} C above the factory set temperature or set point for the specified **Heat Control Module**. This controller opens the **HEATER ISOLATION RELAYS** as the temperature exceeds this set point or a sensor malfunction is determined.

The two separate control systems preclude a thermal runaway of the chuck as a result of the failure of any single portion of either system to provide over temperature protection.

The 8000 series wafer probe stations are equipped with an emergency stop switch. The H1000 Thermal Chuck System has an interlock that is controlled by the emergency stop switch on the 8000 series probe stations. Activation of the emergency stop switch de-activates the heater isolation relays. Heat and cooling operations should be manually halted by pressing the stop button on the H1000 controller before de-activation of the emergency stop switch.

7.4.2 Standard 300 mm Product

The 300-mm series Thermal Chuck Controllers have a "-12" designation in the product part number. For example, H1000-DC1-V1-12 designates a 300 mm Thermal Chuck Linear DC heat controller.

All over temperature protection in the standard 200 mm product line are included in the "H1000 –12" Series Thermal Chuck controllers. Two additional features are added. Both the Primary and secondary **Safety Temperature Controlle**r actuate the **HEATER ISOLATION RELAYS**, and an additional interlock indication has been added.

7.4.3 Interlock Indication

A yellow light on the Heat Controllers front panel labeled OVERTEMP is energized when any Over temperature or sensor malfunction is determined.
The problem must be corrected and the Heat Controller's power cycled off and back on before any heating operations may be continued.

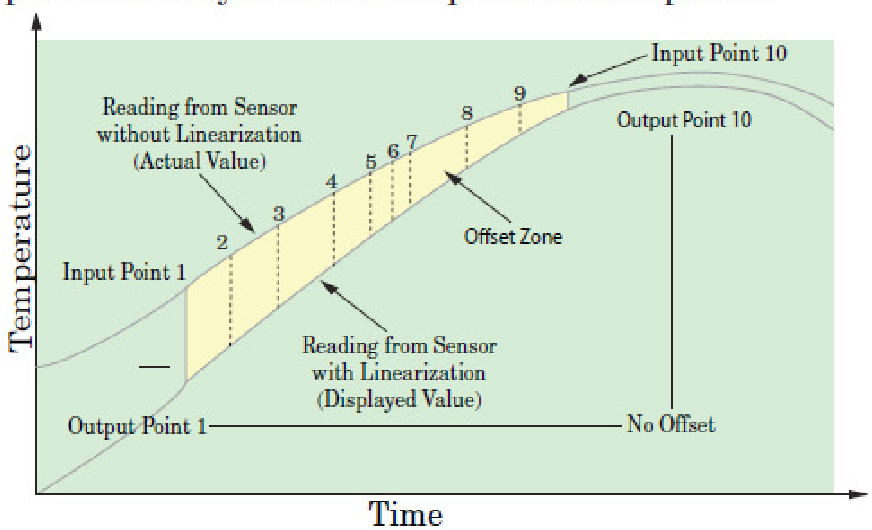
7.5 ERGONOMIC CONSIDERATIONS

The temperature displays on the H1000 Thermal Chuck System should be placed so that surface temperature can be easily read. The temperature controls are of low to medium use and should be placed within arm's reach of 24 to 57 inches for a sit/stand work area. Table integrated or 19" rack mounted systems the placement of the thermal chuck temperature controller should fall within that envelope. Automatic control is recommended for high use applications contact The Micromanipulator Company sales department for details on pcTC software for automated control of your thermal chuck system.

Ten Point Linearization

The linearization function allows a user to re-linearize a value read from an analog input. There are 10 data points used to compensate for differences between the sensor value read (input point) and the desired value (output point). Multiple data points enable compensation for non-linear differences between the sensor readings and target process values over the thermal or process system operating range. Sensor reading differences can be caused by sensor placement, tolerances, an inaccurate sensor or lead resistance.

The user specifies the unit of measurement and then each data point by entering an input point value and a corresponding output point value. Each data point must be incrementally higher than the previous point. The linerization function will interpolate data points linearly in between specified data points.



The Linearization Function is Accessed from the Operations Menu.

Important! If Linearization is used, the first input temperature must be equal to or lower than the lowest operating temperature of the system and the last input temperature entered must be equal to or higher than the highest operating temperature of the system. Temperatures below or above these two "end" points will not be displayed by the system and control below or above them will be unpredictable. Standard systems are shipped with the first 5 linearization entries populated.

5

Chapter 5: Operations Page

Navigating the Operations Page

To go to the Operations Page from the Home Page, press both the Up and Down keys for three seconds. [Ai] will appear in the upper display and [oPEr] will appear in the lower display.

- Press the Up or Down key to view available menus. On the following pages top level menus are identified with a yellow background color.
- Press the Advance Key to enter the menu of choice.
- If a submenu exists (more than one instance), press the Up or Down key to select and then press the Advance Key to enter.
- Press the Up or Down key to move through available menu prompts.
- Press the Infinity Key to move backwards through the levels: parameter to submenu; submenu to menu; menu to Home Page.
- Press and hold the Infinity Key for two seconds to return to the Home Page.

Note:
Some of these menus and parameters may not appear, depending on the controller's options. See model number information in the Appendix for more information. If there is only one instance of a menu, no submenus will appear.

Note:
Some of the listed parameters may not be visible. Parameter visibility is dependent upon controller part number.

[Ai]
[oPEr] Analog Input Menu
- [1] to [2]
- [Ai] Analog Input
  - [Ain] Process Value
  - [iEr] Error Status
  - [iCA] Calibration Offset

[Lnr]*
[oPEr] Linearization Menu
- [1] to [2]
- [Lnr] Linearization
  - [SuA] Source Value A
  - [oFSt] Offset
  - [ou] Output Value

[Pu]*
[oPEr] Process Value Menu
- [1] to [2]
- [Pu] Process Value
  - [SuA] Source Value A
  - [Sub] Source Value B
  - [oFSt] Offset
  - [ou] Output Value

[dio]
[oPEr] Digital Input/Output Menu
- [5] to [12]
- [dio] Digital Input/Output
  - [doS] Output State
  - [EiS] Event State
  - [diS] Input State

[LiM]
[oPEr] Limit Menu
- [LLS] Low Set Point
- [LhS] High Set Point

[Mon]
[oPEr] Monitor Menu
- [1] to [2]
- [Mon]
  - [CMA] Control Mode Active
  - [hPr] Heat Power
  - [CPr] Cool Power
  - [CSP] Closed Loop Working Set Point
  - [PuA] Process Value Active
  - [hEr] Heater Error

[LooP]
[oPEr] Control Loop Menu
- [1] to [2]
- [LooP] Loop
  - [rEn] Remote Enable
  - [CM] Control Mode
  - [AtSP] Autotune Set Point
  - [AUt] Autotune Request
  - [CSP] Closed Loop Set Point
  - [idS] Idle Set Point
  - [hPb] Heat Proportional Band
  - [hhY] Heat Hysteresis
  - [CPb] Cool Proportional Band
  - [ChY] Cool Hysteresis
  - [ti] Time Integral
  - [td] Time Derivative
  - [db] Dead Band
  - [oSP] Open Loop Set Point

[ALM]
[oPEr] Alarm Menu
- [1] to [4]
- [ALM] Alarm
  - [ALo] Low Set Point
  - [Ahi] High Set Point

[CUrr]
[oPEr] Current Menu
- [Chi] High Set Point
- [CLo] Low Set Point
- [CUr] Read
- [CEr] Error

[MAt]*
[oPEr] Math Menu
- [oFSt] Offset
- [ou] Output Value

[SoF]*
[oPEr] Special Output Function
- [ou1] Output Value

[PStA]
[oPEr] Profile Status Menu
- [PStr] Profile Start
- [PACr] Action Request
- [StP] Active Step
- [StyP] Active Step Type
- [tSP1] Target Set Point Loop 1
- [tSP2] Target Set Point Loop 2
- [PtSP] Produced Set Point 1
- [PSP2] Produced Set Point 2
- [hour] Hours Remaining
- [Min] Minutes Remaining
- [SEC] Seconds Remaining
- [Ent1] Active Event Output 1
- [Ent2] Active Event Output 2
- [JC] Jump Count Remaining

* Available with PM4,8 and 9 only with 9th digit of part number equal to "C" or "J" AND with 12th digit equal to "C".
PM[4,8,9] _ _ _ _ _ - _ [C, J] _ _ [C] _ _

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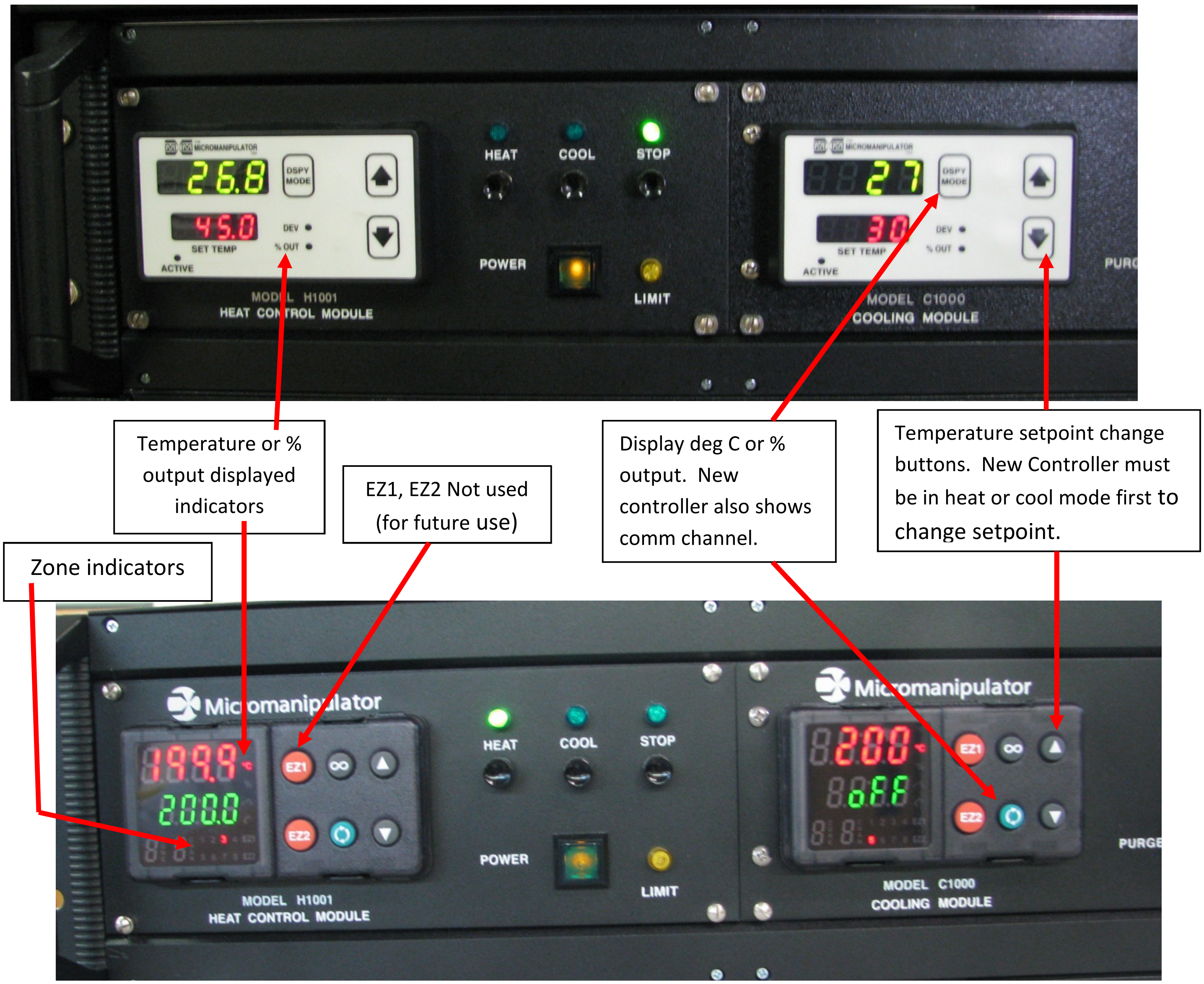
Control Correlation: H1000 / C1000 Old to New Controllers

H1000- Old Control Panel



H1000- New Control Panel

Additional Notes:

1. With NEW controller the Heat or Cool button must be pressed before the temperature setpoint change buttons become active.
2. Zone indicators: 1= Control is active (on); 2= Over temp (heat) or over cross-over point (cool); 3: Controller output active; 5= Controller off.

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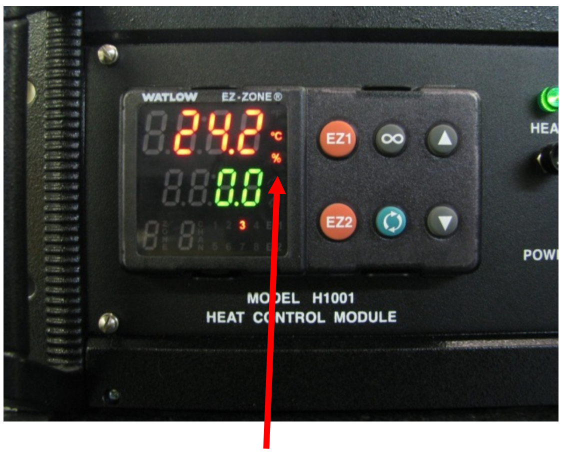
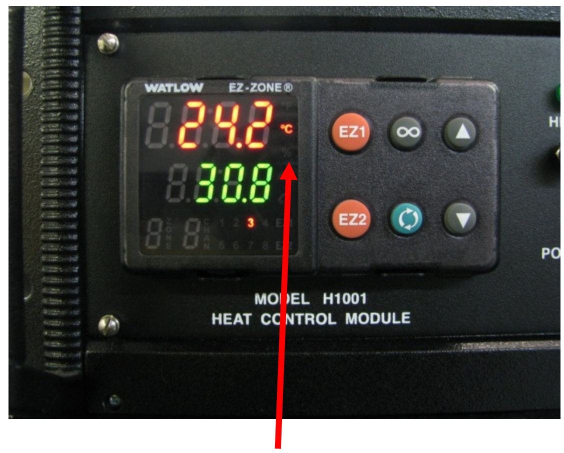
H1000 Watlow Controller Changing from Manual mode to Auto Mode

If the controller has been placed into Manual mode instead of auto mode, the top display will show temperature and the bottom display will show % power. The controller will apply that percent power until the user presses stop. Note, the % power appears like a temperature set point; however, it cannot be set above 100.



Controller in Manual Mode. Note % indicator



Controller in Auto Mode. Note Deg C indicator

To change back to Auto mode, proceed as follows: Note: The controller "heat" button must be pressed to activate the control panel.

Press the "Advance" button to move the controller to the mode screen

This image shows the "manual" mode

"Advance" button

Press the “down” button to move the controller to the next mode screen

This image shows the “auto” mode. This is where the controller should be set

“Down” button

Press the “Advance” button 4 times to move the controller through the following screens ending at the correct temperature and set point display.

This is the correct temperature and set point display. The system will operate normally in auto mode now

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