Allwin21 Corporation

AccuThermo
AW410 / AW610
Rapid Thermal Process System

Technical Manual

ALLWIN21
ACCUTHERMO
AW410 / AW610

RAPID THERMAL PROCESS SYSTEM

TECHNICAL MANUAL

Allwin21 Corporation

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PREFACE

INTENDED AUDIENCE

This manual has been written for technicians and process development engineers working with the AccuThermo® AW410 or the AccuThermo® AW610 Rapid Thermal Processing (RTP) System. It provides an overview of the system operation and maintenance procedures, as well as a troubleshooting guide. Please read this manual carefully before operating the AccuThermo® RTP System.

DOCUMENT CONVENTIONS

FONT CONVENTIONS

The following font conventions are used in this manual.

Bold
> Software screen selections are represented in **bold** type.

Italic
> Screen names are shown in *italic* type.

First Letter Capitalized
> Operating modes are shown in normal type with the first letter capitalized.

For example:
> "Select **Recipe** from the *Main Menu* screen to enter the Recipe Programming mode."

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1.   INTRODUCTION

1.1   SYSTEM DESCRIPTION

The AccuThermo AW410 and the AccuThermo AW610 are rapid thermal processing (RTP) systems, which uses high intensity visible radiation to heat single wafers for short process periods of time at precisely controlled temperatures. The process periods are typically 1-600 seconds in duration, although periods of up to 9999 seconds can be selected.

☞ NOTE

Process periods longer than 600 seconds in duration are normally used only for maintenance testing purposes at low lamp intensity settings.

These capabilities, combined with the heating chamber's cold-wall design and superior heating uniformity, provide significant advantages over conventional furnace processing.

Figure 1-1:   *AccuThermo AW410 / AW610*

The AccuThermo RTP system consists of an oven unit and a controller computer running the Allwin21 AW-900 controller software. The wafer to be processed is placed on a quartz tray that slides into a quartz isolation tube in the oven unit. Two banks of lamps, one above the quartz tube and one below it, provide the source of energy for heating the wafer. The lamps can be controlled manually and automatically from the controller computer.

The AW-900 control software allows full control and diagnostics of the AccuThermo RTP system. In addition, it allows the creation of recipes for automated control of the temperature and, optionally, process gas flow.

The control software uses a set of operating instructions known as recipes to automatically control the AccuThermo RTP system. These recipes are created by the Process Engineer to monitor and control the parameters of the processing cycle. The Operator then uses the software to select and run the process parameters (steady state temperature, process time, ramp rates, etc.).

The AW-900 software is also used to create, delete, copy, modify and store the recipes and to execute system diagnostics.

1.2   FEATURES

KEY FEATURES

➢ Closed-loop temperature control with pyrometer or thermocouple temperature sensing.

➢ Precise time-temperature profiles tailored to suit specific process requirements.

➢ Fast heating and cooling rates unobtainable in conventional technologies.

➢ Consistent wafer-to-wafer process cycle repeatability.

➢ Elimination of external contamination.

➢ Small footprint and energy efficiency.

➢ The watchdog timer shuts down the lamps to prevent run-away heating of the wafer.

APPLICATIONS

The AccuThermo RTP system is a versatile tool that is useful for many applications:

➢ Ion Implant Activation

➢ Polysilicon Annealing

➢ Oxide Reflow

➢ Silicide Formation

➢ Contact Alloying

➢ Oxidation and Nitridation

➢ GaAs Processing

HEATING, COOLING, AND TEMPERATURE MEASUREMENT

The following list contains the key features of the AccuThermo RTP system heating, cooling and temperature measurement systems:

➢ High-intensity visible radiation heats wafers for short periods of 1 to 9999 seconds at precisely controlled temperatures in the 400°C to 1200°C range. (1 to 600 second heating periods are used typically.)

➢ Tungsten halogen lamps and cold heating chamber walls respectively allow fast wafer heating and cooling rates.

➢ The system delivers time and temperature profiles tailored to suit specific process requirements.

➢ Pyrometer or thermocouple sensing offers precise closed-loop temperature control.

➢ Cooling N2 flows around the lamps and quartz isolation tube

➢ MFC controlled gases (up to four) flow through the heating chamber for purge and/or process purposes.

1.3   SYSTEM SPECIFICATIONS

Following are the specifications for the AccuThermo Rapid Thermal Processor (RTP) system.

➢ **Wafer handling:** Manual loading of wafer into the oven, single wafer processing.

➢ **Wafer sizes:** 2", 3", 4", 5" and 6" wafers.

➢ **Ramp up rate:** Programmable, 10°C to 200°C per second.

➢ **Recommended steady state duration:** 0-300 seconds per step.

➢ **Ramp down rate:** Programmable, 10˚C to 250 C per second. Ramp down rate is temperature-and-radiation-dependent and the maximum is 125 C per second.

➢ **Recommended steady state temperature range:** 150°C - 1150 C

➢ **ERP temperature accuracy:** ±1°C, when calibrated against an instrumented thermocouple wafer (ITC).

➢ **Thermocouple temperature accuracy:** ±0.5°C

➢ **Temperature repeatability:** ±0.5°C or better at 1150°C wafer-to-wafer. (Repetition specifications are based on a 100-wafer set.)

➢ **Temperature uniformity:** +5°C across a 6" (150 mm) wafer at 1150°C. (This is a one sigma deviation 100 angstrom oxide.) For a titanium silicide process, no more than 4% increase in non-uniformity during the first anneal at 650°C to 700°C.

➢ **Process/Purge gas inputs:** Any inert and/or non-toxic gas regulated to 30 PSIG and pre-filtered to 1 micron. Typically, Nitrogen (N2), oxygen (O2), argon (Ar), and/or helium (He) are used.+2.5°C

2. SAFETY PRECAUTIONS

2.1   OVERVIEW

This section provides information intended to prevent damage to the AccuThermo RTP system and injury to operation and maintenance personnel. All hazards are not covered, only those most prevalent and serious. Your full understanding of the capabilities and limitations of this equipment is necessary for safe and efficient operation.

☠ WARNING

Only ALLWIN21 or qualified personnel should install, start up, operate and/or repair the AccuThermo RTP system. Damage to the system or injury to personnel could result if the preceding actions are carried out by unqualified personnel.

Prior to applying power or starting up the AccuThermo RTP system, follow these safety precautions:

➢ Check all utilities for proper connections. Connect only those gases specified for use in the system.

➢ Make sure the cabinet cover is on.

➢ Check the scrubber exhaust to make sure it is properly connected to the facility scrubber. Ensure the facility scrubber is operating properly. Check the purge gas outlet for any restrictions.

2.2   NOTES, CAUTIONS AND WARNINGS

When operating and maintaining the AccuThermo RTP system, the following safety procedures and precautions must be followed to avoid certain hazards. Observe all warnings and cautions. Their purpose is to protect personnel from injury and long term health hazards and to protect the machine from damage.

Pay special attention to notes, cautions and warnings located in appropriate areas in this manual.

☞ **NOTE**

Notes provide additional important information which requires special attention.

☞ **CAUTION**

Cautions alert you to avoid system damage.

☠ **WARNING**

Warnings are given for personnel safety to prevent bodily harm.

2.3   SAFETY FEATURES

➢ There is a watchdog timer on the AccuThermo RTP system control board that will shut off the lamps if the software or computer freezes.

➢ Chamber Door Interlock Switch: This interlock detects if the chamber door is closed. If the chamber door is not closed, then the heating source will not come on. This cannot be bypassed.

➢ Cabinet Cover Interlock Switch: This interlock detects if the cabinet cover has been removed. If the cabinet cover has been removed, then the heating source is turned off by disengaging the power contactor. This can be bypassed by a maintenance person by pulling up on the switch into the maintenance position. As soon as the cabinet cover is replaced, the cabinet cover interlock switch is automatically reset to detect the removal of the cabinet cover.

➢ EMO (Emergency Off): When the EMO is depressed, the power to the lamp contactor is turned off. This turns off the heating source.

➢ Overheat Thermal Switch: If the oven overheats (>155°F), there is a thermal switch that opens and the heating source is turned off by disengaging the power contactor. Once the chamber has cooled below 135°F, the thermal switch can be reset by pressing on the thermal switch reset button.

➢ Water Flow Switch: The water needs to flow at least 2 gpm. If the flow rate drops below this, the heating source is turned off by disabling the lamp control circuit. However, if the oven plates are below 74°F, the water may not need to flow. This is to prevent condensation on the oven in an un-air-conditioned facility. If the oven plates are less than 45°F, the water valve is closed, preventing the oven from being cooled more. If this happens, the chiller control temperature has been set too low.

➢ Electrical: The main circuit breaker on the rear panel of the chassis (on 3-phase units only) removes all electrical power from the machine. There are no storage devices (e.g. capacitors) within the machine.

➢ Pneumatic: The pneumatics is used to operate the Positive Shut-off valves. If there is no air pressure, these valves will close. If the power is removed from the AccuThermo RTP system, then the pneumatic gas valves close automatically.

2.4   GAS HANDLING

Be aware of the following cautions when working with gases in the AccuThermo RTP system:

➢ Only use gases that have been specified for use in the AccuThermo RTP system. Typically these include nitrogen (N_2), argon (Ar), Forming Gas, oxygen (O_2) and helium (He).

⚡ CAUTION

Allwin21 Corp. is not liable for the use of gases not recommended by the factory.

➢ Make sure the specified gases are connected to the proper inlets on the rear panel.

☠ WARNING

Failure to properly connect the gas lines may result in dangerous gas mixture that could cause harm to personnel and/or the system.

☠ WARNING

There will be no chemical exposures during normal routine maintenance. However, if the need arises that a gas valve has to be changed, then it is the maintenance person's responsibility to follow all safety procedures for gas exposure.

2.5   <u>HAZARDS</u>

The AccuThermo RTP system presents certain hazards if operated or maintained improperly. These fall into the following categories:

➢ Electrical shock hazards

➢ Process gas hazards

➢ Process byproduct hazards

➢ Oxygen hazards

➢ Thermal hazards.

2.5.1   ELECTRICAL SHOCK HAZARDS

The AccuThermo RTP system requires electrical power which is distributed through the machine. Safety interlocks are installed to shut off electrical power to the system when the cover is removed. Only qualified troubleshooting maintenance technicians should be permitted to work on an uncovered AccuThermo RTP system. Allwin21 assumes no liability for injuries or deaths caused by operation with interlocking devices defeated. Caution and safety measures characteristically taken with AC and DC circuitry are imperative.

2.5.2   PROCESS GAS HAZARDS

An AccuThermo RTP system process may use these two complex process gases: 02 or forming gas (5% to 15% H2 in N2 or Ar), depending on user application. 02 is an oxidant and it supports combustion. It must be handled with care. Forming gas is non-toxic and odorless. It is flammable and never should be stored at 125°F or greater. Inhalation of forming gas should be avoided.

Make sure the forming gas mixture is correct.

2.5.3   **PROCESS BYPRODUCT HAZARDS**

The process byproducts found in the chamber surfaces of the AccuThermo RTP system should be treated as potentially hazardous.

> ## ☠ WARNING
>
> **Avoid skin, eye, and respiratory contact with process byproducts. Some byproduct chemistries have hazardous characteristics. Failure to avoid skin, eye, and respiratory contact with process byproducts may result in injury or death of personnel.**

Due to the variations in chemistry employed to meet application requirements, the exact constituents of effluents from the process family cannot be defined. However, the following general precautions should be observed:

➢ Solvent-proof neoprene or viton gloves should be worn while maintaining the chamber surfaces and its accessories.

Allwin21 Corp. claims no responsibility for the safety of the byproducts of the AccuThermo Rapid Thermal Processor system.

2.5.4   **OXYGEN HAZARDS**

In RTP systems, oxygen (O_2) may be utilized as a process gas, either alone or in conjunction with other gases. A possible EXPLOSIVE condition exists.

Oxygen is an oxidizing agent which accelerates combustion. Contact with flammable materials may cause fire or explosion. Any time there is heat, and if the concentration of oxygen is greater the 21% of the volume, the condition for an explosion exists. It should be noted this potential condition exists anytime oxygen is connected to the system.

Use appropriate procedures when processing with oxygen.

2.5.5   THERMAL HAZARDS

The quartz tray and isolation tube must be allowed to cool down before they are serviced. Allow 20 to 30 minutes for the quartzware to cool before touching. Burns may result if the quartzware is touched before the cooling time elapses.

In addition, use of solvents, such as IPA (isopropyl alcohol) or acetone to clean the chamber, may pose a hazard if used while the quartzware is still hot.

☞ NOTE

The control system contains three safety shutoffs. The first is a watchdog timer that turns OFF the heating lamps if the control software has been interrupted for more than approximately 2 seconds.

The second shutoff shuts down the heating lamps and the MFC's if the measured temperature is above 1250°C. These high readings indicate that the thermocouple is broken or, disconnected from the Controller board, in which case the interface reads something greater than 1250°C.

The third safety shutoff shuts down the heating lamps if the outer chamber walls exceed 65°C. This would only happen if there was no water flow.

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3. INSTALLATION

3.1 INSTALLATION PROCESS OVERVIEW

3.1.1 INSTALLATION PROCEDURES

This manual describes how to install the AllWin21 AccuThermo RTP system and perform an operational check of the system. These activities are outlined in the following sequence of steps.

- ☐ Prepare the site utility connections (refer to Section 3).

- ☐ Unpack the AccuThermo RTP oven, computer, pyrometer chiller and any additional parts (refer to Section 2).

- ☐ Inspect the system for damage or missing parts (refer to Section 2).

- ☐ Connect the utilities to the AccuThermo RTP system and chiller (refer to Section 4).

- ☐ Inspect and install the quartzware (refer to the Maintenance Manual for installing the quartzware for the AccuThermo RTP system).

- ☐ Install and connect the computer to the AccuThermo RTP system (refer to Section 6).

- ☐ Power-up the system (refer to Section 6).

- ☐ Configure the computer and set system constants (refer to Section 6).

- ☐ Confirm proper operation (refer to Section 6).

- ☐ Check for temperature accuracy (refer to Section 6).

- ☐ System troubleshooting (refer to the Maintenance Manual for troubleshooting the AccuThermo RTP system).

3.1.2   REQUIRED TOOLS

You need the following tools to install your AccuThermo RTP system:

➢ Allen wrench set (SAE or non-metric)

➢ Screwdriver set

➢ Open-end wrenches (SAE or non-metric)

➢ Latex gloves

➢ Test wafers

➢ K-Type TC that matches the process wafer configuration

3.2 UNPACKING AND INSPECTING THE SYSTEM

3.2.1 UNPACKING THE SYSTEM

The AllWin21 AccuThermo RTP system is shipped in one crate: a heating chamber (oven), GUI computer, PC monitor, accessories and a chiller (optional).

To open this package, follow the steps below:

Step 1. Remove the clamps that hold down the top of the crate.

Step 2. Remove the packing material.

Step 3. Lift out the Oven Unit.

☠ WARNING

Oven Unit weighs over 90 lbs. (41 kg).

Use proper handling precautions.

Step 4. Carefully unpack the chiller and accessories.

Step 5. Carefully unpack the GUI computer and monitor.

☞ NOTE

Do not discard shipping crate. You may wish to use them later if the system must be returned to AllWin21 for repair.

Use care when unpacking accessories and spares and check that none of the parts are damaged.

3.2.2   **SYSTEM INSPECTION**

Visually inspect the unit for dents, scratches or other visible signs of shipping damage. If you notice any shipping damage, notify the carrier immediately.

Compare the contents of the accessories box with the AllWin21 packing list to make sure all items have been shipped. Handle the quartzware with care. If any parts are missing or broken, notify AllWin21 immediately. The appendix in this manual lists procedures and phone numbers to obtain replacement parts.

☞ NOTE

The quartz isolation tube is shipped inside the oven. Open the oven door and verify that the isolation tube was not damaged during shipment.

3.3   <u>INSTALLATION SITE REQUIREMENTS</u>

3.3.1   SYSTEM DIMENSIONS

The dimensions of the AllWin21 AccuThermo RTP oven, including the extension cabinet containing the optional mass flow controllers, are 10.5" H x 26" W x 17" D.

In addition, space must be made available on the work surface next to the oven for a mid-size personal computer (PC), computer monitor, keyboard, and mouse. Note that the PC, used as the GUI and system controller, must be located within 5 feet of the AccuThermo RTP oven.

Space may also be required, on the floor near the oven, for an external pyrometer chiller unit. The AccuThermo RTP system, when configured with the optional Extended Range Pyrometer (ERP), must be equipped with a Neslab RTE-7 or equivalent chiller. The dimensions of the RTE-7 pyrometer chiller are 24" H x 9.25" W x 19" D.

Finally, while oven-cooling water can be provided to the AccuThermo RTP oven from the facility supply, AllWin21 recommends use of an oven heat exchanger. Typically, a Neslab Coolflow II heat exchanger or equivalent capacity unit is installed near the oven. If this option is selected, sufficient additional space near the AccuThermo RTP oven will also be required. The dimensions of the Neslab Coolflow II heat exchanger are 29.5" H x 16" W x 25.75" D

3.3.2   ELECTRICAL CONNECTIONS

Power requirements vary between the United States, Japan and Europe. Specifications for each are shown in Table 3-1.

Specification	Equipment	Voltage	Frequency	Current	Phases	# Wires	Notes
USA	Oven	208/240	60 Hz	90 A.	1	3	1, 2, 3, 4
	Chiller	110-120	60 Hz	11 A.	1	3	
	Computer	110-120	60 Hz	Variable	1	3	5
Japan	Oven	200	50/60 Hz	90A.	1	3	1, 2, 3, 4
	Chiller	100	50/60 Hz	11 A.	1	3	
	Computer	100	50/60 Hz	Variable	1	3	5
Europe	Oven	220/240	50 Hz	90 A.	1	3	1, 2, 3, 4
	Chiller	220-240	50 Hz	5.5 A.	1	3	
	Computer	220-240	50 Hz	Variable	1	3	5

Note 1: Use an isolation transformer to reduce interference to other equipment.
Note 2: Locate oven within 25 feet line length of isolation transformer.
Note 3: Locate power-disconnect switch within reach of the system.
Note 4: 2 supply wires and 1 ground wire
Note 5: Computer current will be dependent upon the computer manufacturer.

Table 3-1   *AccuThermo RTP System Power Distribution Requirements*

3.3.3　COOLING, PROCESS GAS AND EXHAUST REQUIREMENTS

Oven cooling water, process gas, tube cooling gas, and exhaust requirements are described below:

Oven Cooling Water	type	pre-filtered with conventional particulate filter to 100 microns **(No DI or Distilled Water)**	
	flow rate	2 gpm (7.5 lpm)	minimum
	inlet pressure	30 psig (2.11 kg/cm^2)	minimum
		40 psig (2.81 kg/cm^2)	typical
		60 psig (4.22 kg/cm^2)	maximum
	pressure differential	30 – 50 psi (2.1 – 3.5 kg/cm^2)	
	inlet temperature	15 °C	minimum
		20 °C (3 °C above dew point)	typical
		35 °C	maximum
	oven fitting, inlet and outlet	1/2" tube x 3/8" male pipe Swagelok	

Pyrometer Cooling Water	type	tap water **(No DI or Distilled Water)**
	inlet temperature	20 °C (3 °C above dew point)
	pyrometer fittings, inlet and outlet	1/4" Swagelok

Quartz Isolation Tube Cooling Air	type	Nitrogen (N$_2$) or Clean-Dry-Air (CDA) oil-and-water-free, filtered to 3 microns	
	flow rate	10-15 scfm (283-425 slpm)	minimum
	inlet pressure	20 psig (140 kPa)	typical
	fitting	3/8" Parker Push-Lok 3/8" OD nylon tubing	

Table 3-2　*AccuThermo RTP System Cooling Requirements*

Air Conditioning	
Temperature	20°C to 30°C
Humidity	non-condensing

Process Gases	type	Any inert and/or non-corrosive gas. Typically, Nitrogen (N2), oxygen (O2), argon (Ar), and/or helium (He) are used.	
	pressure	15 psig (1.1 kg/cm^2)	minimum
		20 psig (1.4 kg/cm^2)	typical
		30 psig (2.1 kg/cm^2)	maximum
	flow rate	0-10 SLPM	
	filtering	pre-filtered to 1 micron	
	fitting	1/4" female VCR fitting or 1/4" tube Swagelok	

Process Gas Exhaust	exhaust back pressure (scrubber draw)	0.5" water (0.9 mmHg)	minimum
		0.75" water (1.4 mmHg)	typical
		1.0" water (1.9 mmHg)	maximum
	fitting	1/4" male VCR fitting out to building scrubber system	

Table 3-3 *AccuThermo RTP System Process Gas Requirements*

Oven Chassis Exhaust	flow rate	20 scfm (566 slpm)	
	fitting	4" exhaust vent connected to house exhaust system	

Gas Box Exhaust	flow rate	20 scfm (566 slpm)
	fitting	4" exhaust vent connected to house exhaust system

Table 3-4 *AccuThermo RTP System Exhaust Requirements*

Compressed Pneumatic Actuation Gas Valve	type	Clean Dry Air (CDA) or Nitrogen (N2) oil-and-water-free
	Inlet Pressure	80 psig (550 kPa) $\pm$ 5 psig (35 kPa)
	flow rate	Less Than 1 SCFM Typical
	fitting	1/4" tube Swagelok

Table 3-5 *AccuThermo RTP System Pneumatics Requirements(optional)*

3.4   UTILITY CONNECTION RECOMMENDATIONS

3.4.1   OVERVIEW

The notes in this Section are designed to help the facilities engineer connect the AccuThermo RTP system plumbing and other utilities in a practical and functional manner. This section also emphasizes certain practices and requirements that are considered especially important for system operation and serviceability.

All utilities are connected at the rear utility panel of your system. Refer to Figure 3-1, below.
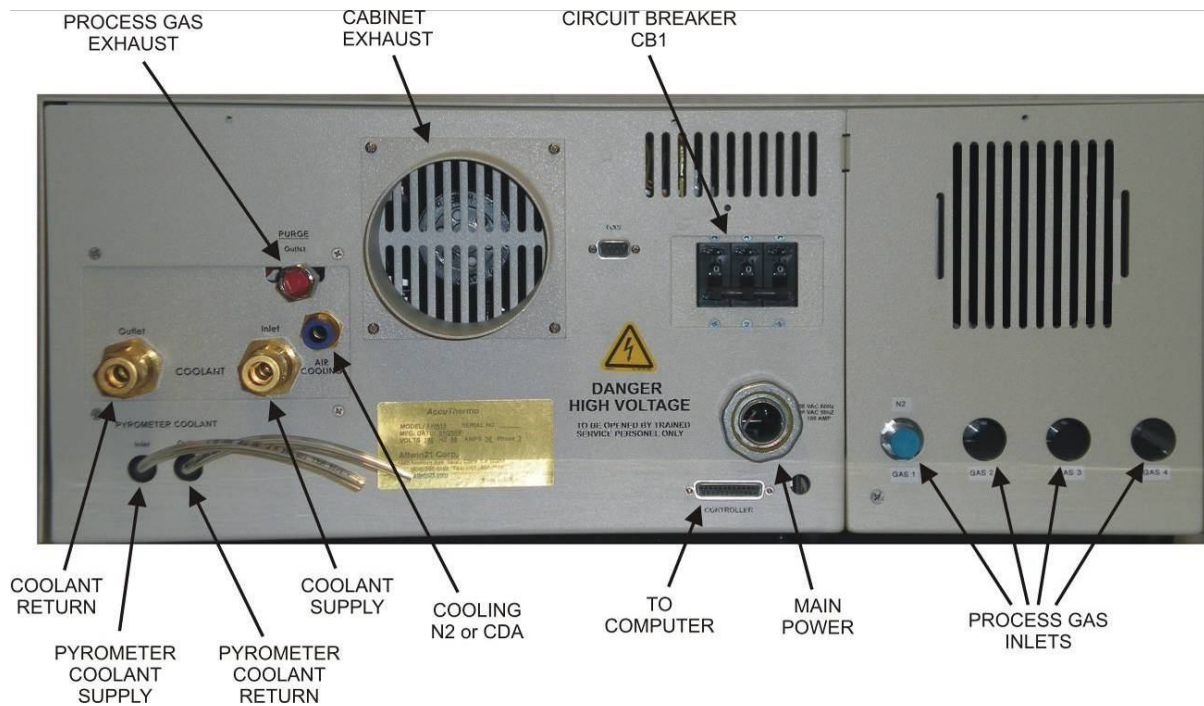
Figure 3-1: *AccuThermo RTP System Rear Utility Panel Connections*

3.4.2   OVEN COOLING WATER PLUMBING

During wafer processing, cooling water flows through the AccuThermo oven walls to remove excess heat. Adequate operation of the cooling water system is extremely important for proper system operation. At least 2 gpm of water should be flowing through the system during, and immediately after, wafer heating. A flow switch, located near the cooling water outlet, disables the lamps if the water flow falls below 1.5 gpm.

A solenoid allows water to flow through the heating chamber walls at the beginning of the first heating cycle. Water continues to flow for 4.5 minutes after the last cycle has been completed. The AccuThermo system switches the water flow off and on as needed to prevent heating chamber overcooling and to save water.

A flow meter is required on the AccuThermo water supply line so that you can visually inspect the flow rate on a periodic basis. Pressure gauges installed on the system water inlet and outlet lines are very useful during system troubleshooting. (See Figure 3-2.)

To reduce particles in the water passages, use a 100 micron filter on the inlet line. In addition, a filter inspection should be part of the periodic maintenance routine. A compressed air fitting connected to the system water inlet line (See Figure 3-2.) will allow service procedures to be easily carried out which require purging cooling water from the AccuThermo system. For facilities with particular water problems (e.g. low water pressure, hard water or dirty water), a closed-loop water cooling system is advisable.
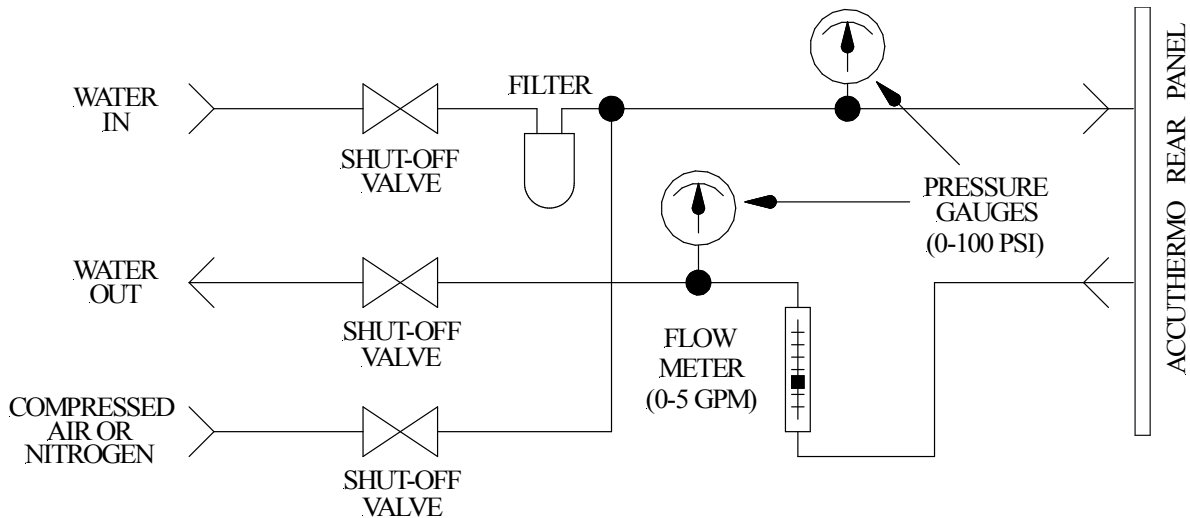
Figure 3-2:   *Optimal Cooling Water Supply Configuration*

3.4.3   QUARTZ ISOLATION TUBE COOLING SUPPLY

Figure 3-3 shows the recommended configuration for the supply of nitrogen (N2) or compressed air (CDA), used for cooling the quartz isolation tube . The configuration illustrated below simplifies maintenance and troubleshooting activities. The nitrogen shutoff valve should be conveniently located so that the nitrogen can be turned off when the system is not in use.

☞ NOTE

The isolation tube cooling system is designed to operate with nitrogen. It is also acceptable to use compressed air, as illustrated in Figure 3-3.

The *tube cooling system* is one of the most important subsystems in the AccuThermo RTP System. During the heat cycle, cooling nitrogen or air flows around the exterior of the quartz isolation tube and through the heating chamber, to maintain a consistent quartz temperature range. Adequate nitrogen or compressed air flow is critical to the proper operation of the system. A flow of 7.5 scfm to 15.0 scfm is essential to ensure reliable and repeatable temperature measurement. To calculate the actual flow rate, use the following formula:

$$F=R\sqrt{1+[(P/14.7)]}$$

where F is the actual flow rate, R is the flowmeter indicated flow rate, and P is the pressure gauge reading (in psig).
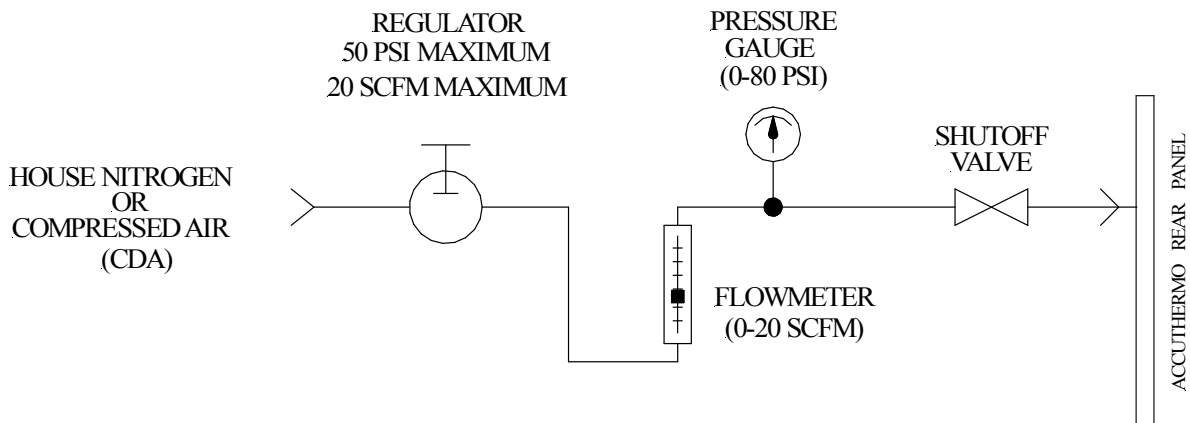
Figure 3-3:   *Recommended Non-Process Nitrogen Supply/CDA Configuration*

3.4.4   PROCESS GAS SUPPLY

The AccuThermo RTP system can use one to four inert or non-toxic gases as inputs. Each of these gas inputs is connected to a separate MFC . The supply lines for the process gases are connected to 1/4" male VCR fittings on the right rear of the AccuThermo RTP oven. It is recommended that the tubing used for the process gas supply line be 316L stainless steel. This tubing is not supplied with the system.

☞ **NOTE**

To minimize wafer contamination, all process gas supply tubing should be made of electro polished stainless steel.

Process gas supply input pressures should be 30 psig. Individual flow rates are controlled by MFC's. A rotometer on the front of the AccuThermo controls cumulative gas flow. Figure 3-4 shows the recommended configuration for the process gas supply system.

The process gas exhaust outlet, located on the rear of the AccuThermo, should be connected to the facility scrubber. The outlet is a 1/4" female VCR fitting.

☞ **CAUTION**

Do not block the process gas outlet. This will cause pressure to build up inside the quartz isolation tube and it __will__ break.
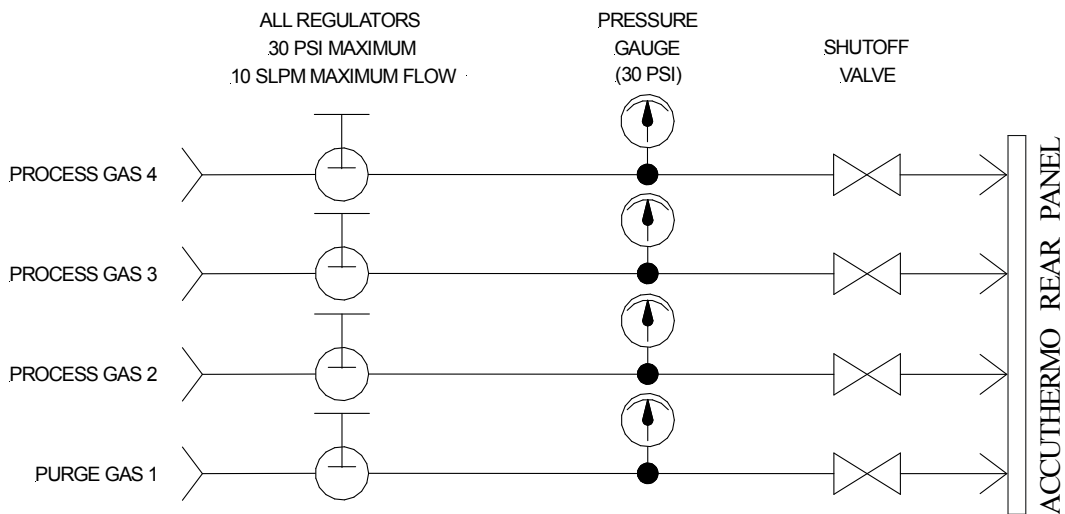
Figure 3-4:   *Optimal Process Gas Supply Configuration*

☞ **NOTE**

There are no pressurized vessels in this unit. However, the end-user needs to provide connection to such vessels in a safe manor that is compliance with local and industrial regulations. It is the end-user's responsibility to meet these requirements.

☞ **NOTE**

The Gas Box is inside the main cabinet. It has its own exhaust port. There is no fan in the gas box to force air through. The cabinet exhaust port is only intended to exhaust the hot cooling air from the chamber lamps. The cabinet exhaust port has a fan to make sure there is no build-up of hot air inside the cabinet. The cabinet exhaust should not be relied upon to exhaust HPM gases. Also, there is a partition between the chamber section and the gas box which will greatly inhibit good exhaust of HPM gases in the left side of cabinet.

3.4.5   **EXHAUST PLUMBING**

There are two exhaust outlets on the AccuThermo RTP system that may need to be connected to your facility exhaust system. See Figure 3-1.

➢ A process gas outlet, to carry spent process gases out of the heating chamber, should be connected to your facility exhaust system if there are hazardous materials present in the exhaust from the wafer process.

➢ An oven exhaust outlet, to carry nitrogen or CDA used to cool the heating chamber, should be connected to your facility exhaust system. The facility exhaust system should draw approximately 20 cfm of exhaust air from the AccuThermo cabinet.

The purge gas outlet on the rear panel of the oven cabinet carries spent process gases. Even though only inert or non-toxic gases are recommended for connection to the AccuThermo RTP system gas system inlets, depending on the type of wafers being processed, the exhaust may be toxic and hazardous. If this is the case, then the purge outlet must be connected to a *facility scrubber*. Figure 3-5 shows the recommended exhaust configuration.
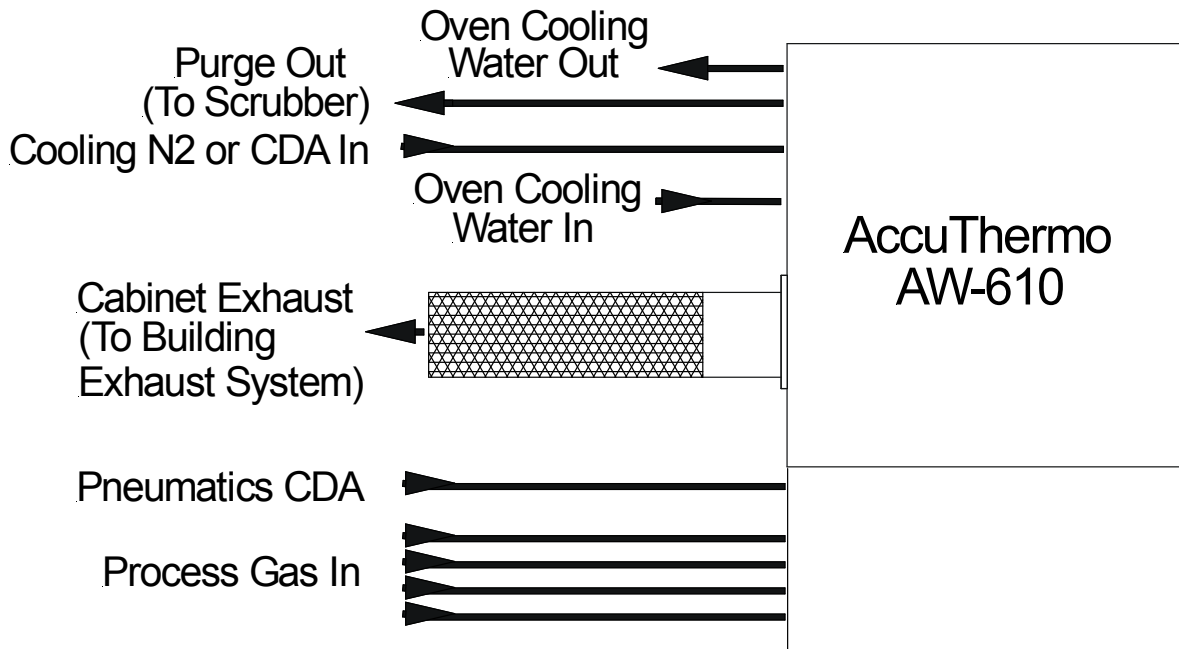
Figure 3-5: *AccuThermo RTP system Gas and Exhaust Connections*

3.4.6   AC POWER CONNECTION

The AccuThermo RTP systems are capable of heating single wafers very rapidly. This capability means that the AccuThermo RTP system has very high instantaneous current demands. Therefore, special care must be taken in connecting the AC power from the facility main AC lines to the AccuThermo RTP system.

The main power lines from the facilities AC source must be kept as short as possible to reduce distributed line inductance, preferably with a line length of less than 25 feet. As the AC power distribution lines become longer, there is a higher resistance or distributed inductance in the wire. This distributed line inductance can result in power line disturbances if measured close to the AccuThermo RTP system AC power connections. These disturbances can result in the AccuThermo RTP system and other equipment on the same distribution panel having operational problems.

To reduce the possibility of electrical interference with other equipment, it is recommended that the AccuThermo RTP system be connected to a separate power distribution panel mounted close to the facilities main transformer. No other equipment should be connected to the same distribution panel and facilities isolation transformer as the AccuThermo RTP system. If more than one AccuThermo RTP system is installed in the same location, each AccuThermo RTP system should have its own distribution panel and facilities isolation transformer (See Figure 3-6). The system should be connected to a customer-supplied time delay circuit breaker. Flexible armored cable is recommended to allow the system to be moved for easy maintenance access. Follow local electrical codes in making the electrical connections.

In summary, the following guidelines should be followed when you connect AccuThermo RTP system power in order to ensure proper system operation:

➢ Put the AccuThermo RTP system on a separate power distribution box from other equipment, preferably with its own power transformer. The power distribution box should be accessible from the system.
➢ Use the correct size circuit breaker and house wiring (AWG #4 or larger).
➢ The distance from the AccuThermo RTP system to the transformer should be as short as possible, preferably with a line length of less than 25 feet.

A summary of the electrical requirements is shown in Table 3-1.
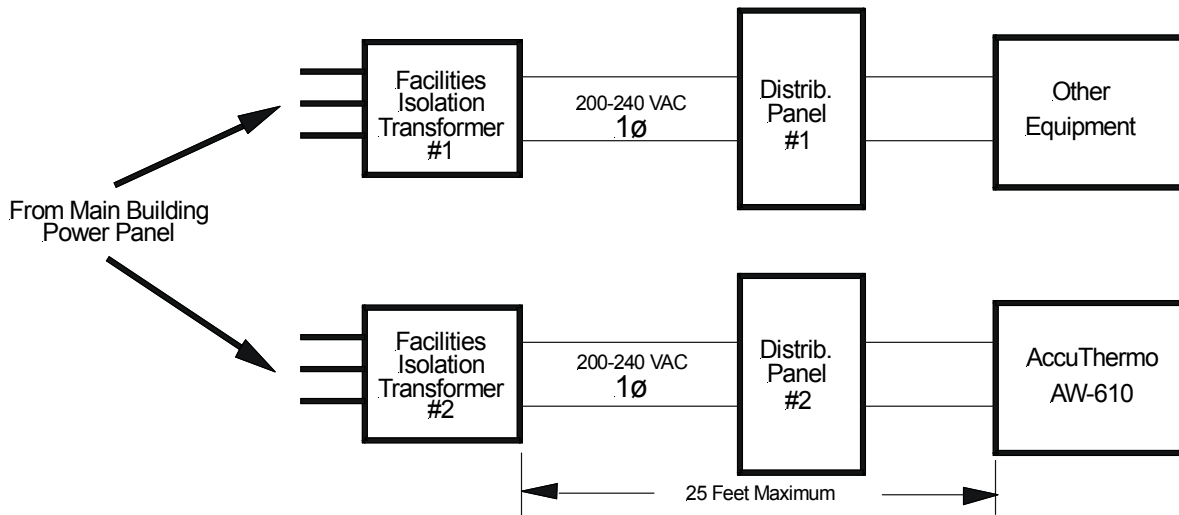
Figure 3-6: *Recommended AccuThermo RTP system power Distribution Diagram*

Once the facility AC power and other facility connections have been routed to the AccuThermo RTP system, use the following procedure and Figure 3-6 for connecting the AC power to the system.

☠ WARNING

Make sure the AC power from the AccuThermo RTP system distribution panel is OFF before you begin this procedure. Even with the AC power switch on the front panel OFF, high voltage still exists on various components inside the system. Follow proper lock-out/tag-out procedures.

Step 1.   Remove the top cover from the AccuThermo RTP system. See Figure 10-1.

Step 2.   Loosen the cable strain relief collar located on the rear panel of the system. See Figure 3-7.

Step 3.   Feed the power cable (AWG 4 or larger) through the strain relief collar.

Step 4.   Loosen the screws on the top of the circuit breaker and connect the two power leads, securing the leads with the hold-down screws. The order of the leads is not important for proper system operation.

Step 5.   Connect the green (or green/yellow) ground wire to the ground bar on the bottom of the AccuThermo RTP chassis (Figure 3-7).

Step 6.   Tighten the strain relief collar on the rear of the AccuThermo RTP system and make sure that it is holding the power cable securely.

Step 7.   Do not install the top cover. Continue on to the next section.

NOTE:
WIRES MAKE A VERY TIGHT 90 DEGREE
BEND ON TOP OF THE CIRCUIT BREAKER

CIRCUIT BREAKER
CB1

FLEXIBLE ARMORED
CABLE

STRAIN RELIEF
COLLAR

GROUND WIRE
(TO CHASSIS)

208 VAC POWER
(#4 AWG WIRE)
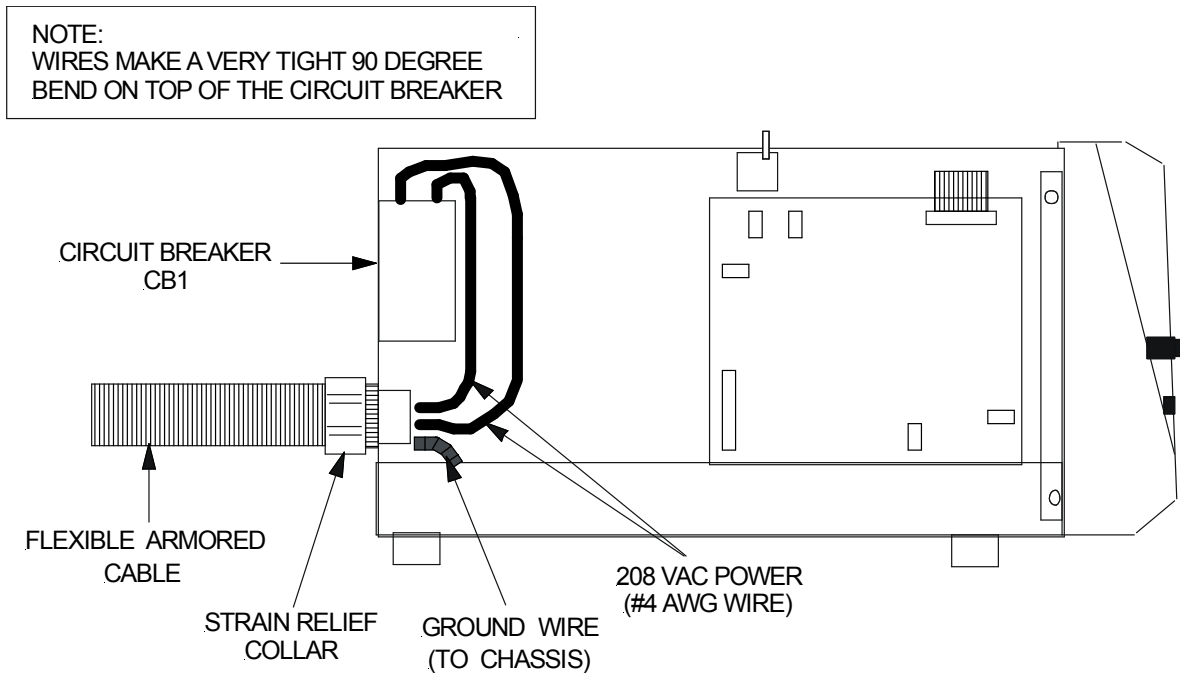
Figure 3-7:   *AccuThermo RTP System AC Power Connections*

3.4.7   PYROMETER COOLING SYSTEM

The AccuThermo RTP system has a separate, closed-loop water system to cool a pyrometer, if one is installed in the system. A Neslab RTE-7 or equivalent water chiller unit, which must be located near the system, circulates water through the pyrometer to maintain a constant pyrometer temperature. The chiller should be set to maintain a constant and stable pyrometer temperature of 17°C to 25 C.

The chiller unit water connections are made to the two tubes on the rear of the AccuThermo RTP system below the oven water cooling connections. Refer to Figure 3-1. Connect the hose on the back of the chiller labeled **PUMP OUTLET** to the tube on the back of the AccuThermo RTP system labeled **PYROMETER INLET**. Connect the hose on the back of the chiller labeled **PUMP INLET** to the tube on the back of the AccuThermo RTP system labeled **PYROMETER OUTLET**. Two quick-connect tube connectors are supplied with the AccuThermo RTP system to make these connections.

The chiller unit plugs into any 110 VAC/60 Hz outlet (220 VAC/50 Hz outlet for international systems). The chiller draws approximately 11 Amps (5.5 Amps at 220 VAC).

☞ CAUTION

Do not operate the chiller with low water level. The chiller may overheat and cause damage to the refrigeration unit.

After the water and power connections have been made and the chiller filled with water, the chiller unit may be turned on to check for leaks and adjusted for proper operation. See Figure 3-8.

Step 1.   Turn ON the RTE-7 chiller. The switch labeled ON/OFF is on the unit's controller.

Step 2.   Set the chiller to 20°C using the keypad on the controller (refer to the RTE-7 manual).

Step 3.   Check to ensure that the pyrometer chiller flow is in the range between 9 gallons-per-hour (gph) and 15 gph. The minimum acceptable pyrometer cooling water flow 6 gph.
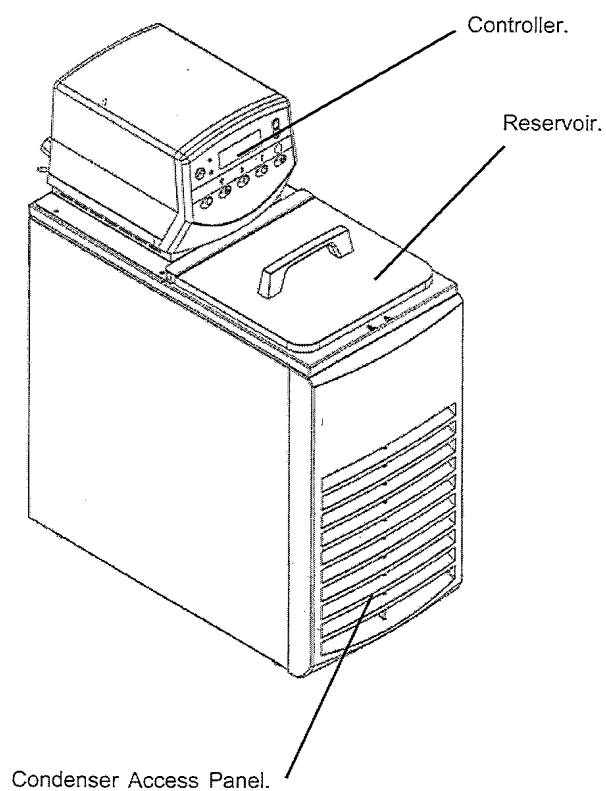
NESLAB RTE-7 Refrigerated Bath Unit
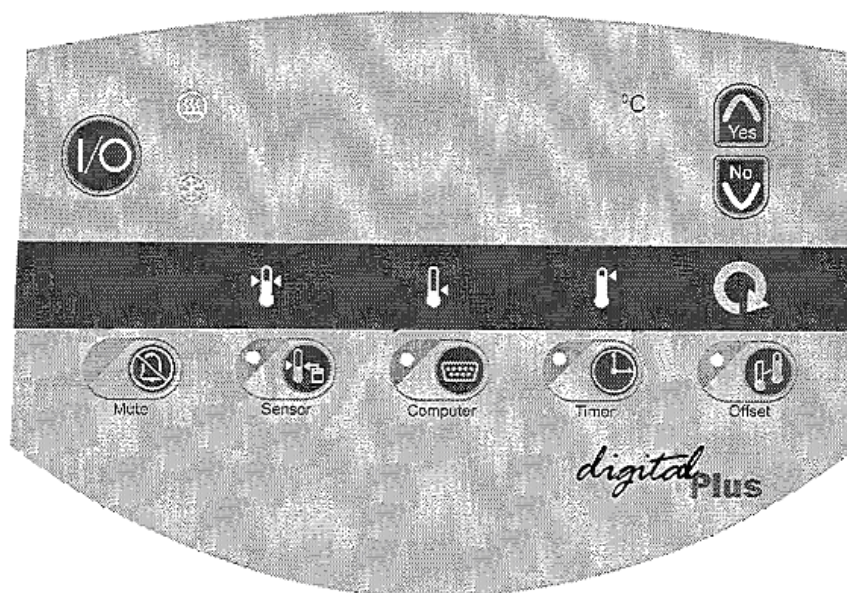
Figure 3-8: *AccuThermo RTP System Chiller and Controller Unit*

Step 4.   Monitor the water temperature on the controller's display. The temperature should begin to drop after a few minutes and stabilize to approximately 17°C within 90 minutes. Once the water temperature has stabilized, the amber HEAT LED will turn ON. If the water temperature stabilizes above or below 17°C, adjust the unit slightly and allow it to stabilize again.

☞ NOTE

Any change in pyrometer cooling water temperature will affect the calibration of the pyrometer. Always verify that the water temperature has stabilized at 17°C prior to running a process cycle.

Step 5.   Check all of the water connections between the chiller and the pyrometer on the bottom of the AccuThermo RTP oven. Make sure that there are no leaks.

Step 6.   Reinstall the top cover on the AccuThermo RTP oven.

This completes the facilities connections to the AccuThermo RTP system and chiller unit. Continue with the quartzware installation and the computer connections and testing before proceeding with the system power up tests listed in Section 6 of this manual.

3.5   <u>INSTALLING THE COMPUTER</u>

This section describes the procedure for installing the AllWin21 AccuThermo RTP Graphical User Interface (GUI) computer and connecting this computer system to the AccuThermo Rapid Thermal Processor (RTP) oven.

3.5.1   OVERVIEW OF THE ACCUTHERMO RTP GUI COMPUTER

The AccuThermo RTP oven is controlled by a Pentium class personal computer that is supplied with the AccuThermo RTP system or as part of the associated upgrade kit, if purchased separately.

The computer interface kit shipped with your AccuThermo RTP system includes the following parts:

Description	Quantity
AllWin21 AccuThermo RTP PC	1
Monitor	1
Keyboard	1
Mouse	1
PC and Monitor AC Power Connection Cables	2
25-Pin M-M D-sub Connector Cable Assembly, 6-feet long	1

This computer is configured at the factory, prior to shipment, with all of the hardware components and software applications needed to operate as the user interface for the AccuThermo RTP system. The only connections that must be completed at the customer site include the following:

➢ Connect the Monitor, Keyboard, and Mouse to the PC

➢ Connect the Power Cables to the PC and Monitor

➢ Connect the PC AccuThermo input/output (I/O) cables between the PC and the AccuThermo RTP oven

✍️ **NOTE**

At least 85% of all problems can be attributed to connectors. At AllWin21 we have these simple rules which we follow.

1) Do not drop connectors. It can bend and damage pins and crack the housing, etc. Treat connectors like "eggs". Treat PCB like "glass".

2) Take the time to tighten all holding screws. A loose connector may not have good contact. It may also bend the pins.

3) Do not plug connectors in & out too many times.

4) Fix the connector correctly the first time. A bad "fix" can further damage the connector.

3.5.2   INTERCONNECTION OF THE COMPUTER ASSEMBLY

Use the following steps and figure 3-1 to complete the power connection and all input/output components of the AccuThermo RTP system computer:

Step 1.   Make sure the computer is turned OFF and it's AC power input cable has not been connected to a power source

Step 2.   Make sure the monitor is turned off and it's AC power input cable has not been connected to a power source

Step 3.   Connect the monitor video input cable to the matching monitor connector on the back of the PC

Step 4.   Connect the keyboard cable connector to the matching keyboard connector on the back of the computer. For some models of computers, there is an adaptor cable to allow the keyboard and the mouse to share the same port.

Step 5.   Connect the mouse cable connector to the matching mouse connector on the back of the PC

Step 6.   Connect PC AC power input cable to the matching AC power input connector on the back of the PC

Step 7.   Connect the Monitor power cable to the matching AC power input connector on the back of the monitor
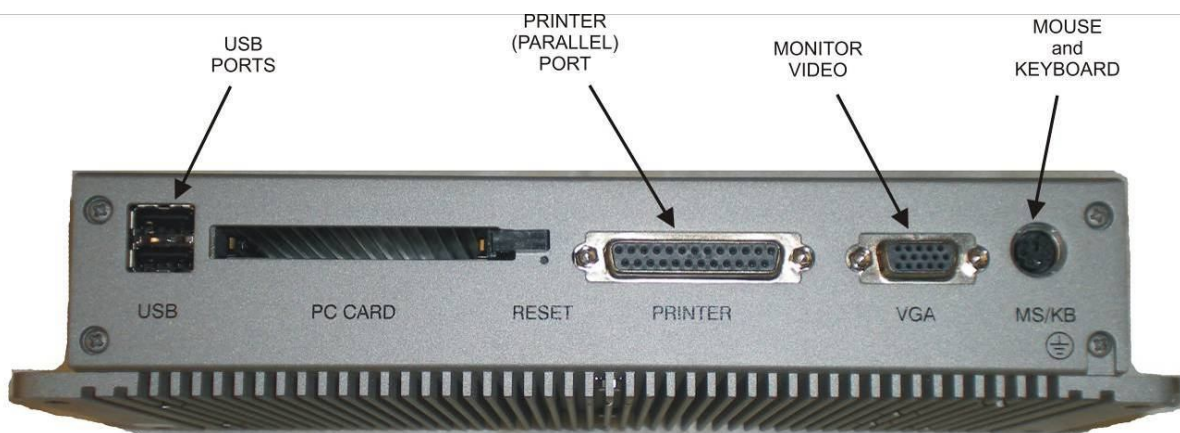
Figure 3-9:   *Computer Rear View*

3.5.3   CONNECTING COMPUTER TO ACCUTHERMO RTP SYSTEM

Connecting the computer to your AccuThermo RTP oven unit consists of simply connecting the appropriate cables between the computer and the AccuThermo RTP oven unit.

➢ Connect the 25-pin M-M D-sub connector cable between the computer's "Parallel Port", and the AccuThermo RTP oven 25-pin connector, labeled "Controller".
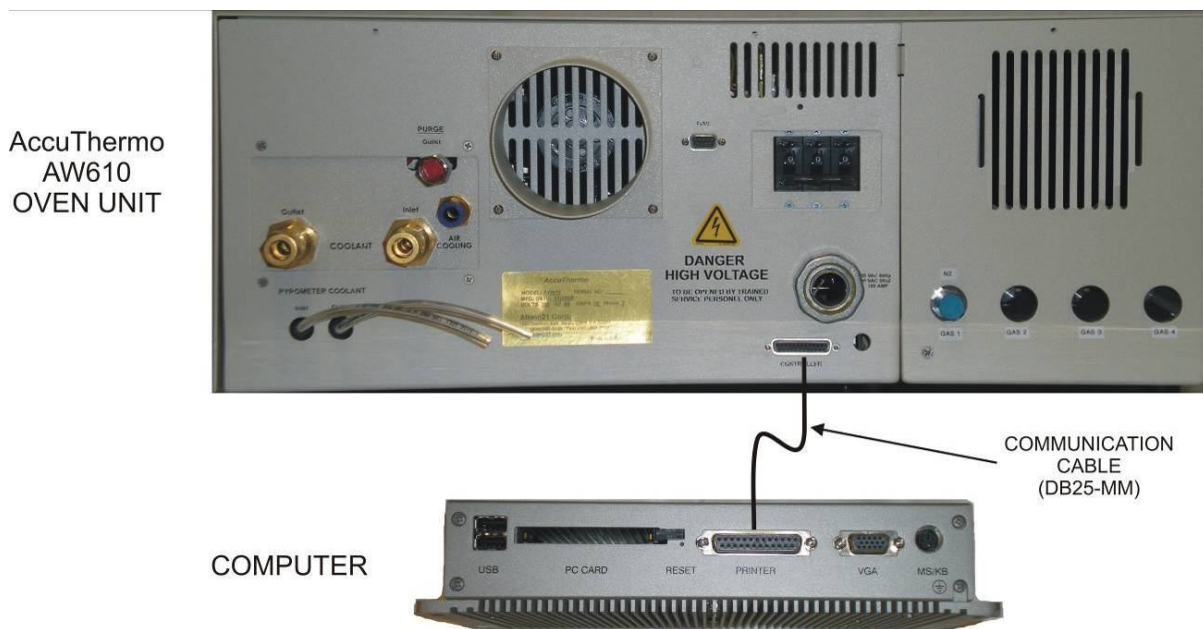
Figure 3-10: *Computer to AccuThermo RTP System Interconnect Diagram*

➢ Tighten the cable hold-down screws at each end of all of the cables installed on the computer or on the AccuThermo RTP oven unit.

This completes the connections between the computer and the AccuThermo RTP oven unit.

3.6   SYSTEM POWER-UP AND TESTING

This section describes the procedures for powering-up the system and the test procedures that must be performed directly after power-up to ensure safe AccuThermo RTP system operation.

3.6.1   SYSTEM POWER-UP

You are ready to power-up your AccuThermo RTP system at this point in the installation procedure. The following steps describe the power-up sequence.

☞ CAUTION

Be alert at all times during the initial power-up procedures. If at any time during these initial procedures the lamps turn on at high intensity unexpectedly, immediately turn the power switch OFF. The system can heat up a wafer very rapidly until it melts. This can cause extensive damage to the AccuThermo RTP system.

Step 1.   Connect the AC power cord of the monitor to an AC outlet.

Step 2.   Connect the AC power cord of the computer to an AC outlet.

Step 3.   Power up the AccuThermo RTP system according to the "Power-Up & Power-Down" section later in the manual and.

3.6.2   **MFC SETUP PROCEDURE**

To properly control the Mass Flow Controllers (MFC's) installed in the system, the specification of the MFC's must be entered into the MFC Setup Screen shown in Figure 3-12, below. To complete this procedure use the following steps:

Step 1.   From the AllWin21 *Main Menu* screen, click on **Maintenance**.

Step 2.   When the *Maintenance Menu* appears, select **Gas Setup**.

Figure 3-11: *AccuThermo RTP System   MFC Setup Screen*

Step 3.   Enter the appropriate values into the Gas Name and MaxFlow fields for each Gas and, when done, click on the **SAVE** button to save the Gas configuration and exit from the screen. Note that MFC sizes lower than 5 slpm should be entered as sccm (e.g.: 2 slpm = 2000 sccm).

3.6.3   MANUAL MODE TESTS

Manual mode installation tests consist of two procedures. The first procedure tests the heating chamber control and the second procedure ensures that the heating chamber is communicating with the controller.

Computer Communication and Oven Control Test Procedure

This test verifies that your AccuThermo RTP system lamps are turning on properly and that there is communication between the computer and the AccuThermo RTP oven unit.

Step 1.   Make certain that the computer is on and the AccuThermo control software is running (refer to section Power-Up & Power-Down).

Step 2.   Load a TC wafer into the oven and connect it to the TC connectors on the inside of the chamber door, observing proper polarity (refer to section "Install and Test the TC Wafer" later in this manual).

Step 3.   Turn on the water cooling and tube CDA or nitrogen cooling.

Step 4.   Select Diagnostics from the Main Menu. Set 3 to 5 slpm of nitrogen flow to ensure tube purging. Observe that there is gas flow being displayed on the Diagnostics screen.
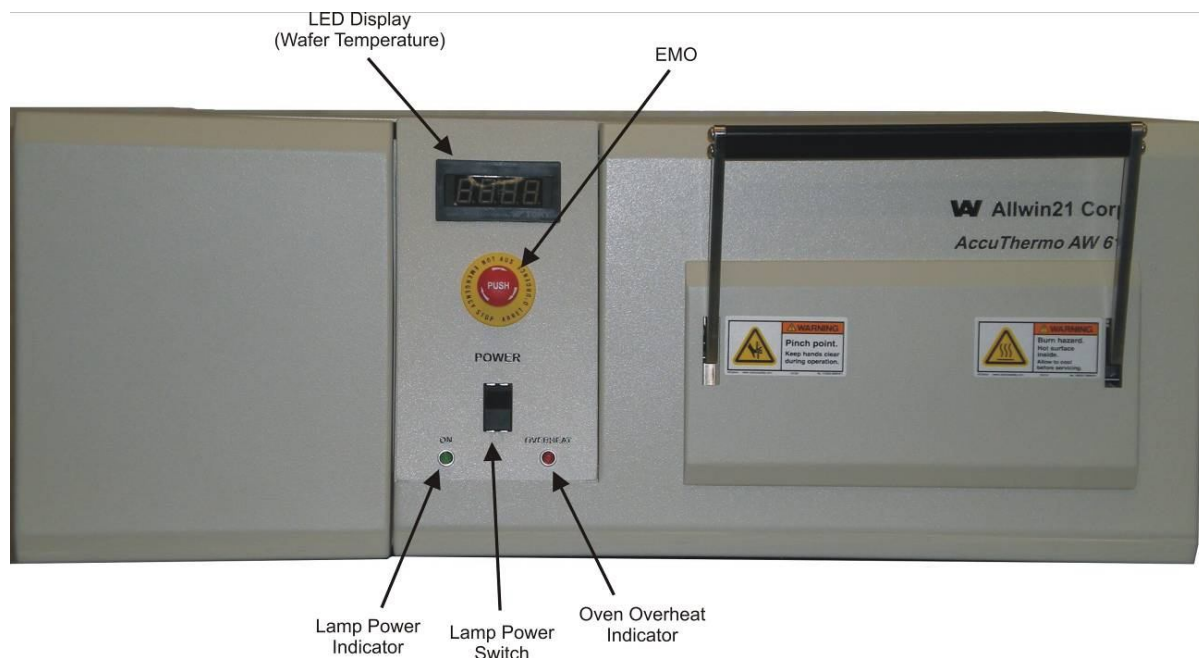
Figure 3-12: *Front Panel Controls*

Enable the lamps.

┌───┐
│   〰 **CAUTION**   │
├───┤
│ **When testing manual lamp control, carefully watch the TC** │
│ **temperature so it does not rise above 500°C.**   │
└───┘

Step 5. Enable the lamps by clicking on the button with the lamp icon. The lamp should turn red.

Step 6. Slowly increase the lamp intensity by using the slider and watch for a rise in TC temperature on the display and the appearance of lamp radiation. After you have observed a rise in temperature, disable the lamps.

Step 7. If you do not see a rise in temperature, call AllWin21 Field Service for assistance. Telephone numbers are listed in the front of this manual.

If the results of this test are correct, the system installation has been completed and the tool can be placed into operation.

Refer to the **Basic Operations** and **Advanced Operations** sections for complete instructions on AccuThermo RTP system operation, recipe creation, and optimization.

Refer to the **Maintenance** section for complete instructions on AccuThermo RTP system tool troubleshooting.

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4. POWER-UP & POWER-DOWN

4.1 <u>OVERVIEW</u>

This section describes how to power-up and power-down the AccuThermo RTP system. Prior to applying power to the system, a visual inspection of the facilities is required. It is also recommended that you read the list of safety precautions given in the *Safety Precautions* section of this manual.

To complete the following procedures, you must first be familiar with the use of the menu screens to execute and interrupt a cycle in Run mode.

If any irregularities occur during power-up, power down the system and immediately notify the service engineer in charge.

<div style="border:1px solid black; padding:10px">

☠ WARNING

Check the system utility connections and sources before switching on the AccuThermo RTP system.

</div>

4.2   <u>UTILITIES INSPECTION</u>

Inspect the system utility connections and sources before switching on the AccuThermo RTP system. Refer to figure 4.1 for the location of each utility connection on the rear of the oven unit.

Visually inspect the following utilities to make sure connections are secure:

➢ Electrical power.

➢ Gas-handling inlets.

➢ Purge Gas outlet.

➢ Cooling water inlet and outlet for chamber cooling.

➢ Nitrogen or Clean Dry Air (CDA) inlet for tube cooling.

➢ Nitrogen or Clean Dry Air (CDA) inlet for system pneumatics.

➢ Scrubber connection.

➢ Cabinet Exhaust.

Check the Utilities Specifications section in the appendix for proper settings.
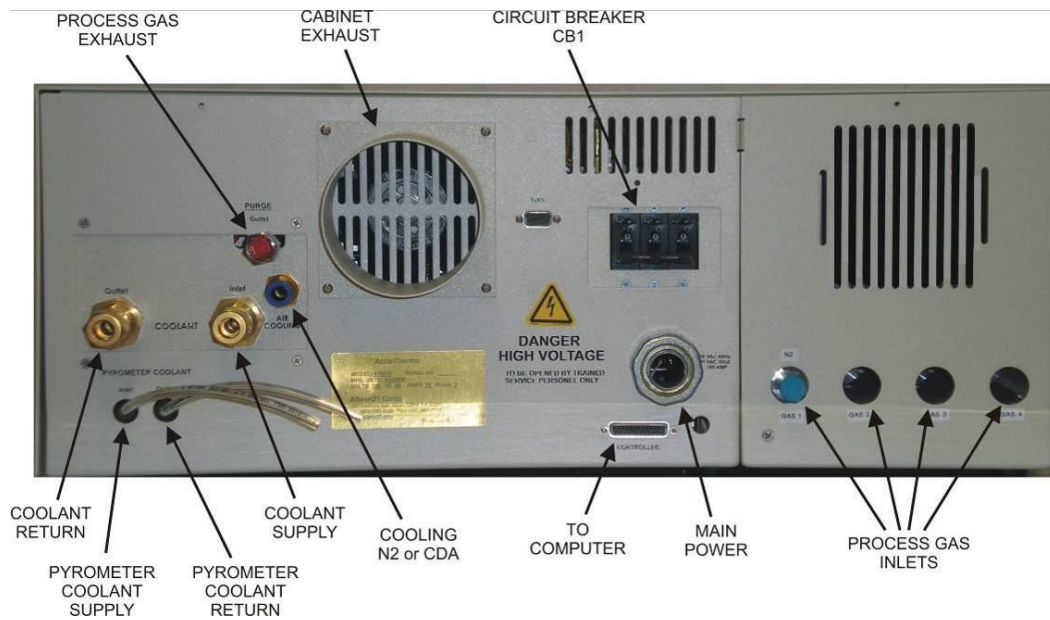
Figure 4-1: *Rear Utility Panel Connections*

☞ CAUTION

Make sure the purge outlet is not restricted. This will cause the quartz isolation tube to over pressurize and it will break.

Check for possible water leaks at the cooling water inlet and water outlet connections.

If any of the utilities are disconnected or any connections appear to be leaking, correct the problem. Make sure the house scrubber is operating if processing with hazardous gases or processing wafer which outgas.

☞ NOTE

Before applying power to the system, the computer must be connected; the cooling water and cooling air must be turned on.

4.3   FRONT CONTROL PANEL

The front control panel houses the controls and meters that indicates system status and provides manual control over the system. See Figure 4-2.
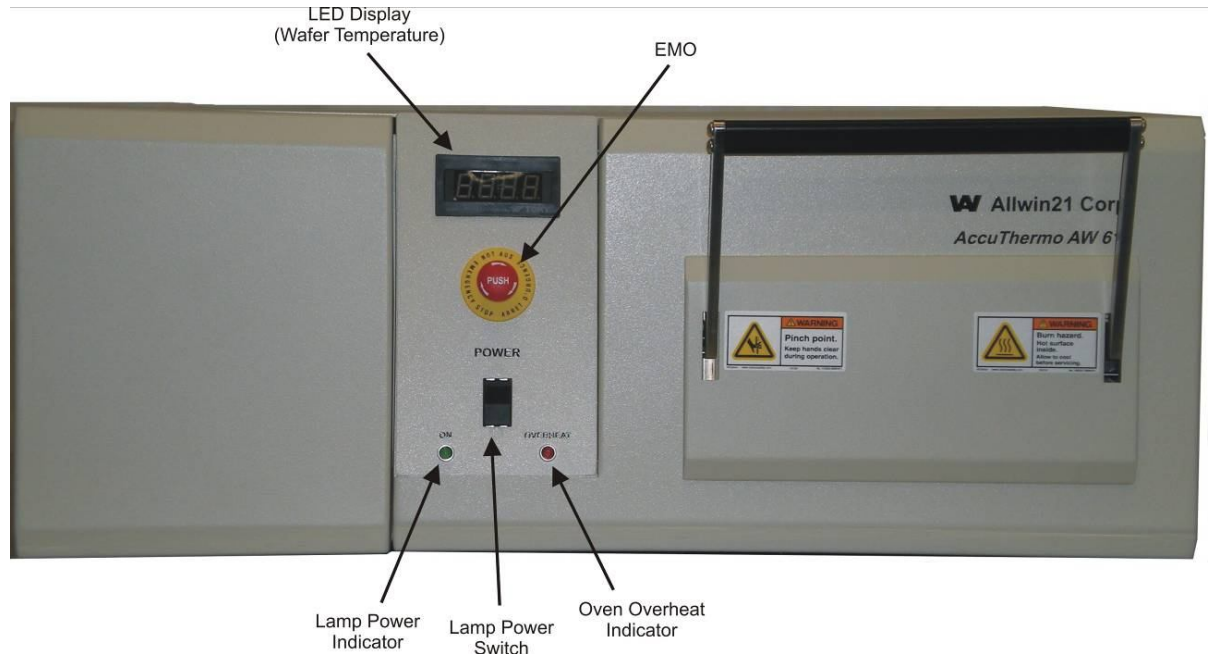
Figure 4-2:   *Front Control Panel*

The features of the front panel are:

LED Readout
This shows the temperature of the wafer inside the chamber. (Disregard the decimal point.)

EMO (Emergency Off)
Shuts down the entire system.

Main Power ON
Pressing the Main Power ON button powers up the AccuThermo RTP system.

Main Power OFF
Pressing the Main Power OFF button removes power from the AccuThermo RTP system.

Power Switch & On/Off Indicator
ON/OFF switch and green power indicator LED for the oven system.

Overheat Indicator
This red LED is lit when either of the following two conditions occur:

➢ The outside surface of the oven chamber bottom plate is equal to or greater than 65°C.

➢ The wafer temperature exceeds the set point of the Wafer High Temperature Interlock.

4.4   <u>FULL POWER-UP</u>

The following steps describe the proper power-up sequence for the AccuThermo RTP system.

🔊 **CAUTION**

Be alert at all times during power-up. If at any time during these procedures the lamps turn on at high intensity unexpectedly, immediately turn the power switch OFF. The system can heat up a wafer very rapidly until it melts. This can cause extensive damage to the AccuThermo RTP system.

Step 1.   Ensure that the system power input circuit breakers and power switches are set to off:

> ➢ The wall circuit breaker(s) for the computer and AccuThermo RTP system are off.

> ➢ Circuit breaker (CB1) on the rear of the AccuThermo RTP system is off (CE version only).

> ➢ The computer power is off.

> ➢ The AccuThermo RTP system LAMP POWER switch (on the front control panel) is off.

🔊 **CAUTION**

Make sure the LAMP POWER switch on the AccuThermo RTP system control panel is OFF prior to proceeding. If the AccuThermo RTP system Lamp Power switch is on when the computer power switch is turned on, the lamps in the heating chamber could turn on.

Step 2.   Ensure all gas valves are turned off.

Step 3.   Make sure the EMO buttons are reset.

Step 4.   Verify there is no restriction to the process exhaust. Verify it is set to the proper negative pressure.

Step 5.   Verify there is no restriction to the cabinet exhaust. Verify it is set to the proper flow rate.

Step 6.   Turn on the facility circuit breakers for the AccuThermo RTP system.

Step 7.   Turn on the facility safety switch for the AccuThermo RTP system.

Step 8.   Turn on the circuit breaker on the rear of the AccuThermo RTP system (CE version only).

Step 9.   If the computer is not powering up, power up the computer. After the computer has boot-up, it will display the AccuThermo RTP system *Main Menu*, as shown in figure 4-3.

☞ CAUTION

Always turn on the facility circuit breakers to the heating unit before powering up the computer.

Figure 4-3: *Main Menu Screen*

Step 10. Turn on the chamber cooling water. Verify it is set to the proper pressure, flow rate and temperature.

Step 11. Turn on the quartz isolation tube cooling CDA/nitrogen. Verify it is set to the proper pressure and flow rate.

Step 12. Turn ON the Pyrometer chiller. Let the pyrometer chiller stabilize before running a process. This will take about 30 minutes.

☞ **NOTE**

The pyrometer chiller temp should be set at 20 ± 0.5 °C.

ᕤ CAUTION

Do not operate the system under pyrometer control until the pyrometer cooling water has stabilized.

Step 13.   Enable the lamps using the front panel Lamp Power switch. The green Lamp ON light indicates the lamps are enabled. You will also hear a "clunk" when the switch is turned on. This is the sound of the contactor engaging.

Step 14.   Open the chamber door about 1 cm. This will ensure the quartz chamber will not over pressurize if there is a problem with the gas system.

ᕤ CAUTION

Open the chamber door 1 cm prior to turning on the process gases. This will ensure the quartz chamber will not over pressurize if there is a problem with the gas system.

Step 15.   Turn on the gas valves. Verify the input pressure is set to the proper pressure.

The AccuThermo RTP system is now ready for operation.

4.5   <u>DAILY POWER-UP</u>

The following steps describe the proper power-up sequence for the AccuThermo RTP system after a "Daily Power-Down".

ᘒ CAUTION

Be alert at all times during power-up. If at any time during these procedures the lamps turn on at high intensity unexpectedly, immediately turn the power switch OFF. The system can heat up a wafer very rapidly until it melts. This can cause extensive damage to the AccuThermo RTP system.

Step 1.   Ensure all gas valves are turned off.

Step 2.   Make sure the EMO buttons are reset.

Step 3.   Verify there is no restriction to the process exhaust. Verify it is set to the proper negative pressure.

Step 4.   Verify there is no restriction to the cabinet exhaust. Verify it is set to the proper flow rate.

Step 5.   Turn on the chamber cooling water. Verify it is set to the proper pressure, flow rate and temperature.

Step 6.   Turn on the quartz isolation tube cooling CDA/nitrogen. Verify it is set to the proper pressure and flow rate.

Step 7.   Check the Pyrometer chiller water level.

Step 8.   Verify the pyrometer chiller temperature is set to 20 °C.

ᘒ CAUTION

Do not operate the system under pyrometer control until the pyrometer cooling water has stabilized.

Step 9.   Enable the lamps using the front panel Lamp Power switch. The green Lamp ON light indicates the lamps are enabled. You will also hear a "clunk" when the switch is turned on. This is the sound of the contactor engaging.

Step 10.   Open the chamber door about 1 cm. This will ensure the quartz chamber will not over pressurize if there is a problem with the gas system.

☞ CAUTION

Open the chamber door 1 cm prior to turning on the process gases. This will ensure the quartz chamber will not over pressurize if there is a problem with the gas system.

Step 11.   Turn on the gas valves. Verify the input pressure is set to the proper pressure.

The AccuThermo RTP system is now ready for operation.

4.6   SYSTEM OPERATION

During system operation, be aware of the following:

➢ The cooling subsystems must be used at all times and should be operational for at least 5 minutes following the last cycle of the lamps.

➢ Experimental substrates contain unknown impurities which may outgas during processing.

☠ WARNING

Allwin21 cannot anticipate the number and variety of materials a user may experiment with, and is not responsible for any potential hazards which may result from wafer outgas.

4.7   <u>FULL POWER-DOWN</u>

The AccuThermo RTP system may be left with power on continuously, unless maintenance to the system requires removing power from the system.

☞ **NOTE**

Allwin21 Corporation recommends leaving the computer on when the system is not in use. The system should be turned off for maintenance and service.

〰 **CAUTION**

Do Not Power-Down the AccuThermo RTP system unless it has been more than 5 minutes since the last use of the unit. Let the system cool down with cooling water and cooling air.

Step 1.   Turn off the gas valves.

Step 2.   Turn off the oven unit LAMP POWER switch (on the oven unit control panel.)

Step 3.   Turn off the quartz isolation tube cooling CDA/nitrogen.

Step 4.   Turn off the oven cooling water chiller if the chiller is dedicated to the AccuThermo RTP system.

Step 5.   Turn off the facilities breaker/safety switch.

Step 6.   Turn off the pyrometer chiller (optional).

Step 7.   If any accessories are being used with the system, turn them off as necessary.

4.8 DAILY POWER-DOWN

The AccuThermo RTP system may be left with power on continuously, unless maintenance to the system requires removing power from the system.

ℰ✎ CAUTION

Do Not Power-Down the AccuThermo RTP system unless it has been more than 5 minutes since the last use of the unit. Let the system cool down with cooling water and cooling air.

Step 1.   Turn off the gas valves.

Step 2.   Turn off the oven unit LAMP POWER switch (on the oven unit control panel.)

Step 3.   Turn off the quartz isolation tube cooling CDA/nitrogen.

Step 4.   Turn off the oven cooling water chiller if the chiller is dedicated to the AccuThermo RTP system.

Step 5.   If any accessories are being used with the system, turn them off as necessary.

✑ NOTE

The pyrometer chiller should be left on to ensure a quick start-up for the next time the system will be used.

✑ NOTE

If the AccuThermo RTP system will be idle for extended periods, it is advisable to do a full power down.

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5. BASIC OPERATION

5.1 <u>OVERVIEW</u>

The AccuThermo RTP system is a rapid thermal processing system, which uses high intensity visible radiation to heat single wafers for short process periods of time at precisely controlled temperatures. The process periods are typically 1-600 seconds in duration, although periods of up to 9999 seconds can be selected.

☞ NOTE

Process periods longer than 600 seconds in duration are normally used only for maintenance testing purposes at low lamp intensity settings.

These capabilities, combined with the heating chamber's cold-wall design and superior heating uniformity, provide significant advantages over conventional furnace processing.

The wafer to be processed is manually placed on a quartz tray that slides into the chamber.

The AccuThermo RTP system is fully controlled by a computer running the AW-900 GUI control software and the front control panel. The AW-900 software is an advanced control software standard on all Allwin21 AccuThermo RTP system benchtop systems.

The AW-900 uses a set of operating instructions known as recipes to control the AccuThermo RTP system. These recipes are created by the Process Engineer to monitor and control the parameters of the processing cycle. The Operator then uses the software to select and run these recipes.

The AW-900 software program is also used to create, delete, copy, modify and store the recipes and to execute system diagnostics.

To get an understanding of how to operate the AccuThermo RTP system, you must first be familiar with the use of the menu screens to execute and interrupt a cycle in Run mode. This section provides a discussion of the operation of the AccuThermo RTP system. Calibration and diagnostics of the AccuThermo RTP system are discussed in the maintenance section.

SOFTWARE FEATURES

The AW-900 software features the following:

➢ Closed-loop temperature control with pyrometer or thermocouple temperature sensing.

➢ Precise time-temperature profiles tailored to suit specific process requirements.

➢ Fast heating and cooling rates unobtainable in conventional technologies.

➢ Consistent wafer-to-wafer process cycle repeatability.

➢ Elimination of external contamination.

➢ Small footprint and energy efficiency.

➢ Automated calibration of all subsystems from within the AW-900 software. This allows faster, easier calibration, leading to enhanced process results.

➢ Recipe creation. It features a recipe editor to create and edit recipes to fully automate the processing of wafers inside the AccuThermo RTP system process chamber.

➢ Validation of the recipe so improper control sequences will be revealed.

➢ Storage of multiple recipes, process data and calibration files so that process and calibration results can be maintained and compared over time.

➢ Passwords provide security for the system, recipe editing, diagnostics, calibration and setup functions.

➢ Simple and easy to use menu screen which allow a process cycle to be easily defined and executed.

➢ Troubleshooting features which allows engineers and service personnel to activate individual subassemblies and functions.

➢ The AW-900 software runs on any Pentium class PC computer with a DB-25F parallel (printer) port. The computer interfaces to the AccuThermo RTP system with only one cable: the control interface cable.

➢ The control board inside the machine that translates the computer commands to control the machine has a watchdog timer. If this board looses communication with the control software, it will shut down all processes and halt the system until communication is restored.

5.2   USING THE MENU SCREENS

This section is a general description of how to use the controls of the AW-900 Control Software. It will cover the use of buttons, editable fields, data display fields and filename lists.

Buttons

Buttons are rectangular boxes with a phrase on them describing their function. They may also have a value on them describing its current state. The color of a button is also important. It also defines the current state of the function of the button. The color, however, is defined by the function of the button. Buttons that are gray in color are inactive and cannot be selected.

Clicking on a button changes its state. Thus, the button may change color and the value describing the current state will change.

Editable Fields

Editable Fields are data entry fields where the operator can enter information into the software.

To edit the field, the operator must first select it by clicking on it. This enables the ability to edit the field. The operator now types in the desired information and presses ENTER when finished. The information now is displayed in the field, replacing what was there previously.

Data Display Fields

Data Display Fields are very similar to Editable Fields, except the operator cannot change the information being displayed in them. They look just like Editable Fields, except they are like a pushbutton that is always down. Also, when the operator clicks on them, nothing happens.

Filename Lists

Filename Lists display a list of filenames or directories pertaining to the type of information the file contains in a List Box. For example, filenames of files which contain recipes are only displayed in Recipe Filename Lists.

The number of filenames the Filename List can display is limited to its size on the screen. However, there may be more filenames for that type of list than can be displayed at one time. The operator can scroll through the list of filenames by using the slider to the right of the list, or using the up and down arrow keys on the keyboard.

A selected filename is highlighted in red. It may be selected by clicking on the name. It is also displayed in the field above the list of filenames. The operator can also select a filename by manually typing in the filename into the field above the list (see Editable Fields above).

A filename can also be deleted. The operator would first select the filename to be deleted. Then the operator would either click on the red box with an 'X' in it (located in the upper right corner of the List Box) or press the **Delete** key on the keyboard.

☞ NOTE

Deleting a filename will remove the filename and all information it contains permanently.
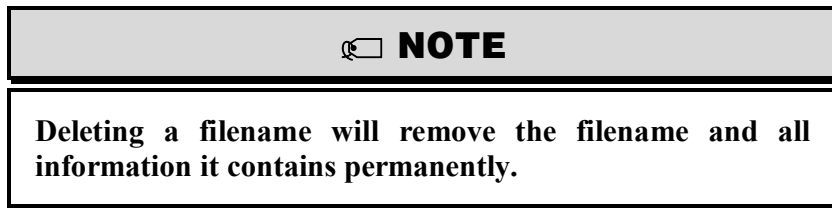
Exit a Screen

Exit the screen by clicking on the [Exit] button or pressing **ESC** on the keyboard.

Many screens allow the user to change the values for parameters, such as the *Recipe Editor* and the *System Setup*. The user needs to save the information before exiting the screen. However, if the user didn't save the information before exiting the screen, a dialog box will appear asking if the information should be saved.

Click **Yes**   (or press **Y** on the keyboard) to save the information.

Click **No**   (or press **N** on the keyboard) to discard all changes since the last save.

Click **Cancel**   (or press **ESC** on the keyboard) to go back to the editing screen and continue editing. It does not save any changes.

5.3   **PROCESS A WAFER**

The controller uses a set of operating instructions known as recipes to control processing wafers in the AccuThermo RTP system process chamber. These recipes are created by the Process Engineer to control the parameters of the processing cycle. The operator then uses the AW-900 software to select and run the recipe.

This section will explain step-by-step how to load and run a recipe. This procedure is the same for the *Process for Engineer* screen (figure 5-1) and the *Process for Production* screen (figure 5-2). These screens can be accessed by clicking on the appropriate button from the *Main Menu*, [Pr cess for engineer] or [Pr cess for production].
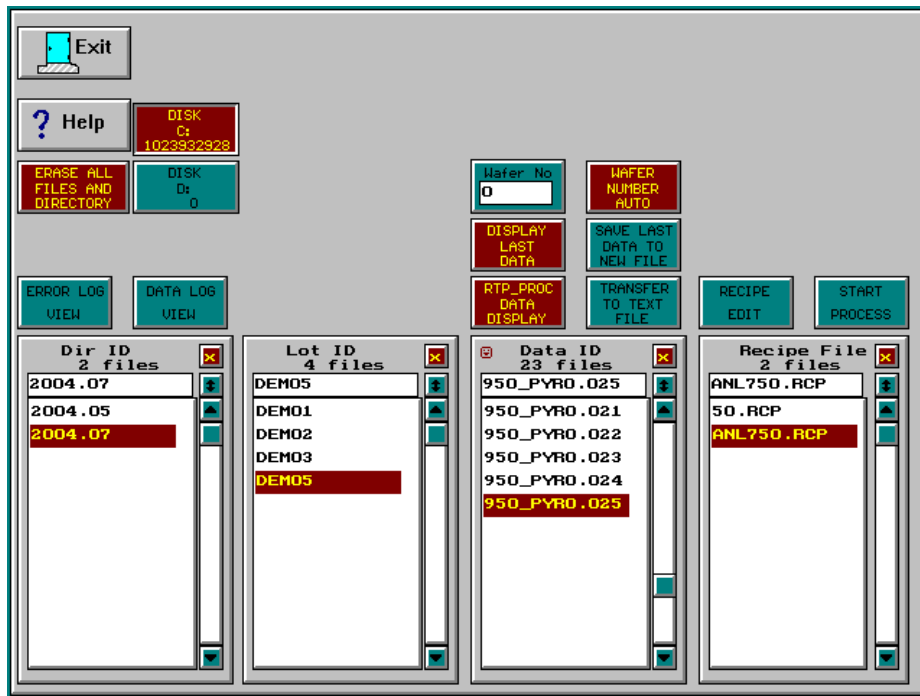
Figure 5-1: *Process for Engineer screen*

Location: Main Menu ➜ Process for Engineer
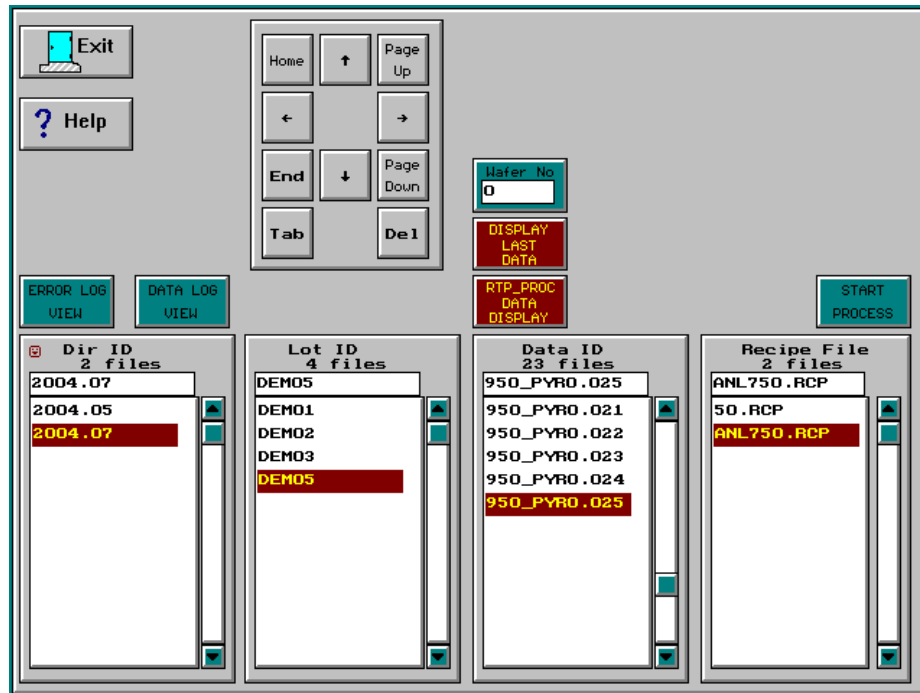
Figure 5-2:   *Process for Production screen*

Location: Main Menu ➜ Process for Production

Step 1.   **Select a Recipe**

The first step for using the AW-900 software is to select a recipe. Select a
Recipe from the list of Recipes in the column "Recipe File". A highlighted
Recipe means it is selected. Use the slider to the right of the list to display
Recipes that are not visible in the list window. Click on the Recipe to select
it.

Step 2.   **Select Where the Process Data will be Stored**

The process data is stored on the hard drive after the process ends. The place
on the hard drive it will be stored needs to be specified. Select a "Dir ID" and
a "Lot ID" from the list of Directory IDs and Lot IDs.

Step 3.   **Run the Recipe**

To run the selected Recipe, click on the **Start Process** button. This will
display the *Process Monitor screen* (figure 5-3). When this screen is
displayed, the process will begin processing the wafer inside the heating
chamber according to the selected Recipe.
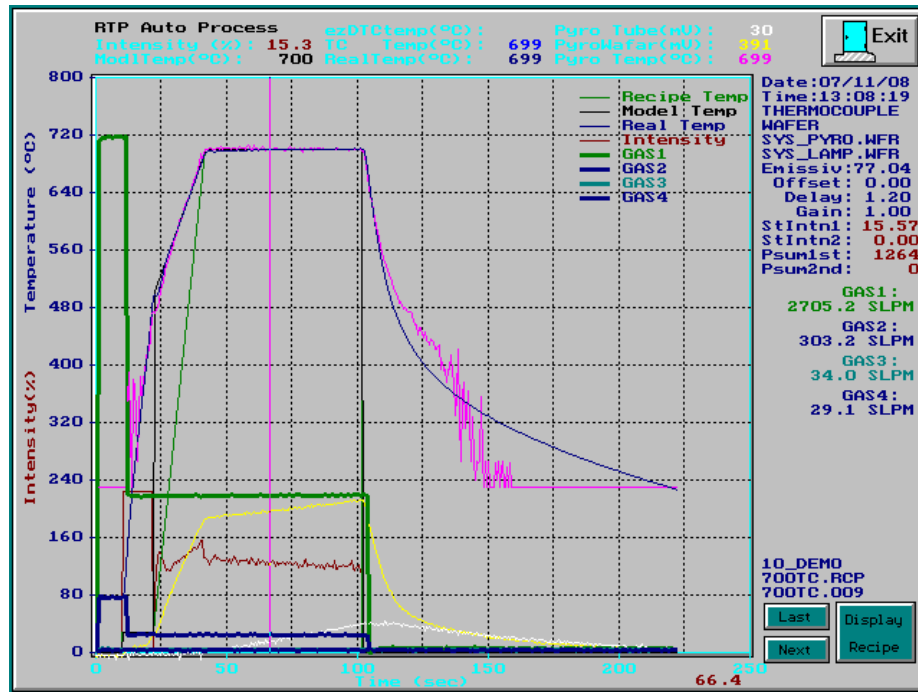
Figure 5-3: *Process Monitor screen*

The *Process Monitor screen*, figure 5-3, shows a completed process curve. In this figure, the x-axis indicates the process time and the y-axis indicates the measured process temperature. There are four curves to display the monitored process:

Green	The recipe temperature as defined by the Recipe.
Black	The Model (ideal) temperature curve.
Blue	The real, measured temperature during the wafer process.
Red	The lamp intensity (power percentage) during the wafer process. The range is from 0 to 100.
Light Blue	The temperature feedback from the thermocouple.
Pink	The temperature feedback from the pyrometer. The temperature from this pyrometer is not reliable below 450 °C.

At the end of the process, "Process Over" will be printed over the *Process Monitor screen* and be blinking in different colors.

Press any key to save the process data. This will also exit back to the *Process for ... screen*.

5.4   STOP PROCESS

A process may be interrupted and stopped by pressing the ***ESC*** key on the keyboard.
This will turn off the lamps.

If the "Turn Off Gases After Process" in the recipe is set to NO, then the gases that are on
will stay on and flow at the current flow rate. If it is set to YES, then the gases will be
shut off.

5.5   REVIEW THE PROCESS DATA

To view the last run process data graphically, click on the **Display Last Data** button.
This will display the process data on a screen very similar to the *Process Monitor screen*.

To view process data from previous runs, select the process data to be viewed from the
"Data ID" column, and then click on the **Display Process Data** button.

6.   ADVANCED OPERATION

6.1   OVERVIEW

The operation of the AccuThermo RTP system is by using the computer keyboard, mouse and the graphical user interface (GUI) menu screens of the AW-900 control software. The easy-to-use menu-driven display enhances reliability and greatly reduces the learning process.

The menu screens are designed to allow straightforward operation. Figure 6-1 illustrates the menu organizational map. It outlines the overall AW-900 screen architecture.
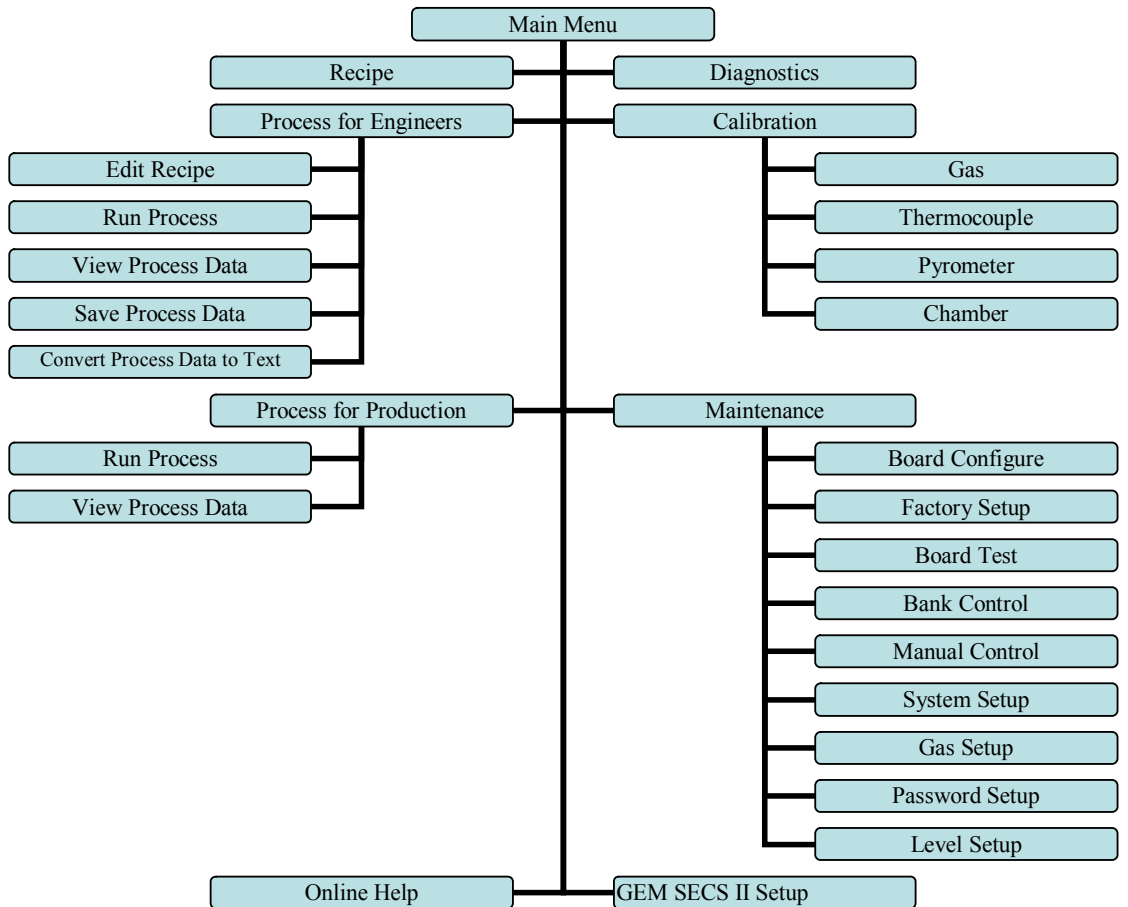
Figure 6-1:   *Menu Organizational Map*

After a successful power-up, the controller displays the *Main Menu screen*, figure 6-2. From this screen, any mode of operation can be accessed by using the mouse to click on the desired button.

Figure 6-2:   *Main Menu*

The operator can Load and Run a Recipe to process a wafer from the *Process for Production* screen or the *Process for Engineer* screen, whichever security level access the operator has. The *Process for Production* screen is intended for daily operation of the AccuThermo RTP system. This mode is available to all users.

This section is designed for the process and maintenance engineers to create, edit and run recipes for processing wafers in the process chamber.

The *Recipe Editor* allows the Engineer to create and edit a Recipe for controlling the process of the wafer in the process chamber. Here, the recipe can be fine tuned to give precise temperature control and uniformity of the process.

There are global parameters that need to be setup and defined. These parameters are normally set during factory testing and machine installation and never changed, unless an option is added or removed. They can be accessed from several screens in the *Maintenance Menu* and are divided into categories.

6.2   <u>RECIPE PROGRAMMING</u>

The control software allows the creation of recipes for automated control of the temperature and process gas flow.

It uses a set of operating instructions known as recipes to automatically control the AccuThermo RTP system. These recipes are created by the Process Engineer to monitor and control the parameters of the processing cycle. The Operator then uses the software to select and run the process parameters (steady state temperature, process time, ramp rates, etc.).

The AW900 software is also used to create, delete, copy, modify and store the recipes.

The recipe editor allows the process engineer to create and edit process recipes for desired temperature profiles and gas flow rates. The recipe editor allows the selection of the desired temperature feedback device and adjustment of the process control parameters.

6.2.1   CREATE AND MODIFY A RECIPE

The procedures for creating a new recipe and editing an existing recipe are very similar. These procedures essentially involve loading an existing recipe, editing the recipe's parameters, and then saving the changes. The differences between creating a new recipe and editing an existing recipe occur when the changes are saved. Creating a new recipe also involves changing the **Recipe Name** field, as discussed later in this section.

The steps to create or edit a recipe would be:

Step 1.   Select a pre-existing Recipe.

Step 2.   Edit it. (If a new Recipe is to be created, also change the Recipe Name field before saving.)

Step 3.   Validate the Recipe.

Step 4.   Save the Recipe.

The *Recipe Edit Selection* screen, figure 6-3, allows the user to select an existing recipe and load it into the recipe editor. The recipe can then be modified or a new recipe can be created based on this recipe.
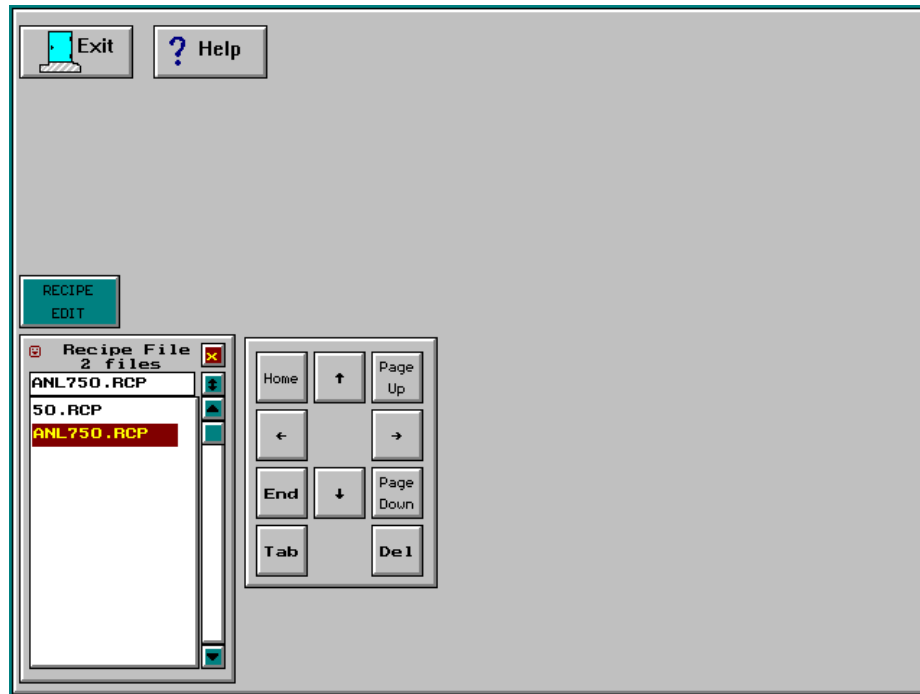
Figure 6-3:   *Recipe Edit Selection screen*

Location: Main Menu ➜ Recipe

Select a Recipe. Use the slider to the right of the list to display Recipes that are not visible in the list window. Click on the Recipe to select it. Click on the **Recipe Edit** button to display the Recipe Editor.

Alternatively, a Recipe can be created or modified from the *Process for Engineer screen*, figure 5-1. First, select a recipe from the "Recipe File" list. Then click on the **Recipe Edit** button to display the Recipe Editor.

6.2.2   RECIPE EDITOR

The *Recipe Editor*, figure 6-4, allows the user to modify the recipe and to validate it. This editor offers a great deal of flexibility in designing time/temperature profiles to construct process cycles. The user can specify variable ramp rates, specify the monitor control temperature, and also specify a gas flow rate for each step.

The *Recipe Editor* is used to create and edit recipes to be run on the AccuThermo RTP system. It is designed like a spreadsheet for easy data entry and readability. The editor is divided into two main sections. The top section (header) is where the user inputs information pertinent to the overall recipe. The lower section (data entry area) is for the process recipe data entry.

Figure 6-4:   *Recipe Editor*

At the end of section 6, you should be able to:
1) Change an existing recipe
2) Create a new recipe
3) Understand when to use a thermocouple or pyrometer
4) Adjust the temperature control parameters within the recipe

The Header

The header is the top part of the *Recipe Editor* and it describes the substrate, the sensor type and performance variables that are used during the entire process cycle of the recipe, along with the Recipe Name.

The Recipe Name can be edited. This should be done if a new recipe is to be created. However, leave the EXT field as RCP. This is the filename extension and the AW-900 software expects it to be RCP for a recipe.

RECIPE NAME **246TC**	The name of the recipe when it is saved to the hard disk. The Recipe Name can be edited. This should be done if a new recipe is to be created.
EXT **RCP**	Leave the EXT field as RCP. This is the filename extension and the AW-900 software expects it to be RCP for a recipe.
WAFER TYPE **WAFER**	This button toggles between "wafer" and "susceptor". Default value is "wafer". For III-V compound semiconductor wafers, it is necessary to use a susceptor to hold the wafer due to the IR transparency of the wafer. Because the thermal capacitance of the susceptor is very different from the standard silicon wafer, it is necessary to use a different type of chamber calibration data specific for the susceptor.
SENSOR TYPE **THERMOCOUPLE**	The temperature measurement sensor can be toggled between the TC, pyrometer and ezDTC. ezDTC is an option.
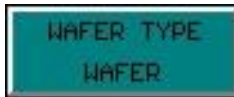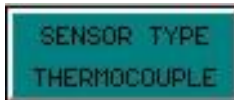
☞ CAUTION

Make sure the proper sensor is selected. A selected sensor that is not installed could give low temperature readings. This would make the temperature control increase the lamp intensity too much and may overheat and melt the wafer. The melted wafer could drip onto the quartzware and break it.

Use PYRO Offset LOCAL	Toggles between the use of the "system" global value or "local" recipe value (Pyro Offset) for the pyrometer temperature measurement correcting offset.
PYRO Offset 1.00	The pyrometer temperature measurement correcting offset.
Use Emissivity LOCAL	The pyrometer emissivity can use either the "system" global value or "local" recipe value (Emissivity).
Emissivity 77.04	The value for the emissivity to be used with the pyrometer. A standard silicon wafer has an emissivity of 77.04. The software treats emissivity as a factor that offsets the pyrometer temperature reading. If the pyrometer temperature isn't the same as the real processed temperature, then adjusting the emissivity offsets the pyrometer temperature reading.
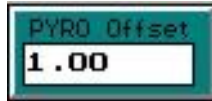
The five variables (Gain, Sensitivity, Delay, Psum1 Average and Psum2 Average) are for fine tuning the temperature control performance.

SENSITIVITY 1.00	The value for the coefficient of the gain in the STEADY period of the recipe. This makes the gain for a STEADY step different from a RAMP step. The gain value for STEADY is GAIN x SENSITIVITY. If the SENSITIVITY value is 1.0, there is no difference between the gain for a RAMP and a STEADY.
DELAY 1.00	This is the value for the transient period from RAMP to STEADY. Normally and default value is 1.0.
Gain 1.00	The value for the gain of the temperature PID control for the process steps RAMP and STEADY.
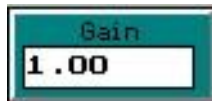
Psum1 Average **1.00**	This checks the average intensity. If Psum1 is set larger than 10.0 and if the first steady-state step is out of range, then there will be an alarm. If Psum1 is set smaller than 10.0, then the range checking is disabled. To get some statistical data for the normal average intensity of Psum1, Psum1 should be set to 1.0 to disable the alarm. *(see PSum in the Alarm Parameters section for a detailed explanation of this parameter)*
Psum2 Average **1.00**	This checks the average intensity. If Psum2 is set larger than 10.0 and if the second steady-state step is out of range, then there will be an alarm. If Psum2 is set smaller than 10.0, then the range checking is disabled. To get some statistical data for the normal average intensity of Psum2, Psum2 should be set to 1.0 to disable the alarm. *(see PSum in the Alarm Parameters section for a detailed explanation)*

TURN OFF GAS AFTER PROCESS (Yes)	This button toggles between **Yes** and **No**. **Yes** means that all of the gases will be turned off when the process ends. **No** means the last gas settings will remain on after the process ends. This is good if the last step purges the heating chamber and it is desirable to keep purging the chamber after the process ends.
	
	     YES (red) turn off gases after the process has ended
	     NO (cyan) do not turn off gases after the process has ended

LAMP ZONE FACTOR RESET	This button resets all bank factors to the default value of 1.0. (see section *Zone Control* below)
USE ZONE FACTOR LOCAL	**SYSTEM** (cyan) use the default system zone factors that are defined in the *Zone Control* screen **LOCAL** (red) use the zone factors that are defined in the *Recipe Head* screen or the *Page 2 Lamp Zone Control* screen
RECIPE HEAD	Go to the *Recipe Header Editor screen*.

Page 1 Gas Control	This button toggles the Data Entry Area between editing the **Process Parameters** and editing the **Lamp Zone Control Factors** for the recipe.
Page 2 Lamp Zone Control	**CYAN** Edit the Process Parameters. **RED** Edit the Lamp Zone Control factors for each step of the recipe. The factor range is from 0.021 to 3.0. If using the zone factor as defined in the recipe, then make sure the **"Use Zone Factor"** button in the Recipe Editor is set to LOCAL.

The Data Entry Area

The recipe contains steps or instructions that describe the process cycle. Each step describes the state of the process for a certain amount of time. The steps are defined in the data entry area of the *Recipe Editor*. Up to 40 steps can be defined. Each column of the data entry area describes a parameter that is to be controlled or is used to describe how to control a parameter.

No.	This is the Step Number. It denotes the step number and is non-editable.
Step Temp Func	This is the Process Function, which describes the type of process function for that step. It can be RAMP, INTN, STEADY, DELAY, or FINISH.
Steady	During the Steady step, the controller increases and decreases the lamp intensity so the specified temperature can be maintained. It then maintains that value until the specified time spent in the step has elapsed.
Ramp	The Ramp step instructs the controller to increase the temperature at a constant rate until the specified temperature has been reached. The rate is calculated by dividing the difference between the temperature specified in the step and the temperature specified in the previous step by the time specified in the step. The starting temperature is the real measured temperature at the time the step started. The gas flow is set to the specified value as in a STEADY step. **The process controller can not do two consecutive RAMP steps.**
Intn	The controller keeps the lamp power at a constant intensity during an Intensity step. It is normally used to warm up the wafer sufficiently for the pyrometer sensor, since the pyrometer is not reliable below a temperature of 400ºC. If an INTN step is followed by a RAMP or STEADY step and the setpoint temperature has been achieved during the INTN step, then the temperature will be maintained at that setpoint.
Delay	The Delay step instructs the controller to turn the lamps off while setting and maintaining the setpoint of the other controlled parameters (i.e. Gases), until the specified time spent in the step has elapsed.

`Finish`   Finish ends the recipe. This is the last step in the recipe. Once the process controller sees a "FINISH", it stops all processing.

`Time (sec)`   This is the amount of time, in seconds, to act on the current step. The time can be from 1 - 32000 seconds in increments of 1 second. If there is a need for a step that is longer than 32000 seconds, break the step into two or more steps.

✆ CAUTION

Extremely long, high temperature processes may damage the AccuThermo RTP system.

This is the target temperature or intensity the AccuThermo RTP system strives for.
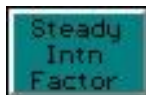
If the step function is **STEADY,** then this is the set-point temperature that is to be maintained.

`Temp/ Intn (°C/%)`   If the step function is **RAMP,** then this is the ending temperature of the ramp.

If the step function is **INTN,** then this is the percentage of the lamp power intensity.

If the step function is **DELAY,** then this field has no effect if this is a DELAY step. The lamps are turned off during this step.

`Steady Intn Factor`   The Steady Intensity Factor is a coefficient used only during RAMP and STEADY steps. It is used at the beginning of the steps to correct the initial lamp power intensity. See the section for fine tuning the system to understand how to use this parameter effectively.

`Gas 1 GAS1 SLPM`   This is the value for the flow rate of GAS 1 for the system.

Gas 2 GAS2 SLPM	This is the value for the flow rate of GAS 2 for the system.
Gas 3 GAS3 SLPM	This is the value for the flow rate of GAS 3 for the system.
Gas 4 GAS4 SLPM	This is the value for the flow rate of GAS 4 for the system.
Gas 5 N2 SLPM	This is the value for the flow rate of GAS 5 for the system.
Gas 6 GAS6 SLPM	This is the value for the flow rate of GAS 6 for the system. (This is depicted as being disabled and can not be used in a process.)
Steady Intn	This is a legacy parameter as is no longer used. It is now a global parameter and is in the *System Setup screen* as the **Intn Tolerance** field. It is normally less than 20%.

When entering data values into the data entry area, the recipe editor checks for out-of-range entries. If a value is out-of-range, the editor will alert you and will advise you of the proper range.

Validating the Recipe
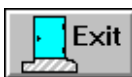
The recipe can be validated by clicking on the **Recipe Validate** button or pressing **F10** on the keyboard. If the recipe is invalid, an error message will appear. Once the error has been corrected, validate the recipe again. It will check for more errors. All errors need to be corrected before the recipe can be used for processing.

Saving the Recipe

The recipe can be saved at anytime by clicking on the [Save] button or pressing **F2** on the keyboard.

Exiting the Recipe

Exit the *Recipe Editor* by clicking on the button or pressing **ESC** on the keyboard. If exiting the *Recipe Editor* before saving the recipe, a dialog box will appear asking if the recipe should be saved.

Click **Yes**   (or press **Y** on the keyboard) to save the recipe.

Click **No**   (or press **N** on the keyboard) to discard all changes since the last save.

Click **Cancel**   (or press **ESC** on the keyboard) to go back to the *Recipe Editor* and continue editing the recipe. It does not save any changes.

Keyboard Editing Keys and Meanings

F2	Save recipe.	
ESC	Exit the *Recipe Editor*.	
Home	Go to the first column of the step.	
End	Go to the last column of the step.	
↑	Move up one line.	
↓	Move down one line.	
←	Move left one column.	
→	Move right one column.	
PgUp	Move up one page.	
PgDn	Move down one page.	
Ctrl + Home	Move to the top of the page yet stay in the same column.	
Ctrl + End	Move to the bottom of the page yet stay in the same column.	
Ctrl + PgUp	Go to the beginning of the recipe.	
Ctrl + PgDn	Go to the end of the recipe.	
Ctrl + Ins	**Line Insert**	Insert a step above the current step.
Ctrl + Del	**Line Delete**	Delete the current step. (click on the step number to select it).
Ctrl + F7	**Line Copy**	Copy the current line into a memory buffer. (click on the step number to select it).
Ctrl + F8	**Line Paste**	Insert a step above the current step and then Paste the step that was copied into the memory buffer into the inserted step.
F8	Show the recipe on a graph.	
F10	Validate recipe.	

While in the process function column (**Step Temp Func**), pressing the first letter of the function name is another way to select the function (i.e. S = STEADY, R = RAMP, I = IDLE, D = DELAY and F = FINISH).

6.2.3   RECIPE HEADER SCREEN
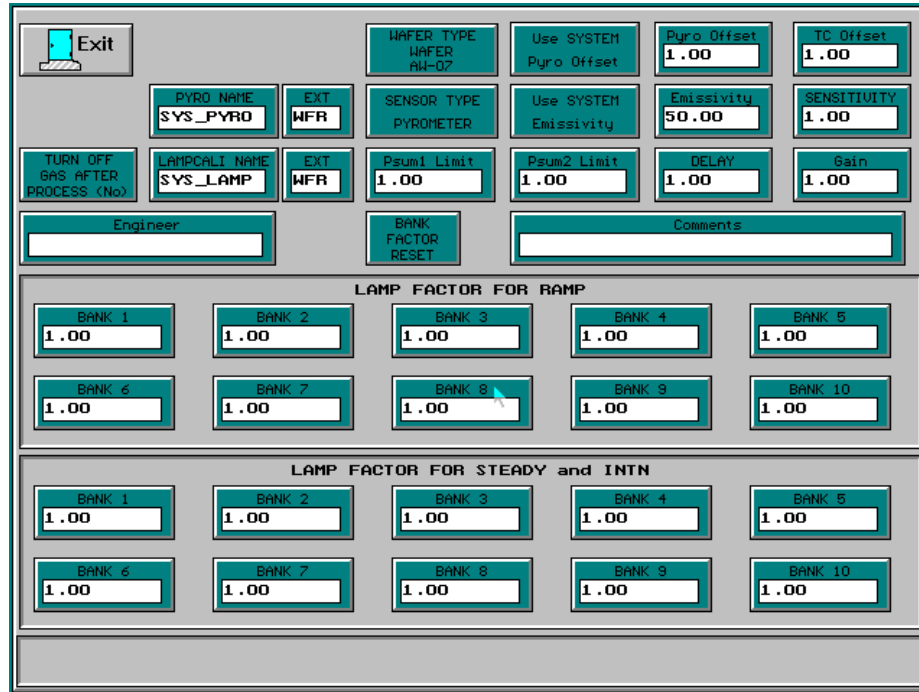
Figure 6-5:   *Recipe Header screen*

The *Recipe Header screen*, figure 6-5, has parameters that are used during all steps of the process recipe. Many of the parameters in the top part of the *Recipe Editor* are also shown here, and can also be changed here. Besides these parameters, the *Recipe Header screen* also includes:

	This is the filename of the pyrometer calibration file for this type of substrate. If the substrate is a wafer, then the file extension (EXT) would be **WFR**. If the substrate is a susceptor, then the file extension would be **SPT**.
	This is the filename of the lamp calibration file for this type of substrate. If the substrate is a wafer, then the file extension (EXT) would be **WFR**. If the substrate is a susceptor, then the file extension would be **SPT**.
Engineer	The name or initials of the engineer creating the recipe
Comments	A comment field about the recipe

LAMP FACTOR FOR RAMP	Adjust the intensity of each zone of lamps with respect to the process control intensity during a RAMP step. The value is a factor of the control intensity.
LAMP FACTOR FOR STEADY and INTN	Adjust the intensity of each zone of lamps with respect to the process control intensity during a STEADY or INTN step. The value is a factor of the control intensity.

6.3   <u>OPTIMIZING THE TEMPERATURE PROFILE</u>

6.3.1   OVERVIEW

The recipes for the control software are optimized after the calibration of the pyrometer and the chamber have been performed. For most process steps the user will encounter, the control parameters need to be adjusted very little.

The control software includes the ability for the process engineer to optimize the temperature control parameters for each recipe. The parameters in the recipe are used to fine-tune the recipe to provide the desirable temperature profile.

The Recipe Parameters optimize the temperature profile. When troubleshooting temperature control, make sure the following parameters are selected correctly.

6.3.2   WAFER TYPE
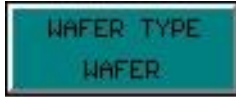
This button toggles between "wafer" and "susceptor". Default value is "wafer".

Make sure this parameter is properly selected for the type of substrate that is to be processed.

If **WAFER** is selected, but a susceptor is to be processed, then the control will be too week and sluggish, and will undershoot. It may never reach the steady state temperature from a RAMP.

If **SUSCEPTOR** is selected when this recipe is for a wafer, then the control of the temperature will be too strong, and it will overshoot, undershoot and oscillate.

☞ NOTE

For III-V compound semiconductor wafers, it is necessary to use a susceptor to hold the wafer due to the IR transparency of the wafer. Because the thermal capacitance of the susceptor is very different from the standard silicon wafer, it is necessary to use a different chamber calibration data specific for the susceptor.

6.3.3   **SENSOR TYPE**

SENSOR TYPE
THERMOCOUPLE
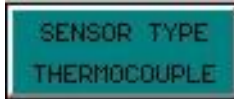
The temperature measurement sensor can be toggled between the TC and pyrometer. The thermocouple is used for processes below 700 °C, while the pyrometer is used for processes between 550 °C and 1250 °C.

✍ NOTE

Remember, the lamps will automatically shut down if the temperature is above 1250°C.   So, if the process temperature is defined to be 1250°C and if there is any overshoot, the lamps will shut down.

CAUTION

Make sure the proper sensor is selected. A selected sensor that is not installed could give low temperature readings. This would make the temperature control increase the lamp intensity too much and may overheat and melt the wafer. The melted wafer could drip onto the quartz ware and break it.

✍ NOTE

There is a difference in response times when running in thermocouple mode versus pyrometer mode. The pyrometer detector has a faster response time which means the temperature control parameters may be different between the thermocouple and the pyrometer.

6.3.4   PYROMETER CALIBRATION FILE

Also known as "Pyro Name".

Enter in the filename of the pyrometer calibration file for this type of substrate. If the substrate is a wafer, then the file extension (EXT) would be **WFR**. If the substrate is a susceptor, then the file extension would be **SPT**.

The default pyrometer calibration file is called "SYS_PYRO".

> ☜ **NOTE**
>
> **Make sure the proper Pyrometer Calibration file is used. This will reduce the invalid temperature measurement due to the difference in backside roughness and doping.**

6.3.5   CHAMBER CALIBRATION FILE

Also known as "LampCali Name".

Enter in the filename of the chamber calibration file for this type of substrate. If the substrate is a wafer, then the file extension (EXT) would be **WFR**. If the substrate is a susceptor, then the file extension would be **SPT**.

The default pyrometer calibration file is called "SYS_LAMP".

> ☜ **NOTE**
>
> **Make sure the proper Chamber Calibration file is selected. This compensates for the thermal capacitance of the chamber and substrate.**

6.3.6   EMISSIVITY

The Process Engineer needs to provide the system software with empirical information in the form of emissivity . This value compensates for the reflective properties that are different from the "standard" wafer. The standard wafer is usually pure silicon and it has an emissivity of 77%.

Compensating for Emissivity

When the pyrometer is used as the temperature sensor for temperature control, the EMISSIVITY compensation must be set to suit the emissivity of the type of wafer being processed.

To determine the correct EMISSIVITY setting, you will need a TC wafer thermocouple assembly or a cantilever thermocouple wafer with its bead in contact with a process wafer. The thermocouple is used to indicate the true temperature in the oven while the oven is run under pyrometer control.

The wafer is heated to the processing temperature that will be used. The output of the thermocouple is read by the control software.

When the steady-state temperature is reached, read the TC temperature. Compare this reading with the pyrometer-indicated temperature. If the readings differ, the EMISSIVITY must be adjusted. The heating cycle and adjustment are repeated until the pyrometer shows the same temperature as indicated by the TC wafer.

If the TC temperature is greater than the pyrometer temperature, then decrease the emissivity.

If the Pyrometer is **less** than the Real Temperature, then **decrease** the emissivity .
If the Pyrometer is **greater** than the Real Temperature, then **increase** the emissivity .

6.3.7　LAMP ZONE FACTORS

If the uniformity of the wafer is such that an undesirable point is over a certain zone of lamps, the lamp zone factor for that zone can be adjusted to compensate for the problem. If the problem is caused by the temperature being too high, then reduce the value for the lamp zone factor.　Default is 1.0.

For the AccuThermo RTP system, only Lamp Zones 1 and 2 are used.　They are the top (Lamp Zone 1) and bottom (Lamp Zone 2) set of lamps.　The process engineer can adjust or even turn off a set of lamps so either the top of the wafer or the bottom of the wafer gets most of the heating.

6.3.8   TEMPERATURE PROFILE STAGES

The temperature profile for any given recipe is shown in figure 6-6. The profile is divided into the following phases:

Delay (Purge)

Intensity (Preheat)

Ramp

Transition

Steady-State

Cool-Down
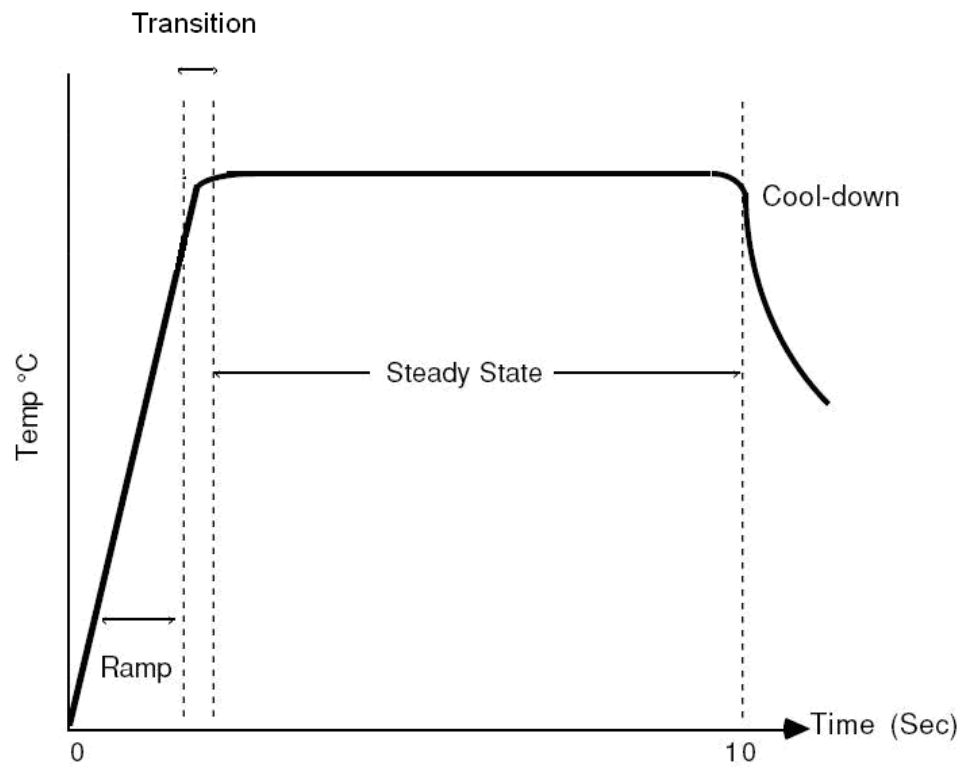
Figure 6-6: *Temperature and Time Profile in a Recipe Cycle*

Stage	Description
Delay	The Delay Stage (not shown in figure 6-6) is used to purge the chamber of ambient air.
Intensity	The Intensity Stage (not shown in figure 6-6) preheats the wafer to a temperature that is sufficient for the pyrometer to be usable. This is normally used if a pyrometer is to be used.
Ramp	The first Ramp of the recipe increases (Ramp Up) the temperature at a controlled rate to a desired setpoint. There can be subsequent Ramps in a recipe, either increasing or decreasing the temperature at a controlled rate to a desired setpoint.
	During a ramp, the intensity is adjusted to have the real-temperature follow the model-temperature.
Transition	The Transition Stage is a stage in which the temperature control changes from a controlled Ramp to a Steady-State control. This transition region starts "Delay" seconds before the programmed steady state value.
	At the beginning of the transition stage, the lamp intensity is reduced to make the change from Ramp to Steady-State.
	At the end of the transition to the Steady-State, the intensity is adjusted, usually increased, to keep the temperature from decreasing below the setpoint.
Steady-State	During Steady-State control, lamp intensity fluctuates to keep the temperature within the Steady-State range ($\pm2°C$). This is the Steady step programmed in the recipe.
Cool-Down	When the Steady-State portion of the cycle is completed, the cycle enters the cool-down phase. The rate of cool-down of the wafer is dependant on heat radiation from the ambient chamber temperature. At high temperatures, the wafer cools at a faster rate, initially, than it does at lower temperatures. The cool-down rate is therefore not uniform.

6.3.9   TEMPERATURE PROFILE OPTIMIZATION

Overview

This section describes the parameters that can be used to optimize the temperature profile and provides a step-by-step tutorial to guide the process engineer to tune the temperature control to get the best temperature profile possible for a new recipe.

Temperature Control Parameters

The following parameters can be found in the *Recipe Editor*. They are used to reduce and eliminate temperature control problems during a process. These parameters are discussed briefly here. The tutorial is an excellent step-by-step discussion to get a good handle on how and why to adjust these parameters.

Gain 1.00	The Gain determines the strength of the temperature control. A strong gain will bring the temperature to the setpoint fast, but it can make the temperature oscillate.
SENSITIVITY 1.00	The Sensitivity is a factor to the GAIN during the Steady step. The Sensitivity determines the strength of the temperature control during the Steady step. A strong Sensitivity will bring the temperature to the setpoint fast, but it can make the temperature oscillate.
Steady Intn Factor 1.00 1.50 2.23 0.70	The control algorithm already understands the intensity has to be reduced when the process transitions from a Ramp Up step to a Steady step. The "Steady Intn Factor" helps fine-tune the amount the intensity needs to change. For the end of the Ramp step, it helps determine how much to reduce the intensity to make the transition smoothly. For the beginning of the Steady step, it helps determine how much to increase the intensity to hold the temperature at the setpoint.
DELAY 1.00	Delay is used for purging the chamber and for natural cool-down of the substrate. There is no heating of the substrate during this step, therefore there is no fine tuning of parameters to perform.
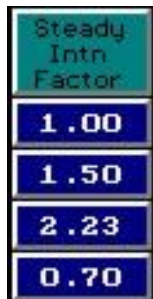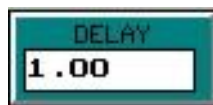
Tutorial

After tuning for one recipe at a medium temperature range for the system, the parameters should be very similar for all the other recipes and wafer type. There would be very little adjustment necessary to tune other recipes if they use the same values for the tuning parameters.

Below gives a step-by-step procedure on how to tune the temperature control to give the best possible temperature profile. After each step, run the recipe to determine the extent the parameter adjustment made on the temperature control and to determine if further adjustment is necessary, before proceeding to the next step.

Review the process data by clicking on the "Display Last Data" button. Move the vertical pink line (using the left and right keyboard arrow keys) so it lines up at a point that is of interest. The values at the top of the screen are the values at the intersection of each curve with the vertical pink line.

Step 1. **CREATE A RECIPE**

Start out by creating a recipe that ramps to a process temperature. If using the pyrometer as the temperature sensor device, then create an INTN (intensity) step before the first RAMP step. Set all the tuning parameters to 1.00 (GAIN, SENSITIVITY, DELAY, Steady Intn Factor).

Step 2. **ADJUST THE INTN STEP**

If using the pyrometer as the temperature sensor device, run the recipe until the intensity step ends.

If the real-temperature is not above the minimum reliable temperature for the pyrometer (usually 400°C, see section for calibrating a pyrometer), either increase the INTN step time or increase the intensity value.

If the real-temperature is far above the minimum reliable pyrometer temperature, either decrease the INTN step time or decrease the intensity value.

Step 3. **ADJUST THE GAIN**

Run the recipe until the RAMP step ends. Observe the Real-Temperature curve (blue) and Intensity curve (red). The Real-Temperature curve should follow the Model-Temperature curve (black) very closely. The Intensity curve should not have large spikes and oscillations, except for the first 2 seconds.

☞ **NOTE**

The real-temperature must be under control when the RAMP step ends. If not, tuning the recipe to get reliable and consecutive results will be impossible.

If the real-temperature doesn't follow the model-temperature, adjust the GAIN by a value of 0.20 (0.6, 0.8, 1.00, 1.20, 1.40, etc.) until it does. Smaller adjustments can be used if necessary. Increase the GAIN if it is always too low. Reduce the GAIN if it is always too high.

If the intensity is too volatile (oscillates with large spikes), decrease the GAIN by decrements of 0.20 (1.40, 1.20, 1.00, 0.8, 0.6, etc.) until the spikes are small, yet the real-temperature should follow the model-temperature closely.

Step 4. **ADJUST THE SENSITIVITY**

Once the GAIN is tuned, adjust the SENSITIVITY.

Run the recipe for about 5 – 10 seconds into the STEADY step. Observe the Real-Temperature curve and Intensity curve. The Real-Temperature curve should follow the Model-Temperature curve very closely. The Intensity curve should not have large spikes and oscillations.

If the real-temperature doesn't move to the setpoint quickly and control to the model-temperature, adjust the SENSITIVITY by increments of 0.20 (0.6, 0.8, 1.00, 1.20, 1.40, etc.) until it does. Smaller adjustments can be used if necessary. Increase the SENSITIVITY if it is always too low. Reduce the SENSITIVITY if it oscillates too much.

If the intensity is too volatile (oscillates with large spikes), decrease the SENSITIVITY by decrements of 0.20 (1.40, 1.20, 1.00, 0.8, 0.6, etc.) until the spikes are small.

Step 5. **ADJUST "STEADY INTN FACTOR" FOR STEADY**

Now, adjust the "Steady Intn Factor" for the STEADY step so the temperature doesn't overshoot or undershoot. If the temperature overshoots during testing of the recipe, reduce this value. If it undershoots during testing, increase this value. Do this in increments of 0.10. Use your judgment if you feel it needs to be adjusted more than 0.10 (0.20, 0.30, etc.).

To get an idea of how much to change it, review the process data by clicking on the "Display Last Data" button. Move the vertical magenta line (using the left and right keyboard arrow keys) so it lines up at the point the temperature starts to transition from the RAMP to the STEADY step (the intensity will suddenly drop at least 5-10% or more). Take note of the intensity. Next, move the vertical line to a point where the intensity is relatively stable during the STEADY step. Take note of this intensity. These 2 intensities should be almost the same value. Use the following formula to calculate the *Steady Intn Factor*.

SIF2 = (I1/I2) * SIF1

where:
I1   intensity that is relatively stable during the STEADY step
I2   the intensity at the beginning of the transition, when it first decreases
SIF1   the current *Steady Intn Factor* for the Steady Step
SIF2   the new calculated *Steady Intn Factor* for the Steady Step

Normally if the chamber was calibrated with current facility conditions, this factor should be close to 1.0. This value should be between 0.5 and 2.0.

Step 6. **ADJUST DELAY**

If the temperature always overshoots, increase the DELAY by increments of 0.20. If the temperature always undershoots (levels out before getting to the setpoint temperature), decrease the DELAY.

Step 7. **FINE TUNING**

Once the "Steady Intn Factor" parameter has been roughly tuned for RAMP and STEADY, adjust it even finer, until it is acceptable.

6.3.10   TROUBLESHOOTING THE TEMPERATURE CONTROL

This section will describe the common problems with temperature control and how to correct them. These problems are temperature oscillation, overshoot and undershoot.

When diagnosing temperature control problems, refer to the process data graph and use the pink vertical line to help understand the situation. The pink vertical line can be moved with the left and right keyboard arrow keys and moving the mouse pointer to a position on the graph and clicking the left mouse button.

Oscillation

Oscillation occurs when the wafer temperature does not stabilize within the steady state or ramp, as shown in figure 6-7. This problem is cause by the temperature control over compensating the intensity to try to get the wafer temperature to the setpoint.
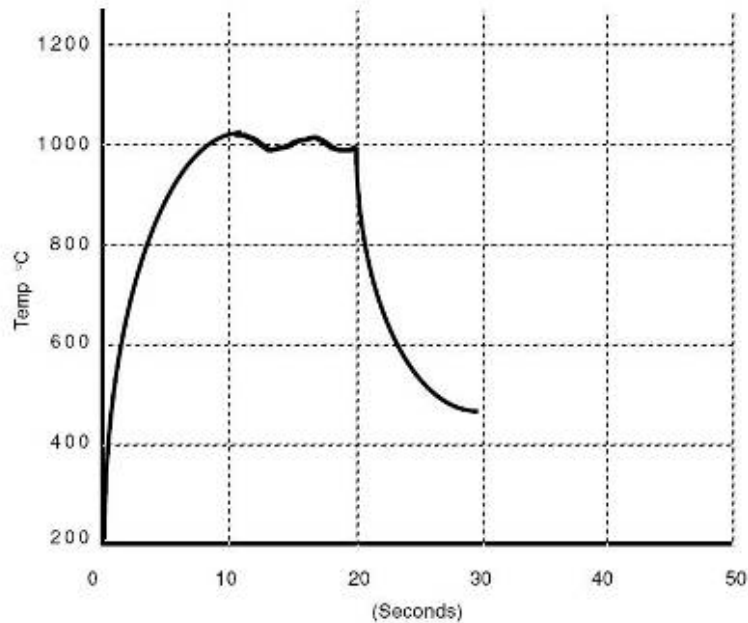
Figure 6-7:   *Oscillations*

➢ During the Ramp step,

   o   short time oscillations are eliminated by decreasing GAIN.

   o   long time oscillations are eliminated by increasing GAIN.

➢ During the Steady step:

   o   short time oscillations are eliminated by decreasing SENSITIVITY.

   o   long time oscillations are eliminated by increasing SENSITIVITY.

Remember, SENSITIVITY is dependent on the GAIN. Therefore, if the GAIN has been changed, SENSITIVITY may also have to be changed.

Be careful. The oscillation of the intensity needs to be controlled. If it spikes too much, the gain needs to be reduced.

Overshoot

An overshoot is when the wafer temperature exceeds the steady state temperature during a transition and then drops back down to the steady state setpoint, as shown in figure 6-8.
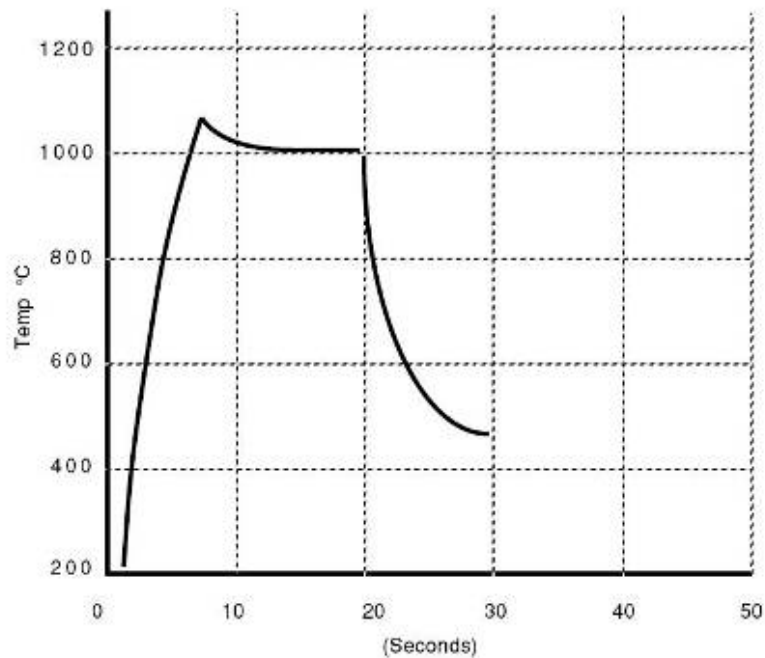
Figure 6-8:   *Overshoot*

The following variables can be changed to compensate for an overshoot. Change only one variable at a time and run a few cycles. If the overshoot still occurs, change another variable.

➢ If the temperature is oscillating during the Ramp Up, there would be a good chance an overshoot would occur. Decrease the GAIN until the oscillation is eliminated (refer to the oscillation section above).

➢ If the overshoot is caused by the intensity being too high during the transition, decrease Steady-Intn-Factor for the RAMP step. The temperature at the end of the transition should be exactly the same as the setpoint for the Steady step.

➢ If the overshoot is caused by the intensity being too high at the end of the transition, decrease Steady-Intn-Factor for the STEADY step.

➢ If the overshoot cannot be controlled during the transition by decreasing the Steady-Intn-Factor for the RAMP step, the transition may be too short. Increase DELAY.

Undershoot

An undershoot occurs when the transition from Ramp to Steady-State is too gradual and the temperature takes too long to get to the Steady-State setpoint, as shown in figure 6-9.
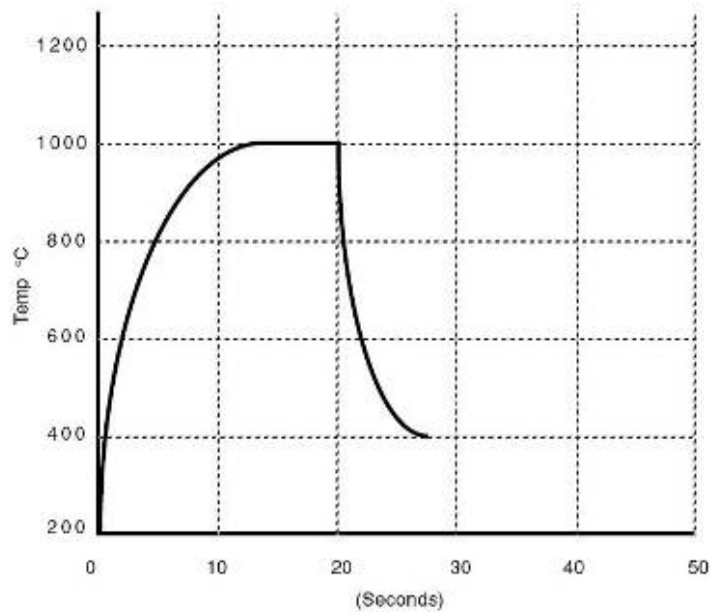
Figure 6-9:   *Undershoot*

The following variables can be changed to compensate for an undershoot. Change only one variable at a time and run a few cycles. If the undershoot still occurs, change another variable.

➢ If the real-temperature is oscillating during the Ramp Up, there would be a good chance an undershoot would occur. Decrease the GAIN until the oscillation is eliminated (refer to the oscillation section above).

➢ If the real-temperature is sluggish during the Ramp Up and not reaching the model-temperature, increase the GAIN until the real-temperature follows the model-temperature.

➢ If the undershoot is caused by the intensity being too low during the transition, increase Steady-Intn-Factor for the RAMP step. The temperature at the end of the transition should be exactly the same as the setpoint for the Steady step.

➢ If the end of the transition reaches the setpoint temperature, but there is a dip at the beginning of the Steady step, the intensity is too low at the end of the transition. Increase Steady-Intn-Factor for the STEADY step.

➢ If the Steady-Intn-Factor for the Ramp and Steady steps are large, then the DELAY may be too large. Decrease DELAY.

6.3.11   PROCESS CONTROL ALARMS

Alarm Parameters

The control software has alarm parameters that will cause an alarm if a parameter goes beyond the set tolerance. These alarm parameters will warn of certain conditions developing during the process.

The values of these alarm parameters can be changed by the user to prevent a condition that may ruin a wafer or even damage the machine. It is unlikely the machine will be damaged, though, because it has built-in safeguards.

Refer to the appropriate section of an Alarm Parameter for a greater explanation of these parameters.

The following parameters can be found in the *System Setup* section.

> ➢ MaxTemp (WFR)
> ➢ MaxTemp (SPT)
> ➢ Trmp Tolerance
> ➢ Tstd Tolerance
> ➢ ez-P Tolerance
> ➢ Psum1 Tolerance
> ➢ Psum2 Tolerance
> ➢ Intn Tolerance

The following parameters can be found in the *Gas Setup* section.

> ➢ Gas Tolerance
> ➢ Check Gas

The following parameters can be found in the *Recipe Editor* section.

> ➢ PSum1 Average
> ➢ PSum2 Average

PSum

PSum is the integration of the intensity starting from the beginning of a ramp step and ending at the end of the following steady-state step. This, basically, measures the amount of energy applied to the wafer. For the same kind of wafer with the same recipe, PSum with one wafer should be repeatable for another similar wafer, under perfect conditions. Factors affecting repeatability can be a dirty quartz isolation tube , a lamp failure, or an improperly functioning temperature sensor.

After processing several wafers and the processes went well, the engineer can calculate the average PSum from these processed wafers. Processing subsequent wafers will reveal degradation with the machine. If the measured temperature from the sensor is higher than the real temperature of the wafer, PSum will be smaller than the average PSum. If the measured temperature is lower than the real temperature, PSum will be larger than the average PSum. To get the same temperature control if the quartz isolation tube is dirty, PSum will be larger than the average PSum. To get the same temperature control if some of the lamps have degraded or are bad, PSum will be larger than the average PSum.

A recipe can have more than one ramp step followed by a steady-state step. The PSum for the first ramp/steady-state pair is called PSum1. The PSum for the second ramp/steady-state pair is called PSum2. The benefit to using PSum1 and PSum2 is to avoid damaging any single wafer, since it will stop the process during the steady-state steps if Psum1 or Psum2 are out of range. It is believed that only 2 PSum's are needed.

The engineer can set parameters which use the PSum information to alarm and abort the process if PSum1 or PSum2 exceed a specified tolerance from that of the average PSum1 or PSum2. These parameters are **PSum1 Average** (Limit), **PSum1 Tolerance**, **PSum2 Average** (Limit) and **PSum2 Tolerance**.

The average PSum is determined by averaging the PSum from several wafers. Once the average of PSum1 has been determined by the engineer, it can be entered into the **PSum1 Average** field in the *Recipe Editor*. **PSum2 Average** is done the same way for PSum2. **PSum1 Average** and **PSum2 Average** can be any positive value.

The tolerance of PSum is a window that encompasses the average PSum. If PSum is either too large or too small so that it is above or below this window, then an alarm will be issued. The tolerance of PSum is specified as a percentage of the average PSum. Therefore, the tolerance of PSum is **PSum1 Tolerance** or **PSum2 Tolerance**, which are found in the *System Setup* screen. By default, **PSum1 Tolerance** and **PSum2 Tolerance** are set to 20%.

The alarm can be disabled by making **PSum1 Average** and **PSum2 Average** less than 10.0. This is necessary for the first several wafers in order to get some statistical data to determine the average PSum for **PSum1 Average** and **PSum2 Average**.

6.3.12   TROUBLESHOOTING THE PROCESS CONTROL

Intensity varies and spikes greatly when starting a RAMP.

➢ If using the pyrometer, the starting temperature is not high enough for the pyrometer to sense the temperature reliably. Use the intensity step and make the intensity high enough and long enough so when the intensity step ends, the temperature of the wafer is high enough for the pyrometer to sense the correct temperature.

➢ If using the thermocouple, the GAIN is too large. Reduce the GAIN in the recipe.

Gases do not turn off after process ends

There is a button in the recipe editor that allows the gases to flow after the process ends. It is called "Turn Off Gas After Process". Toggle it so it displays "YES".

6.4   PROCESS ADMINISTRATION

6.4.1   PROCESS FOR PRODUCTION

The *Process for Production screen*, figure 6-10, is designed for the production operator in mind. It features a limited amount of controls so the operator only needs to press a few buttons to start running a process. It allows the selection and processing of predefined recipes. It also allows viewing graphically the process data.
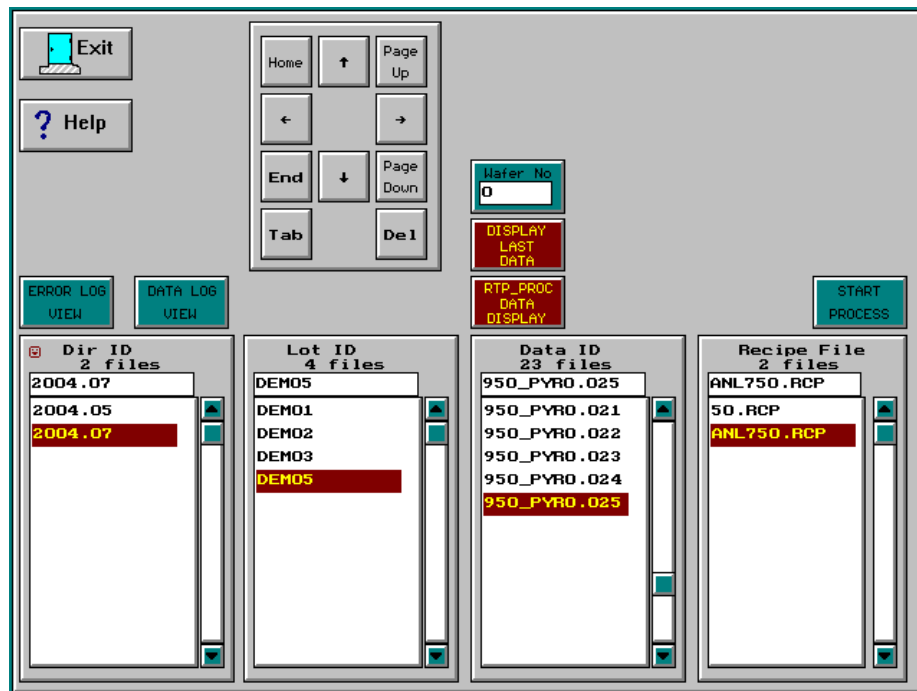
Figure 6-10: *Process for Production screen*

Location: Main Menu ➔ Process for Production

Wafer No.	The number of wafers that have been processed for the selected recipe. This will be used for the wafer ID for the next wafer that will be processed with the selected recipe.
Display Last Data	View the process data graphically of the last wafer that was processed on the *Process Plotting screen*.
RTP_PROC Data Display	Display the selected process data graphically on the *Process Plotting screen*.

Dir ID	This groups certain types of lots together.
Lot ID	The user defined lot ID. All process data pertaining to this lot should be kept under here.
Data ID	The process data for each wafer is stored here. The operator can review the process of each of the process data.
Recipe File	This lists the available recipes. The operator needs to select a recipe before processing the wafer.

6.4.2   PROCESS FOR ENGINEER

The *Process for Engineer screen*, figure 6-11, is designed for the production and maintenance engineers in mind. It is a flexible dialog which allows the engineer to create recipes and process a wafer.
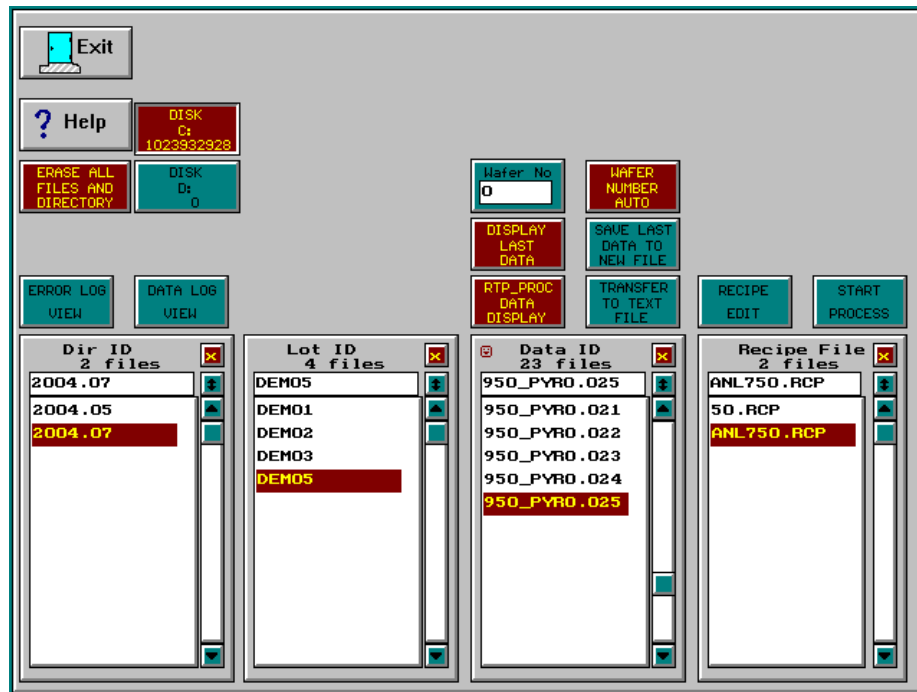
Figure 6-11: *Process for Engineer screen*

Location: Main Menu ➜ Process for Engineer

Wafer No.	The number of wafers that have been processed for the selected recipe. This will be used for the wafer ID for the next wafer that will be processed with the selected recipe.
Wafer Number	Automatically increment the "Wafer No." (process wafer number) for the selected recipe, or the user has to manually change the wafer number.
	Auto Automatically increment the process wafer number
	Manual User manually changes the wafer number
Display Last Data	View the process data graphically of the last wafer that was processed on the *Process Plotting screen.*

RTP_PROC Data Display	Display the selected process data graphically on the *Process Plotting screen*.
Recipe Edit	Loads the selected recipe file into the *Recipe Editor* to allow the engineer to modify the recipe.
Start Process	Start processing the wafer that is in the process chamber, using the recipe that is selected.

Dir ID	This groups certain types of lots together.
Lot ID	The user defined lot ID. All process data pertaining to this lot should be kept under here.
Data ID	The process data from each wafer is stored here. The operator can review the process of each of the process data.
Recipe File	The list of recipes which are available to be used to process wafers in the process chamber.

6.5   **FILE ADMINISTRATION**

The *Process for Engineer screen* includes 3 additional options for file administration:

Transfer to Text File	This button creates a translation of the selected process data file to text and copies it to a floppy disk (drive A:), precede the filename with A:.
Save Last Data to New File	This button saves the generated process data to the hard disk under the Dir ID and the Lot ID. The filename that is given is the same as the recipe that was used to process the substrate. The file extension is generated by the number of processes that were run using this recipe. Example: if this was the 7th time the recipe was run, then the file extension would be 007.
(delete)	Delete Recipes, Data files, Lots and Directories. The delete button is located on each of the list boxes. (See **Filename Lists** in the "How to Use the Menu Screens" section.) It is used to delete the selected item in the list box. Example: To delete a Data File, select the Data File and then click on the red box in the Data File list box. Note: Recipes cannot be deleted from this screen. Only from the *Recipe Edit Selection* screen.

File Extensions

The manual recommends using "RCP" for recipe extensions, but the software does not force you to do this. "RCP" makes it easier for a user to determine the type of file based on its extension. The software, however, separates the different types of files into their respective directories. So it really depends on which directory the file came from that determines the type of file it is, according to the software. However, you don't want to put a calibration file into the recipe directory. It will be listed in the "Recipe File" list box. But if you try to load it into the recipe editor, it will give unpredictable results.

Recommended extensions:
RCP   for recipes
WFR   for calibration files for a wafer
SPT   for calibration files for a susceptor
001 - 999   for process data files

7.   SOFTWARE SETUP

7.1   OVERVIEW

There are many different ways the AW-900 control software can be setup. Some settings depend on the factory configuration. Sometimes the customer configures the software their own particular way. This section will guide and explain the many choices to setup the software.

Many of these settings will never be changed once the software has been setup, and many of them are already setup at the factory.
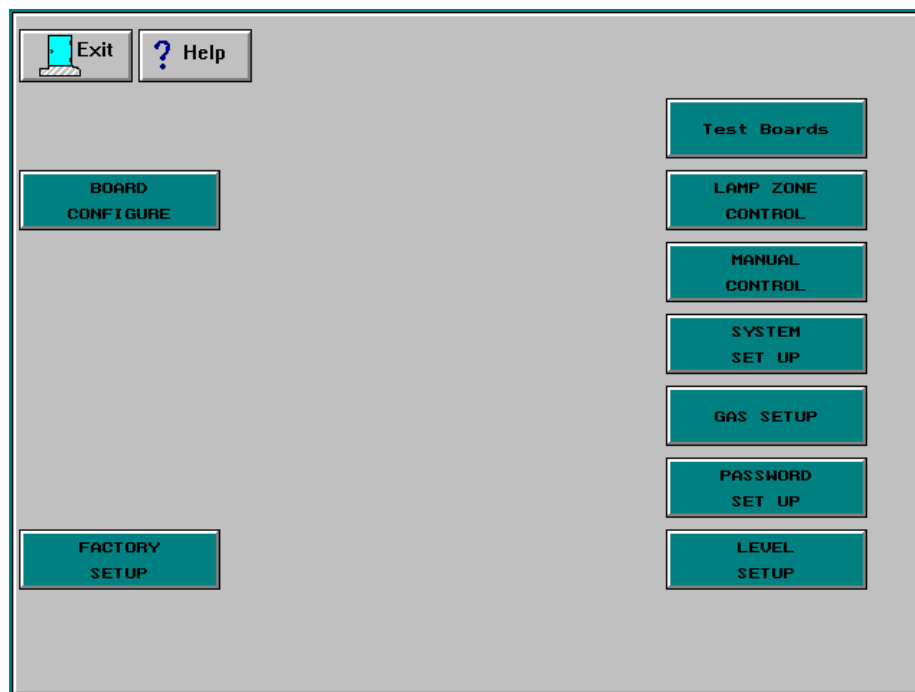
Figure 7-1: *Maintenance Menu*

Location: Main Menu ➔ Maintenance Menu

The *Maintenance Menu,* figure 7-1, allows access to the screens that allow changing and configuring of the settings.

7.2   CONTROL BOARD SELECTION

The proper configuration depends on the hardware that is used in the AccuThermo RTP system. Figure 7-2 shows the different communication and control boards available.
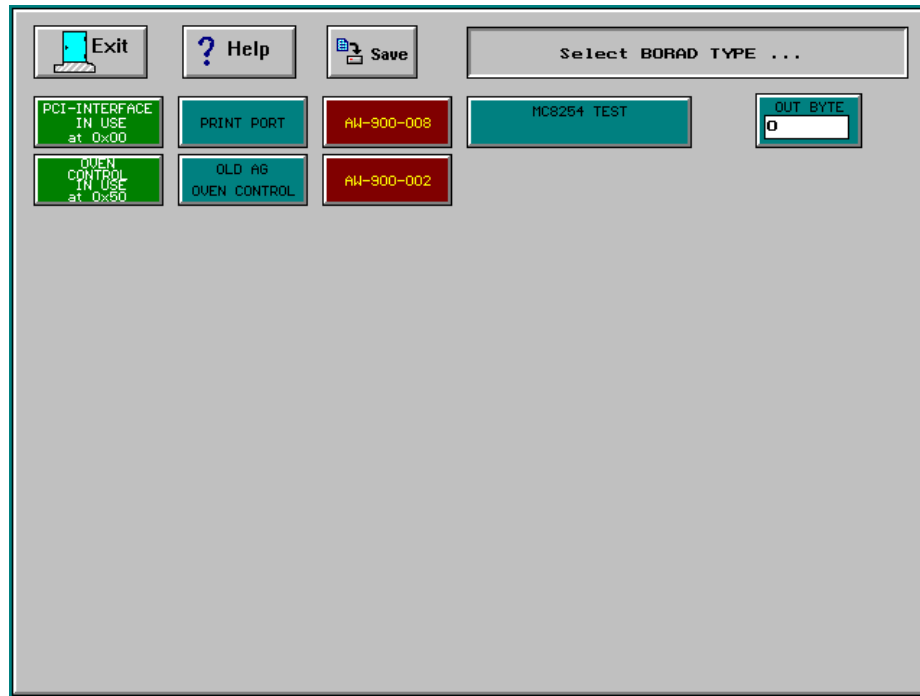
Figure 7-2:   *Board Selection screen*

Location: Main Menu ➔ Maintenance Menu ➔ Board Configure

The system interface in the computer controller is determined by the **PCI-INTERFACE**.

The interface in the oven unit is the **OVEN CONTROL**. It is Allwin21's AW-900-058 control board.

☞ CAUTION

The PCI-INTERFACE and the OVEN CONTROL are pre-configured at the factory and should not be changed. Changing the settings from the factory settings will render the AccuThermo RTP system inoperable.

7.3   <u>FACTORY SETUP</u>

The Factory Setup screen, figure 7-3, allows configuring the system to settings the factory deems proper for the system. These settings should not be changed by the user.
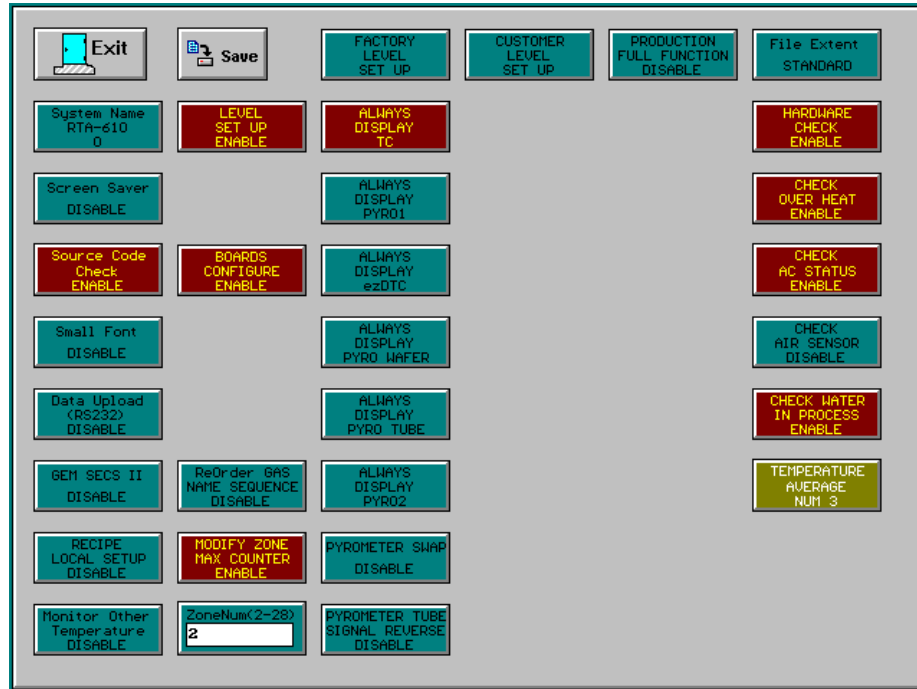
Figure 7-3:   *Factory Setup screen*

Location: Main Menu ➔ Maintenance Menu ➔ Factory Setup

Save	Save the changes to the system and configuration file
FACTORY LEVEL SETUP	Revert back to the factory default settings
CUSTOMER LEVEL SETUP	Change to the customers last saved settings
PRODUCTION FULL FUNCTION	Allows the Production Operator extra functions in the "Process for Production" screen.
File Extent	STANDARD – the standard 3 character extension for a filename

System Name	Select the appropriate name for the system. This defines the system so the software knows which machine is connected to the computer.
Screen Saver	Enable (yes) / Disable (no) the Screen Saver.
Small Font	Enable (yes) / Disable (no) the Small Font
DATA UPLOAD (RS232)	
GEM SECS II	Enable (yes) / Disable (no) the GEM SECS II communication.
Recipe Local Setup	Enable / Disable the user to use the local values for certain parameters in a recipe.
LEVEL SETUP	Ability to access the Level Setup screen.
BOARDS CONFIGURE	Ability to access the Board Setup screen.
Reorder Gas Names	Allows the user to change the order of the gas names.
MODIFY ZONE MAX COUNTER	Enable/disable changing the Lamp intensity counter max value. This essentially turns off the lamps. If it is any larger, then there would be a chance the trigger, when the counter finishes, is too close to the zero crossing. Then the lamps would flicker, sometimes being very bright. Default: (60 Hz = 7800), (50 Hz = 9360)
Zone Num(2-28)	The number of banks of lamps the system is setup to control. For the RTA-210, RTA-410 and RTA-610, this is always 2.

Always Display TC	Plot the temperature indicated by the thermocouple on the graph screens *Process Display* and the *Manual Control*. **red** Plot **cyan** Do not plot
Always Display Pyro1	Plot the temperature indicated by the pyrometer on the graph screens *Process Display* and the *Manual Control*. **red** Plot **cyan** Do not plot
Always Display ezDTC	This option is not available for the AW-900 systems.
Always Display Pyro Wafer	Plot the voltage (mV) output of the pyrometer that is "looking" at the wafer on the graph screens *Process Display* and the *Manual Control*. **red** Plot **cyan** Do not plot
Always Display Pyro Tube	Plot the voltage (mV) output of the pyrometer that is "looking" at the quartz tube on the graph screens *Process Display* and the *Manual Control*. **red** Plot **cyan** Do not plot
Always Display Pyro2	If there is a dual color pyrometer or a second set of pyrometers mounted on the chamber, then plot the temperature indicated by the pyrometer on the graph screens *Process Display* and the *Manual Control*. **red** Plot **cyan** Do not plot
Pyrometer Swap	Swap the wafer pyrometer and tube pyrometer signals.
Pyrometer Tube Signal Reverse	If the tube pyrometer is going negative when the temperature is increasing, then this will reverse the signal of the pyrometer and have it go positive.

HARDWARE CHECK	Ability to turn off checking of the hardware during a process so the system will not alarm because of some boarder-line hardware problem.
CHECK OVER HEAT	Enable/disable checking of the over heat sensor
CHECK AC STATUS	Enable/disable AC power checking. The software checks if the main power from the wall is on.
CHECK AIR SENSOR	Check the cooling air sensor (optional) during the process to make sure cooling air is flowing.
CHECK WATER IN PROCESS	Check the cooling water sensor during the process to make sure cooling wafer is always flowing.
TEMPERATURE AVERAGE	The number of consecutive temperature samplings to average for a reading of the temperature to be displayed and logged.

7.4   <u>SYSTEM SETUP</u>

The *System Setup screen*, figure 7-4, contains global settings the user can change for their desired system setup.
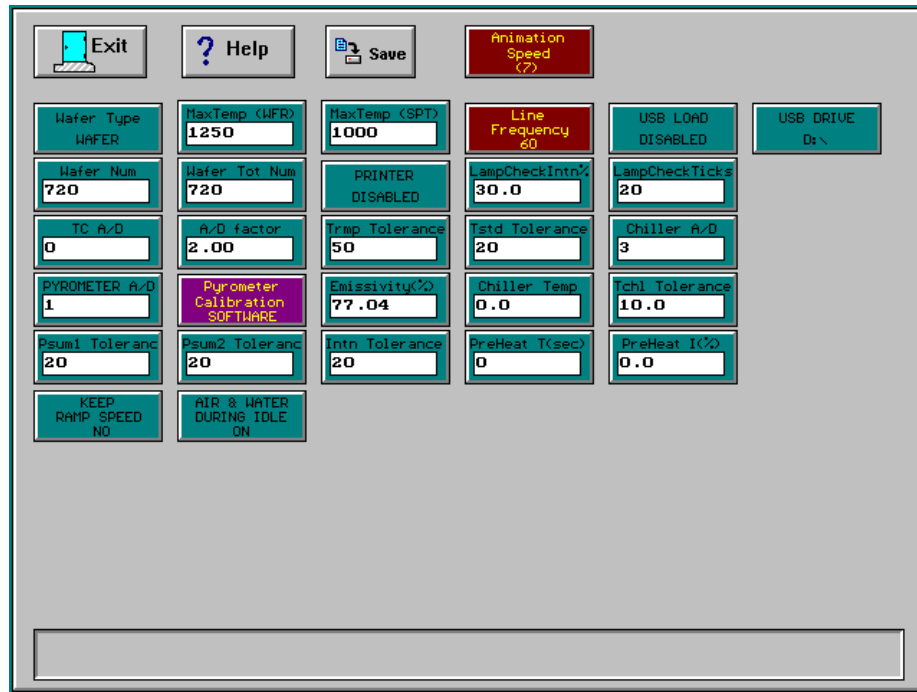
Figure 7-4:   *System Setup screen*

Location: Main Menu ➔ Maintenance Menu ➔ System Setup

Save	Save the settings to the configuration file.
Animation Speed	This controls the speed of the animated bitmap buttons in the main menu. The larger the number, the slower the animation. (0 = no animation)

Row #1 (Top Row)

Wafer Type	WAFER, SUSCEPTOR
MaxTemp (WFR)	The maximum allowed temperature for a wafer
MaxTemp (SPT)	The maximum allowed temperature for a susceptor
Line Frequency	The electrical supply frequency for the system (50 Hz or 60 Hz)

Row #2

Wafer Num	Display only. The number of wafers that have been processed. (can be reset by customer)
Wafer Tot Num	Display only. The number of total wafers processed by the machine since it was built at the factory.
PRINTER	ENABLED, DISABLED
LampCheckIntn%	When doing a Lamp Check in the *Lamp Zone Control* screen, set the intensity to this value.
LampCheckTicks	When doing a Lamp Check in the *Lamp Zone Control* screen, do it for this number of ticks. Each tick is 55ms in duration.

Row #3

TC A/D	The analog channel (0 – 7) the thermocouple is connected to
A/D Factor	Factory determined only. Depends on the A/D chips used.
Trmp Tolerance	The amount the measured temperature during a RAMP step of a process can deviate (+/-) from the model temperature during a process. (Specified in percent of maximum temperature.)
Tstd Tolerance	The amount the measured temperature during a STEADY step of a process can deviate (+/-) from the model temperature during a process. (Specified in percent of maximum temperature.)
Chiller A/D	

Row #4

PYROMETER A/D	The analog channel (0 – 7) the pyrometer is connected to
Pyrometer Calibration	Calibrate the pyrometer by means of Software, Hardware, or Disable the calibration.
Emissivity (%)	33% - 100%. A standard silicone wafer has an emissivity of 77.04%.
Chiller Temp	The temperature setpoint of the pyrometer chiller.
Tchl Tolerance	The tolerance the temperature of the chiller can deviate from the pyrometer chiller's setpoint.

Row #5

Psum1 Tolerance	If, during a process, PSum1 exceeds a certain percent of PSum1 Average, as specified in the recipe, an alarm will be generated. Default is 20%. *(see PSum in the Alarm Parameters section for a detailed explanation)*
Psum2 Tolerance	If, during a process, PSum2 exceeds a certain percent of PSum2 Average, as specified in the recipe, an alarm will be generated. Default is 20%. *(see PSum in the Alarm Parameters section for a detailed explanation)*
Intn Tolerance	Is used during the STEADY step to determine if the system is having a hard time heating a wafer as compared to previous wafers. Default is 20%.
Preheat T(sec)	When a process starts, the system preheats the chamber for T seconds
Preheat I(%)	When a process starts, the system preheats the chamber with intensity I.

Row #6

KEEP RAMP SPEED	**YES**	The model recipe curve will follow the theoretical recipe curve. That is, the black curve on the run process screen will align itself to the green curve whenever there is a Ramp. In other words, it will keep the ramp rate to the specified temperature in the recipe.
	NO	The model recipe curve will <u>not</u> follow the theoretical recipe curve during a Ramp. In other words, it will calculate the ramp rate based on the time specified in the step and the difference between the current temperature and the specified temperature in the recipe.

This is usually a situation for the first Ramp of the recipe, where the starting temperature is unknown until the Ramp step starts.

AIR & WATER DURING IDLE		Turn off the air and water 5 minutes after the machine sits idle.
	cyan	ON, keep the air and water always on. Do not turn it off
	red	OFF, turn off the air and water after 5 minutes.

7.5   <u>GAS SETUP</u>

The Gas Setup gives the ability to setup the gas name, gas flow rate unit, maximum flow rate, flow rate factor, A/D and D/A channel.

Figure 7-5:   *Gas Setup*

Location: Main Menu ➔ Maintenance Menu ➔ Gas Setup

Save	Save the settings to the configuration file.
Gas Tolerance	The amount the **<u>Gases</u>** can deviate (+/-) from the setpoint during a process. (Specified in percent of maximum gas flow rate.)
CHECK GAS	Check to see if the gas is flowing during the process.
NCTN Flow	N/A
Purge Flow	The amount of purge gas that is constantly flowing whenever a process is not running.

Gas Name	The name of the gas that will be displayed on various screens throughout the control software.
Unit	The unit of gas flow through the MFC (SLPM or SCCM)
(*color*)	The color to plot the gas flow on the process run screen
Gas MaxFlow	The maximum gas flow allowed by the MFC
FACTOR	The gas conversion factor relative to nitrogen (or whatever the MFC was calibrated for).
D/A	The D/A channel the MFC is connected to. Normally, these values will never be changed.
A/D	The A/D channel the MFC is connected to. Normally, these values will never be changed.
Valve	The digital channel the On/Off gas pneumatic valve is connected to.
Use Gas	Enable (yes) / Disable (no) the gas usage. Enable (yes) / Disable (no) using the gas. If disabled, then the gas cannot be used anywhere in the AW-901 control software.

> ## ☠ WARNING
>
> **The gas channels are determined at the factory and should <u>NOT</u> be changed. Changing them will either prevent gas flow or create an undesirable gas mixture or flow rate.**
>
> **PLEASE LEAVE THESE ALONE.**

7.6   GEM/SECS II MANAGEMENT

GEM/SECS II is a specification developed by the Semiconductor Equipment and Materials International (SEMI) trade association. This standard details the requirements for communication between manufacturing equipment and a host controller in a GEM/SECS II environment

In this section it is assumed that the user has an understanding of GEM/SECS II communication and has the ability to setup and configure the GEM/SECS II communication to their factory host system.

To enable GEM/SECS II for this system, go to the *Factory Setup* screen and enable the **GEM SECS II** button. Then go to the *RS232 Configure* screen to enable the GEM/SECS II communication port.
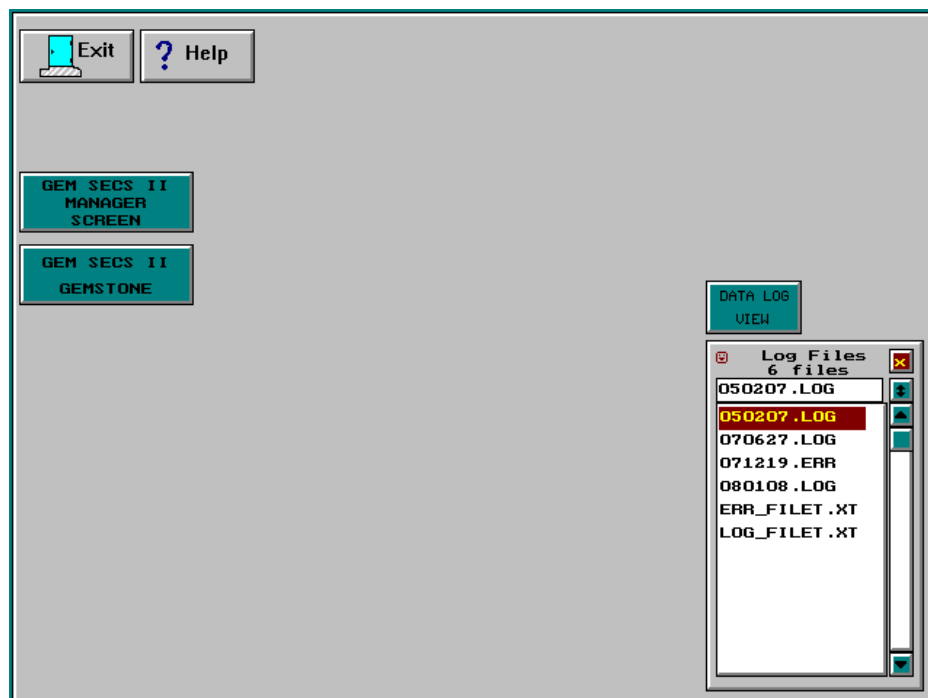
Figure 7-6:   *GEM/SECS II Management Menu*
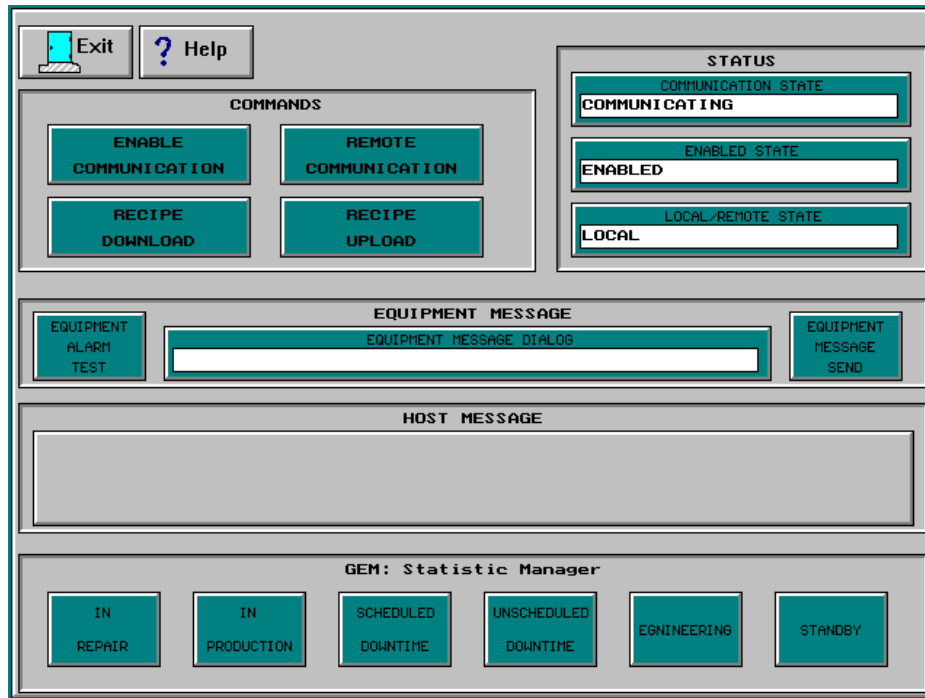
Figure 7-7: *GEM/SECS II Manager screen*
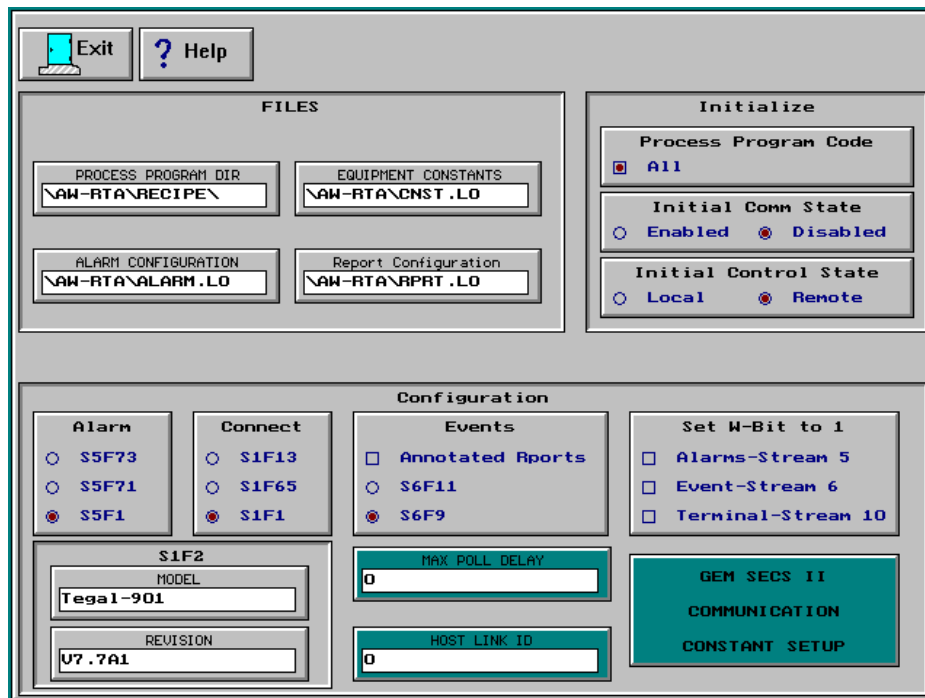
Figure 7-8: *GEM/SECS II Gemstone Setup screen*

8. SECURITY

8.1   PASSWORD SETUP

Figure 8-1:   *Password Setup*

Location: Main Menu ➔ Maintenance Menu ➔ Password Setup

To setup a user account, enter in the USER ID, USER NAME, PASSWORD and USER LEVEL.

There are 7 password levels available to manage user accounts. (See the Level Setup section for an explanation on the levels.)

Click the **PASSWORD DISABLE / ENABLE** button to disable or enable the password protection. When password protection is enabled, users have to logon on, before access to the software is allowed.

8.2 LEVEL SETUP
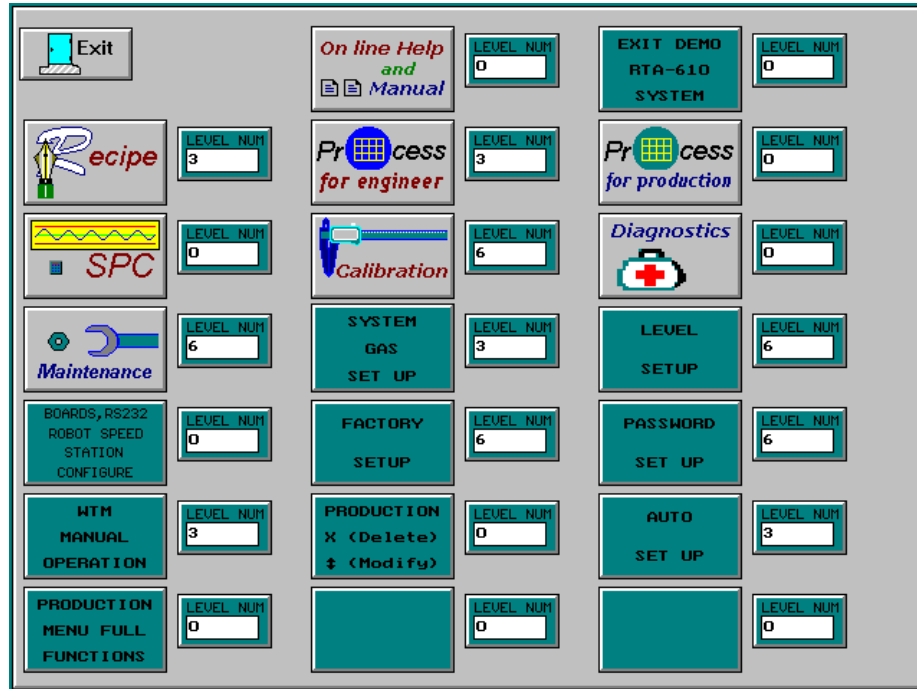
Figure 8-2: *Level Setup*

Location: Main Menu ➔ Maintenance Menu ➔ Level Setup

The *Level Setup screen*, figure 8-2, allows system administrators to change the degree of level for different screens. There are 7 levels of password protection. Level 0 allows anyone access to that item. Level 6 allows only system administrator access.

User Access Level	User's Accessibility
0	Can only access level 0
1	Can access levels 1 and 0
2	Can access levels 2, 1 and 0
3	Can access levels 3, 2, 1 and 0
4	Can access levels 4, 3, 2, 1 and 0
5	Can access levels 5, 4, 3, 2, 1 and 0
6	System Administrator... Can access levels 6, 5, 4, 3, 2, 1 and 0

After the levels have been changed, the control software has to be re-booted.

If the user tries to access a function that has a level which he is not allowed to enter, the control software will display the message:

"You don't have the right level for this function".

The user must log on with an appropriate level. Either the user logs on with another user name and password with the appropriate level or have the system administrator change the level for the user.

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9. TEMPERATURE MONITORING

9.1 OVERVIEW

The AccuThermo RTP system can be equipped with two types of temperature monitoring devices: an optical pyrometer and a thermocouple.

The optical pyrometer is the extended range pyrometer (ERP). Unlike earlier pyrometers used that were restricted to use at process temperatures above 800°C, the ERP can be used throughout the recommended process temperature range of 400°C to 1200°C.

The thermocouple is used for controlling processes at temperatures below 800°C.

9.2 OPTICAL PYROMETRY

Optical pyrometry is the preferred method of monitoring process wafer temperature because of a fast response time and low service requirements.

The Extended Range Pyrometer (ERP) which is discussed in detail in the following section, is an optical pyrometer attached to the bottom plate of the oven. Radiation from the wafer reaches the pyrometer through the bottom of the transparent quartz isolation tube and through a small aperture in the oven floor. The pyrometer converts detected infrared light energy to a voltage.

Optical pyrometer readings are emissivity-dependent. This means that these readings are affected by changes in wafer backside surface color and roughness, deposited backside layers, or variations in substrate materials.

9.3 THE EXTENDED RANGE PYROMETER (ERP)

The Extended Range Pyrometer (ERP) is a dual infrared detector that provides accurate and consistent temperature measurement during rapid thermal processing of semiconductor wafers. The ERP measures wafer temperature by detecting infrared light radiation emitted from the wafer within a specified wavelength range. The resulting signal is adjusted to compensate for the effects of non-wafer radiation sources.

Undesired radiation emitted from non-wafer sources must be compensated for or filtered out in order to accurately measure wafer temperature inside an AccuThermo RTP system heating chamber. Sources of undesired radiation include the tungsten halogen heating

lamps and light energy emitted from the isolation tube . Figure 9-1 shows the distribution of each primary source of radiation within the heating chamber.
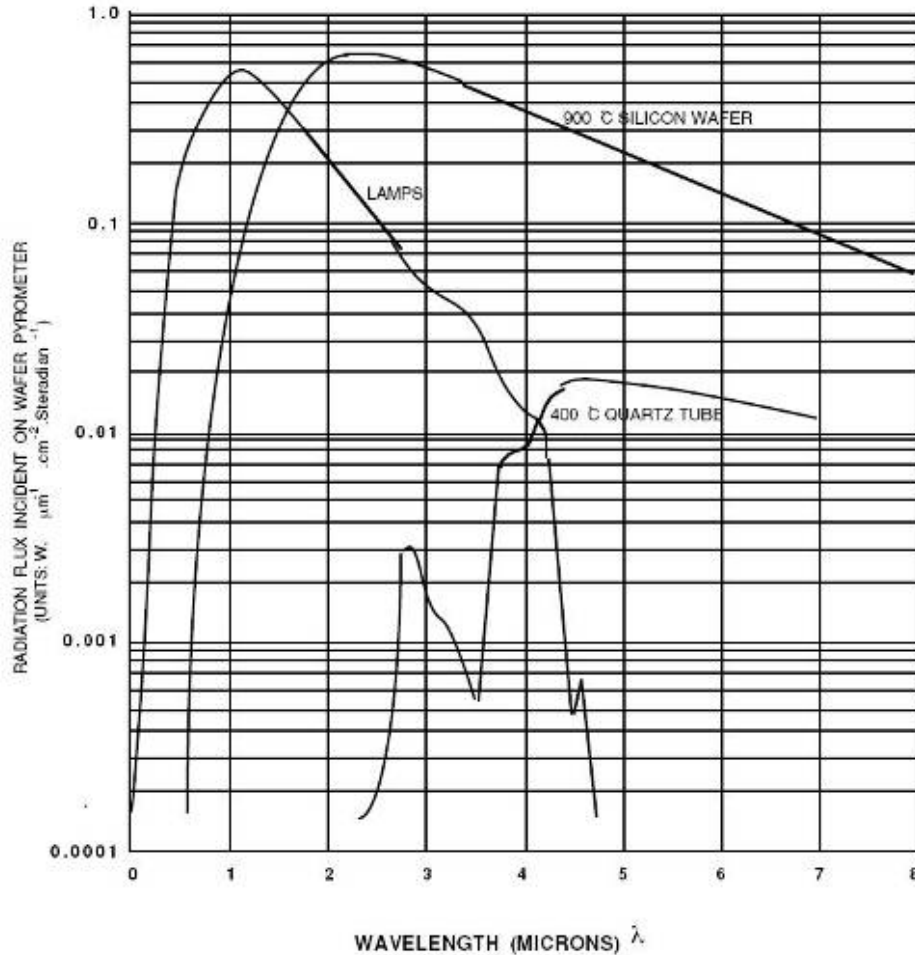
Figure 9-1: *ERP Dual Pyrometers Radiation Wavelengths*

During extended heating cycles, the temperature of the thermopile and AccuThermo RTP system quartz isolation tube gradually increases. Thermopile heating causes increased output signal voltage without a corresponding increase in received infrared radiation. Isolation tube heating creates an additional source of infrared emission adding to and increasing the infrared energy being received by the pyrometer. These phenomena both work to distort the wafer temperature measurements of the optical pyrometer. To eliminate the effects of thermopile heating, the ERP incorporates a water-cooling system that maintains a steady pyrometer thermopile temperature. To minimize the effects of quartz isolation tube heating, the quartz isolation tube is cooled with compressed nitrogen or clean dry air (CDA). This maintains the temperature of the tube within a specified range but does not entirely prevent the temperature measurement distorting effects of isolation tube heating.

Additional cancellation of the effects of isolation tube heating is enabled by the dual range infrared detection capability designed into the extended range pyrometer. Specifically, the ERP incorporates both a Wafer-Sensing Pyrometer (referred to as the Wafer Pyrometer) and a Tube-Sensing Pyrometer (referred to as the Tube Pyrometer). Each of these pyrometers incorporates a different proprietary infrared band pass filter.

➤ Wafer Pyrometer: The wafer-sensing pyrometer measures wafer temperature by "looking" at the wafer through the quartz isolation tube. During wafer processing, the heating of the isolation tube causes the wafer temperature measurements to "drift". To minimize this problem, a proprietary "pyrometer window" has been installed into the bottom of the quartz isolation tube. Mounted below a small aperture in the bottom plate of the AccuThermo RTP system heating chamber, the Wafer Pyrometer measures wafer temperature through this opening. (See Figure 9-2.)

➤ Tube Pyrometer: The tube-sensing pyrometer measures wafer temperature, including a maximized level of isolation tube heating induced "drift" by looking at the wafer through the thickest part of the quartz isolation tube.
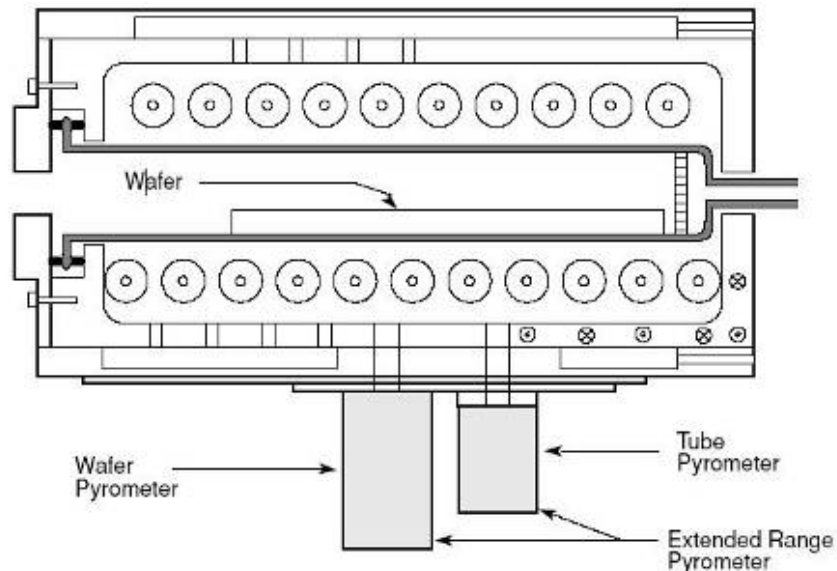
Figure 9-2: *Extended Range Pyrometer*

To cancel the effect of additional radiation from the quartz tube and other sources, measurements taken from the Tube Pyrometer are combined with measurements from the Wafer Pyrometer. This enables the system to correct for the effects of isolation tube heating.

Specifically, the software subtracts a fraction of the Tube Pyrometer output signal from the output signal of the Wafer Pyrometer. The difference of the two signals provides a precise indication of wafer temperature. The resulting signal is mapped by the software for the full range of processing temperatures (from 400°C to 1200°C).

To further insure accuracy, the pyrometer calibration is performed using calibrated thermocouple wafers in the heating chamber.

The operating specifications for the ERP are listed below. Figure 9-3 shows ERP temperature measurement with respect to time.

Range	400°C - 1200°C
Accuracy	±3.5°C
Repeatability	±3.5°C
Application	Silicon and GaAs
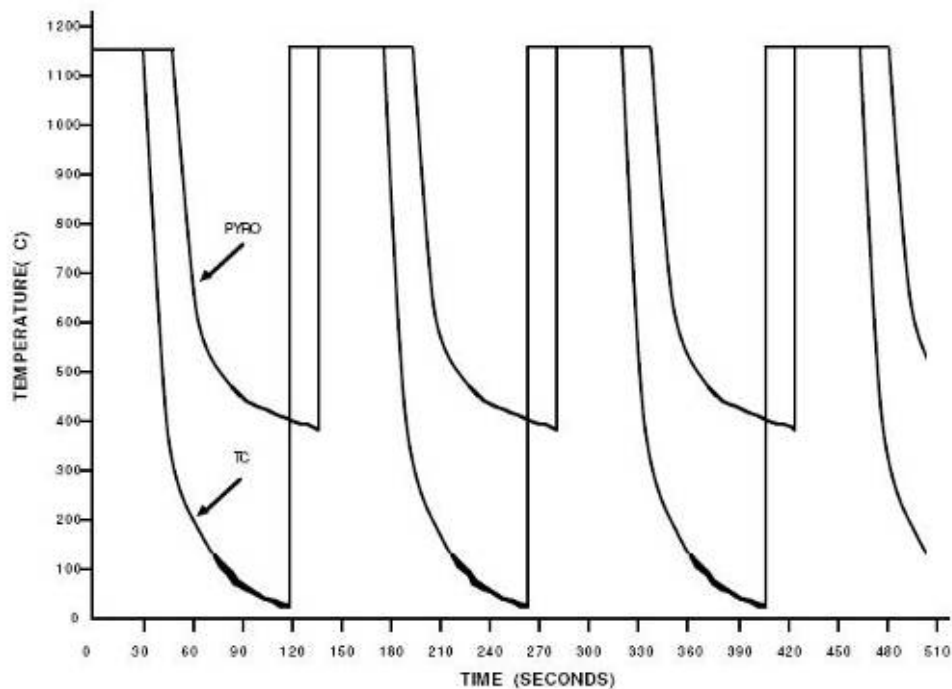
Note: Pyrometer and thermocouple plots were intentionally offset in time on the strip chart recorder. TC output leads pyrometer output.

Figure 9-3: *ERP and Thermocouple Temperature Measurements*

9.4   <u>THE THERMOCOUPLE</u>

The AccuThermo RTP system only uses the K-type thermocouple. K-type thermocouples are made with nickel-chromium (NiCr) for one wire and nickel-aluminum (NiAl) for the other wire. The NiAl lead is attracted to a magnet. Therefore, use a small magnet to determine the proper polarity when connecting thermocouple wires to the door terminals. Wires with the same metal alloy should be connected together.

When in use, the thermocouple is situated inside the quartz isolation tube and positioned so that it is in contact with the wafer being processed. The thermocouple is used typically to control process temperatures below about 800°C.

☞ CAUTION

Thermocouple may fuse into the wafer at temperatures above 800°C. As a result, the thermocouple should be removed and the pyrometer should be used for temperature measurement when the oven is to be operated at temperatures higher than 700°C.

The thermocouple assembly can be any of the following types:

➢ **Cantilever thermocouple assembly:** This type is a 10-mil type K bead thermocouple in direct contact with the backside of the wafer. The thermocouple is held against the wafer by two spring wires that also serve as the thermocouple leads. The wires pass through a removable T-shaped mounting piece made of quartz. See Figure 9-4.

➢ **TC wafer assembly:** This assembly is a type K chromel-alumel thermocouple, which is cemented to a wafer. The cement used is a sodium-free ceramic cement. See Figure 9-5. Typically, the TC wafer is used for the calibration of the pyrometer.

The Cantilever thermocouple is used in place of the TC wafer assembly for the measurement of oven temperature during <u>wafer processing</u>.

The TC wafer thermocouple is used during <u>calibration</u> of the pyrometer.

The two thermocouple wires for these two thermocouple assemblies run through a ceramic tube to K-type terminals on the inside of the oven door. The terminals run through a gas-tight seal in the door.

The door terminals and the terminals in connectors are marked either CH (NiCr) or AL (NiAl) according to their metal alloy composition. Also, the AL terminal is wider than the CH terminal.

Thermocouple voltages are fed to a temperature compensation circuit. The thermocouple compensation circuit contains an analog linearizing circuit with an output calibrated to 1 mv/°C. The signal is digitized and sent to the computer for use by the temperature control system. . (Refer to sections *Thermocouple Calibration* and *Thermocouple Circuit Testing*.)
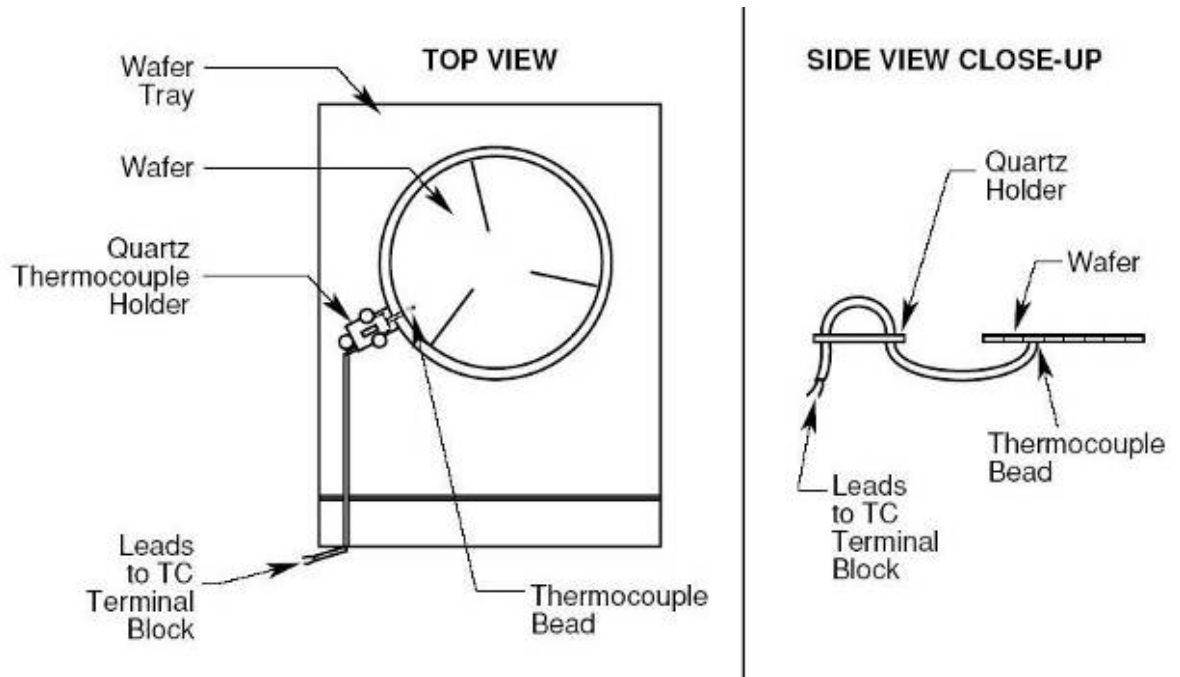
Figure 9-4:   *Cantilever Thermocouple Assembly*

The TC wafer assembly (Figure 9-5) has a thermocouple embedded in a wafer.
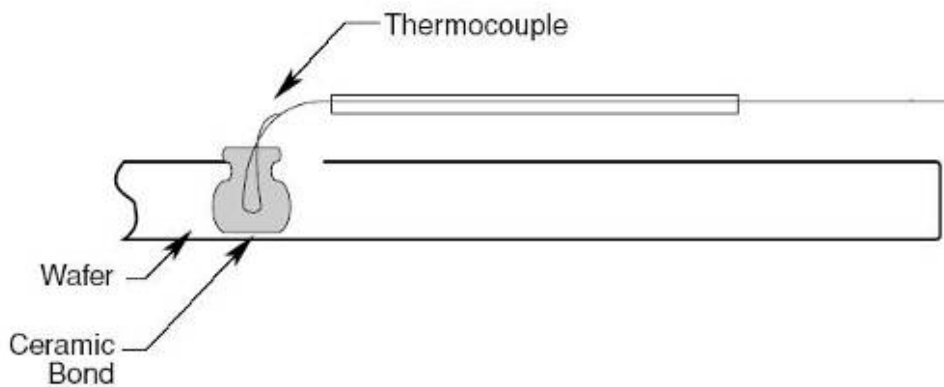
Figure 9-5:   *Thermocouple Wafer Assembly*

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10. MAINTENANCE

The AccuThermo RTP system needs to be powered down before performing any maintenance. Turn off the main power at the circuit breaker. Use proper lock-out/tag-out procedures.

☠ WARNING

Make sure the AC power from the facilities to the AccuThermo RTP system is OFF before you begin any maintenance. Even when the AC power switch on the front panel is OFF, high voltage still exists on various components inside the system.

10.1 MAINTENANCE

During the maintenance operation, observe the following precautions:

➢ Do not use replacement parts not provided or recommended by Allwin21 Corporation.

☠ WARNING

Allwin21 Corporation is not liable for any damage or injury which may occur when unauthorized parts are used.

➢ Disconnect power to the system at the main disconnect box before performing any maintenance activity that requires the removal of access covers. Use proper lock-out/tag-out procedures.

> ➢ Whenever the quartz isolation tube is changed, perform a gas leak test, using a Titanium Silicide (TiSi) wafer, on the process chamber. Replace the O-rings on the isolation tube nipple each time the tube is removed.

☞ NOTE

A Titanium Silicide wafer, when processed at 700-1000°C for 30-40 secs, will turn blue (discolor) in the presence of O2 leaks into the chamber.

10.2   <u>PREVENTATIVE MAINTENANCE SCHEDULE</u>

Preventive maintenance checks should be performed on a weekly and quarterly basis to ensure consistent operation of the AccuThermo RTP system.

Power down and switch off the power to the AccuThermo RTP system at the wall breaker and use proper lock-out/tag-out procedures whenever you remove the cover.

☠ WARNING

There will be no chemical exposures during normal routine maintenance. However, if the need arises to do maintenance on the gas system, then it is the maintenance person's responsibility to follow all safety procedures for gas exposure.

10.2.1   WEEKLY MAINTENANCE

Water Flow   Connect an external flow meter in series to the oven cooling
water outlet line, as recommended in the installation section of
this manual. Check the flow and replace the filter if water flow
drops below 2 gpm. Check the chiller water level to ensure that
the water level hasn't fallen below the low water level marker.

Cleanliness   Check quartz isolation tube and wafer tray for contamination.
Also inspect the oven unit for signs of water and particles. If
GaAs wafers are processed frequently, clean the quartzware
often according to the instructions in the Quartzware section of
this manual.

Thermocouple   (If the thermocouple is connected) - When the system is cold, go
to the *Manual Control* screen. Increase intensity and check for
temperature rise. Note that to do this, the cover must be on the
unit or the interlocks must be satisfied.

Lamps   Check uniformity. Run a test wafer and measure the resistivity.
Compare the values with those obtained on the wafer measured
when the unit was first installed. If the uniformity measurements
are unacceptable, check the lamp continuity using an ohmmeter.
Refer to the section Lamp Troubleshooting and Replacement.

10.2.2   QUARTERLY MAINTENANCE

Oven   Inspect for frayed or damaged wiring to lamps. Check O-Rings
                   for burning or damage.

Interlocks   Check water interlock by turning off water supply to the system
                   and trying to increase the intensity to the lamps from the
                   Diagnostics screen. (If the chamber wall is below 23°C, the lamps
                   will still come on because of the over cooling sensor on the
                   bottom of the chamber. Refer to the chassis wiring diagram.)

                   Check door interlock by opening door and trying to increase the
                   lamp intensity from the *Diagnostics* screen. The Interlocks should
                   prevent the lamps from turning on.

Quartz   Inspect wafer tray and quartz isolation tube for signs of cracking,
                   chipping, or other unusual wear. If GaAs wafers are processed
                   frequently, clean the quartzware often according to the
                   instructions in the Quartzware section of this manual.

Leakage   Perform a gas leak test to ensure the quartz tube is hermetically
                   sealed. See Section *Gas Leak Check Failure*.

Lamps   Visually inspect lamp sockets for cracks or discoloration.

Water   Inspect for water leaks and bad hoses.

                   Check water flow against last quarterly flow reading. If the flow
                   is lower, change the filter. If this does not change the flow, check
                   lines for clogging by checking differential pressure across the
                   oven, as recommended in the installation section of this manual.

10.3   OVEN UNIT CABINET COVER REMOVAL

Turn off the main power to the AccuThermo RTP system at the circuit breaker. Use proper lock-out/tag-out procedures.

☠ WARNING
Make sure the AC power from the facilities to the AccuThermo RTP system is OFF before you begin this procedure. Even when the AC power switch on the front panel is OFF, high voltage still exists on various components inside the system.
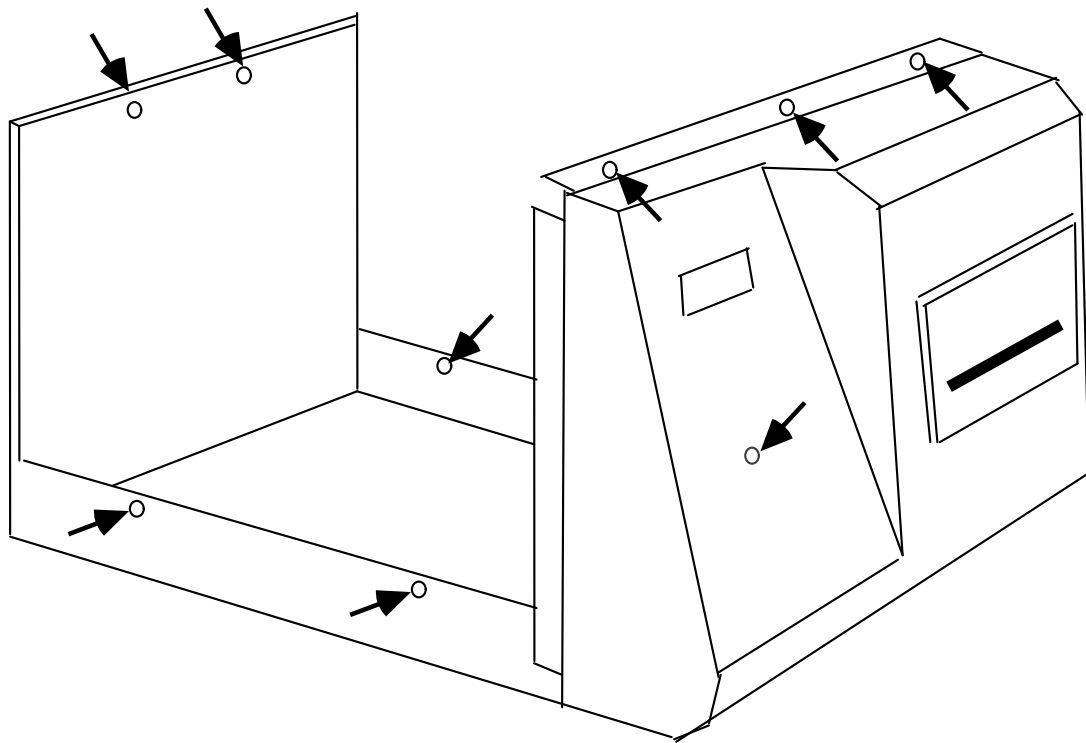
Figure 10-1:   *Oven Unit Cabinet Screw Locations*

Remove the top cover of the oven unit cabinet. See Figure 10-1, above, for the location of the cover screws. After the cover screws have been removed and placed in a safe location, remove the top cover using the following procedure:

Step 1.   Lift up on the rear of cover to release the rear cover support.

Step 2.   Slightly spread the cover at the bottom sides to clear lamps and PC boards.

Step 3.   Lift up on the cover until it is clear of the oven.

10.4　QUARTZWARE (TUBE AND TRAY)

The AccuThermo RTP system uses two major pieces of quartzware. These are the quartz isolation tube and the quartz wafer support tray. AccuThermo RTP systems are normally shipped with the quartz isolation tube installed. The quartz wafer support tray is shipped in a separate packing container. It is recommended that the quartz isolation tube be removed, inspected for damage and cleaned prior to putting the system in service. Procedures for removing and installing this quartzware are detailed in the section below.

10.4.1　QUARTZ ISOLATION TUBE REMOVAL AND INSTALLATION

Removal

The quartz isolation tube may need to be removed from the heating chamber for inspection after shipment or cleaning if it becomes contaminated during normal use. A severely contaminated tube decreases the amount of energy that reaches the wafer and will also adversely affect the accuracy of pyrometer-based temperature measurement.

Step 1.　Obtain the following tools to remove and re-install the quartz isolation tube:

> ➤ Phillips-Head or Straight Screwdriver (to remove the oven top cover)
> ➤ Standard Allen Wrench Set (to remove the front oven flange screws)
> ➤ Latex Gloves

Step 2.　Turn off the main power to the AccuThermo RTP system at the circuit breaker. Use proper lock-out/tag-out procedures.

☠ WARNING

Make sure the AC power from the facilities to the AccuThermo RTP system is OFF before you begin this procedure. Even when the AC power switch on the front panel is OFF, high voltage still exists on various components inside the system.

Step 3.   Open the oven door and, using latex gloves, remove the quartz wafer support tray, if it is installed. The procedure for Wafer Support Tray Removal and Installation is detailed in the section below.

Step 4.   Remove the top cover of the oven unit cabinet. See the section "Oven Unit Cabinet Cover Removal" for help on removing the oven unit cabinet cover.

Step 5.   On the rear of the oven assembly, loosen the knurled gas inlet nut securing the gas inlet connector to gas inlet on the rear of the quartz isolation tube inside the oven. See Figure 10-2.

ᠪᡠ **CAUTION**

Do not use pliers or other tools to remove the gas inlet nut. This will cause damage to the gas inlet fitting and may result in cracking or breaking of the quartz isolation tube gas inlet.
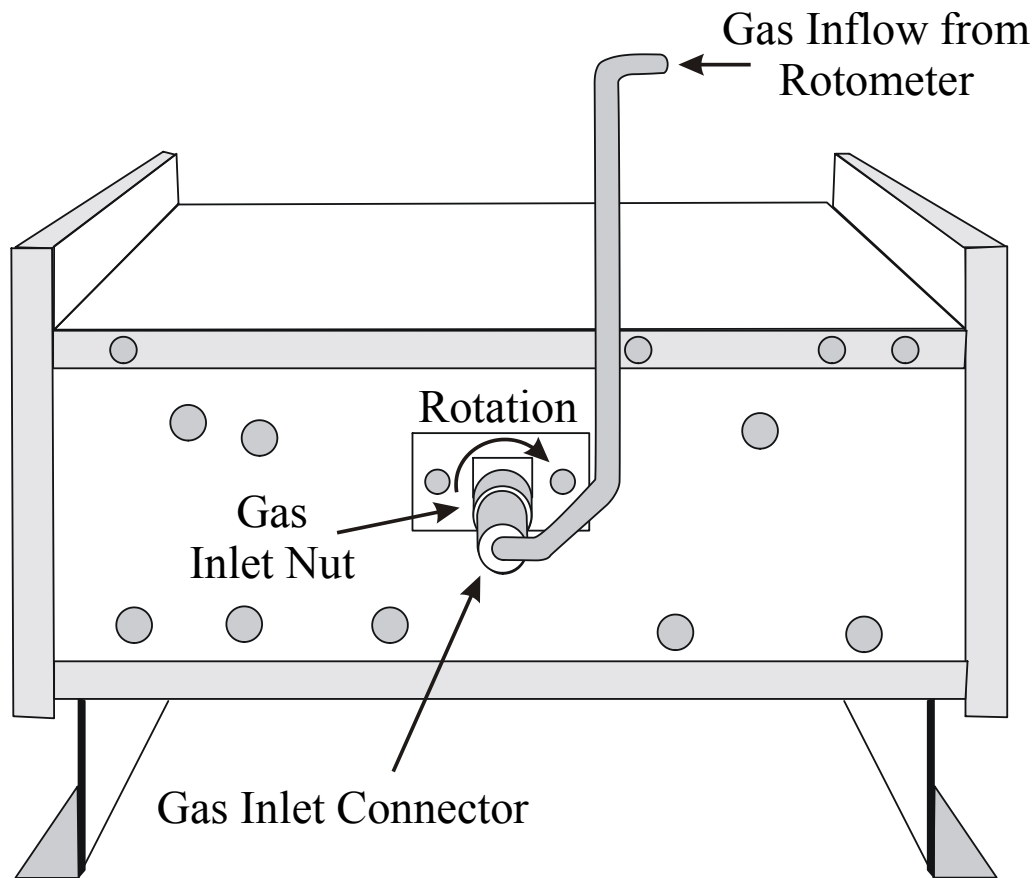
Figure 10-2: *Gas Inlet Fitting Location (Rear of Oven)*

Step 6.   After the gas inlet connector has been removed, push the gas inlet nut forward to expose the inlet O-ring and then remove it from the quartz inlet tube . Retain this O-ring for reuse if it is not damaged.

Step 7.   Carefully remove the eight screws that hold the front flange in place. See Figure 10-3. Put the screws in a safe place. Lay the flange forward onto the rails of the oven door. Be careful not to damage the gas exhaust line.

☞ CAUTION
Do not remove or loosen any water lines or the gas outlet fitting.
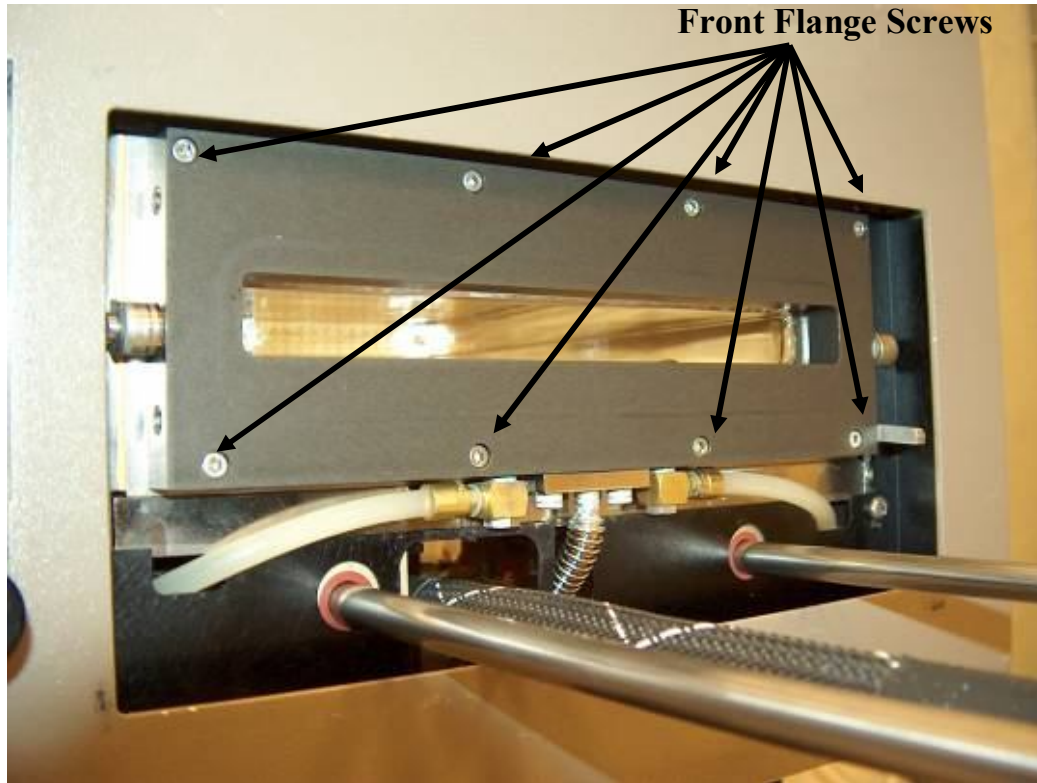
Figure 10-3: *Front Flange Screw Locations*

Step 8.   Put on clean Latex gloves and, from the front of the system, gently pull
forward on the quartz isolation tube . It may be necessary to gently move the
tube from side-to-side or up and down while pulling the tube forward. See
Figure 10-4.

☞ CAUTION

**Once the tube starts to come out, be very careful not to
strike the tube against the lamps inside the oven chamber.
Be careful not to strike the gas inlet nipple at the rear of
the isolation tube against the oven.**
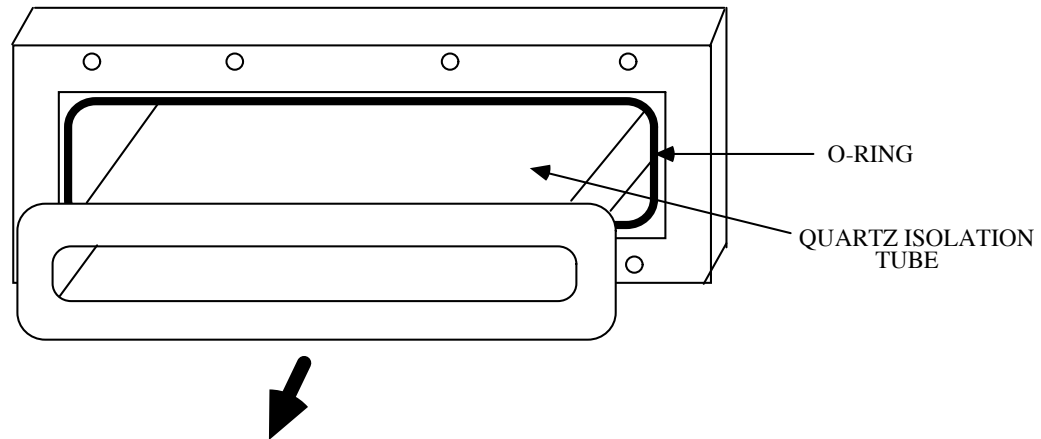
Figure 10-4: *Removing the Isolation Tube*

Step 9.　　With the tube removed, examine the O-rings on the heating chamber flange surface and the rear gas inlet fittings. Make sure that the O-rings are not damaged or burned; if they are, replace them.

Step 10.　Inspect the quartz isolation tube for any defects or scratches. Carefully check for cracks in the front flange facing and in the gas inlet tube. Clean the isolation tube if any evidence of contamination is visible. The procedure for cleaning the quartz is discussed in the section below.

☞ NOTE

When the quartz isolation tube has been removed, use the opportunity to inspect the oven heating lamps above and below the tube. They should be clean, unbroken, and installed so that the gas sealing nipples are pointing away from the wafer (top nipples UP and bottom nipples DOWN).
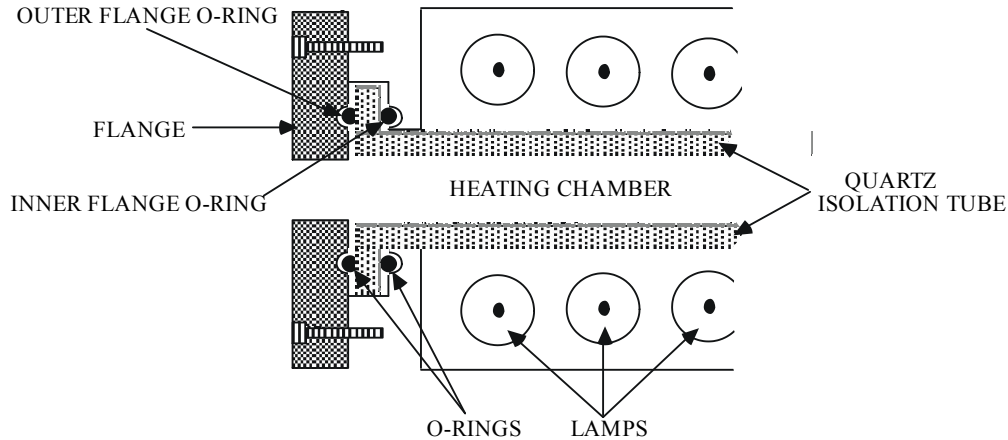
Figure 10-5: *Flange O-rings*

Installation

Step 1.   When ready to re-install the isolation tube , first install the inner flange O-ring. See Figure 10-5.

Step 2.   Install the isolation tube by inserting it slowly straight back into the heating chamber. The isolation tube contains a small window. The tube should be inserted with the window on the bottom. See Figure 10-6.

☞ CAUTION

Use caution when inserting the isolation tube   in the chamber to make sure that you do not strike the lamps. The tube nipple must be inserted into and extend through the hole in the rear of the oven.

Step 3.   Install the outer flange O-ring into the groove of the flange, as shown in Figure 10-5.

Step 4.   Place the front flange against the isolation tube flange and install the eight screws you removed earlier in this procedure. Tighten the screws evenly in a star-pattern, a small amount at a time.

> **⌒ CAUTION**
>
> **Do not over-tighten the screws to prevent stripping the soft aluminum flange. Be sure the outer flange O-ring is properly positioned before tightening the screws.**

Gas Inlet
Nipple

ERP
Window
(bottom of tube)

Front Flange
Face
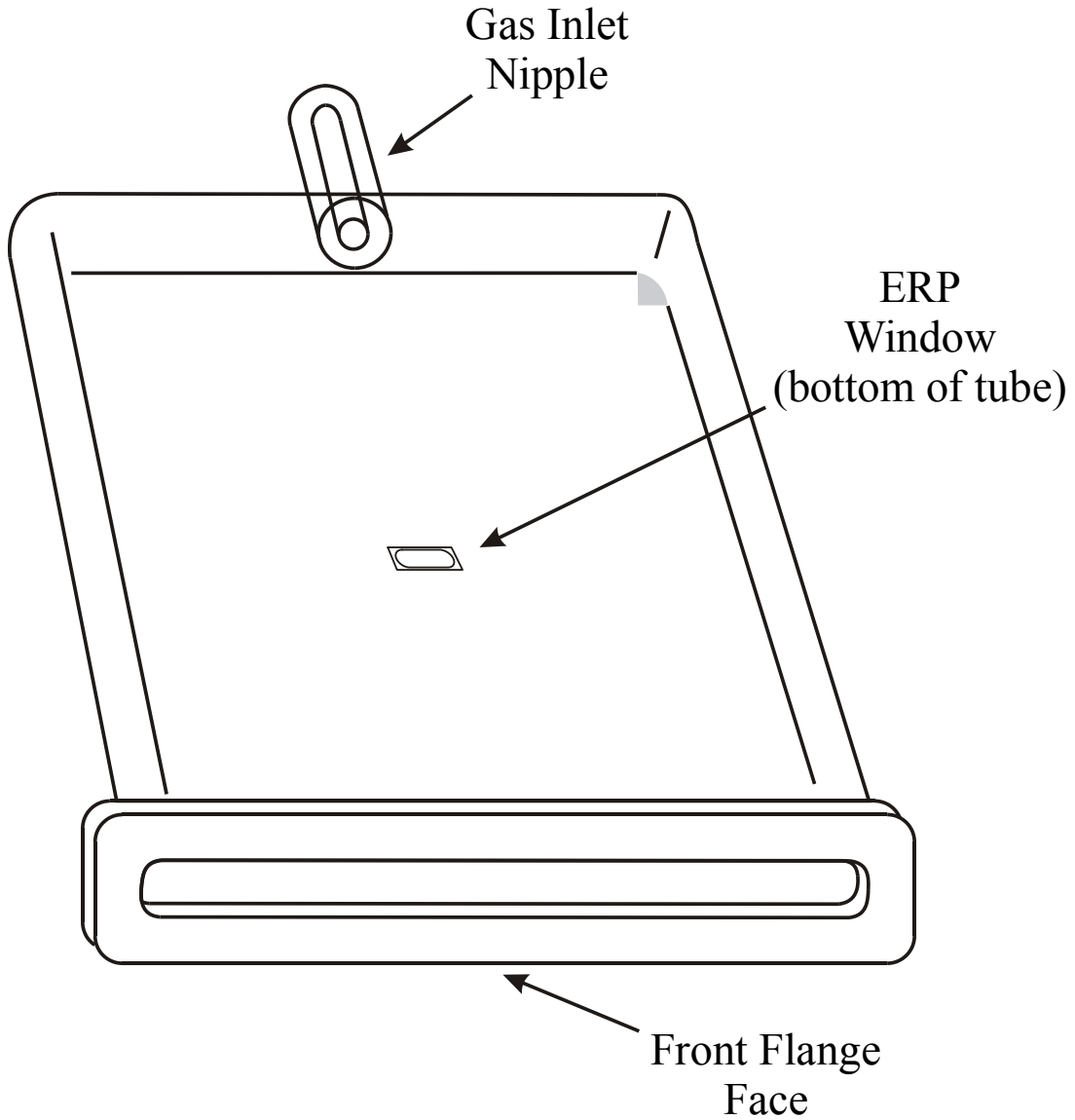
Figure 10-6: *Isolation Tube for Extended Range Pyrometer (ERP)*

Step 5.   Install the gas inlet O-ring onto the gas inlet tube of the quartz isolation tube.

<div style="border:2px solid black; padding:10px;">

∽ CAUTION

Tighten the gas inlet nut so it is finger tight only. Do not use pliers or other tools to tighten the gas inlet nut. It will damage the gas inlet nut and fitting and may break the quartz tube .

</div>

Step 6.   Install the gas inlet connector. Ensure that this connector is only hand-tightened. Do not use any tools to tighten this connector.

<div style="border:2px solid black; padding:10px;">

∽ CAUTION

The back gas fitting base must not be tight against the oven. It must be loose to allow for expansion during heating cycles. When tightening the nut, push in on the fitting so that it is flush with the oven.

</div>

Step 7.   Perform an oven leak check to make sure that the quartz tube is properly positioned and sealed when the oven door closes. An oven leak check can be performed by processing a TiSi wafer and checking for evidence of excessive O2 contamination.

<div style="border:2px solid black; padding:10px;">

∽ CAUTION

Do not use leak check procedures involving pressurization of the quartz tube . This will cause damage to the tube.

</div>

Step 8.   Reinstall the wafer support tray following the procedure for Wafer Support Tray Removal and Installation in the section below.

10.4.2   QUARTZ WAFER SUPPORT TRAY REMOVAL AND INSTALLATION

Removal

Step 1.   Open the oven door and pull it all the way out.

<div style="border:2px solid black">

☛ CAUTION

Make sure that the oven has cooled to a temperature below 50°C before removing the wafer support tray or any other heated components.

</div>

Step 2.   If a thermocouple wafer or cantilever thermocouple is installed, carefully disconnect it from the TC input connectors on the door, and remove it from the wafer support tray. See Figure 10-7.
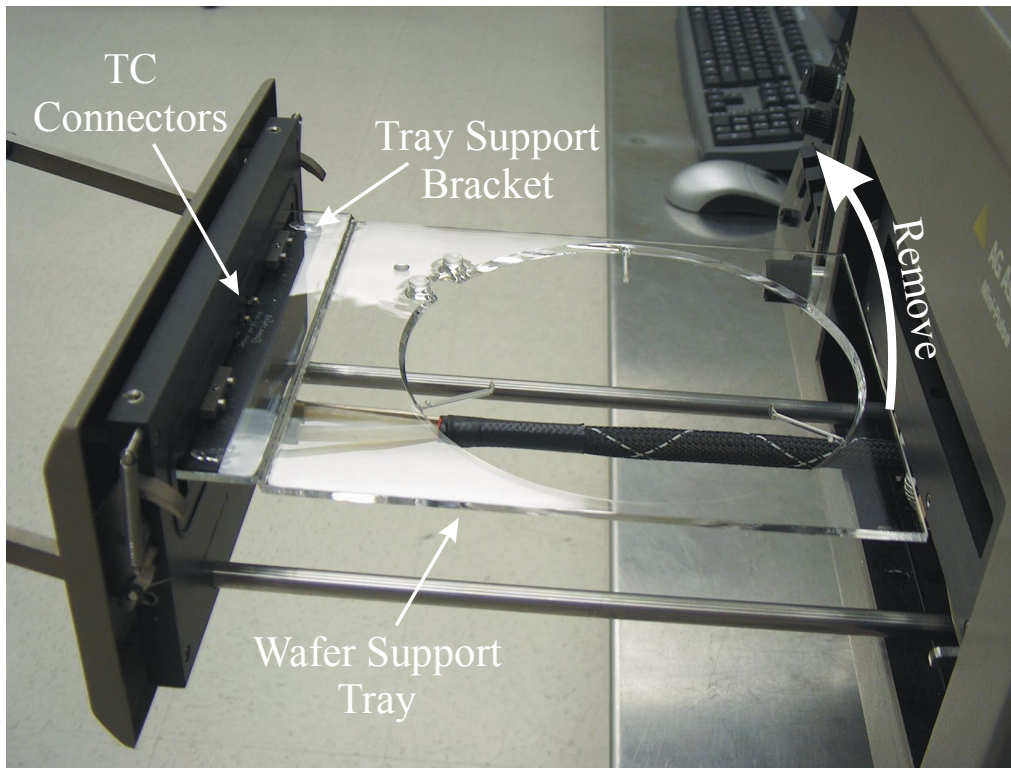
Figure 10-7: *Wafer Support Tray Removal and Installation*

Step 3.   Using Latex gloves carefully lift up on the end of the tray closest to the oven. The tray can be easily lifted from the support bracket on the oven door.

Step 4.   Inspect the tray for damage. Clean the tray, if required, following the instructions provided in the section below of this chapter.

Step 5.   Place the tray on a clean surface, preferably of quartz, or if a quartz surface is not available, place the tray on a surface covered with unused cleanroom wipes.

Step 6.   Perform any additional procedures that need to be done while the tray is removed from the system.

Installation

Step 1.   Reinstall the wafer tray with the wafer support pins up. Place the support edge of the tray on the flange support bracket while lifting the end of the tray closest to the oven. The tray will fit into the flange support bracket. Lower the end of the tray closest to the oven.

Step 2.   In order to achieve optimum process uniformity, it is very important that the wafer tray be level with respect to the AccuThermo RTP oven. Use the procedure on the following page to ensure that the wafer support tray is properly leveled relative to the oven.

10.4.3   QUARTZ WAFER SUPPORT TRAY LEVELING

Step 1.   Close the oven door to a point where the edge of the tray is flush with the oven flange. See Figures 10-8, below, and 10-9, on the following page.

(a)

(b)
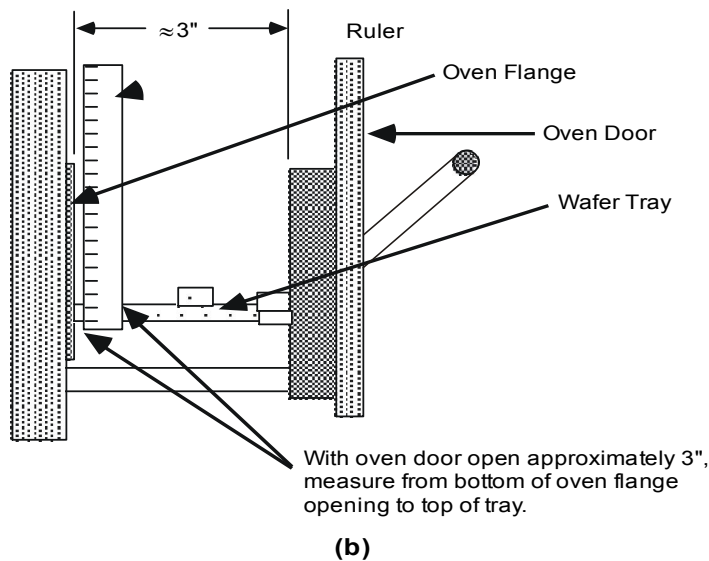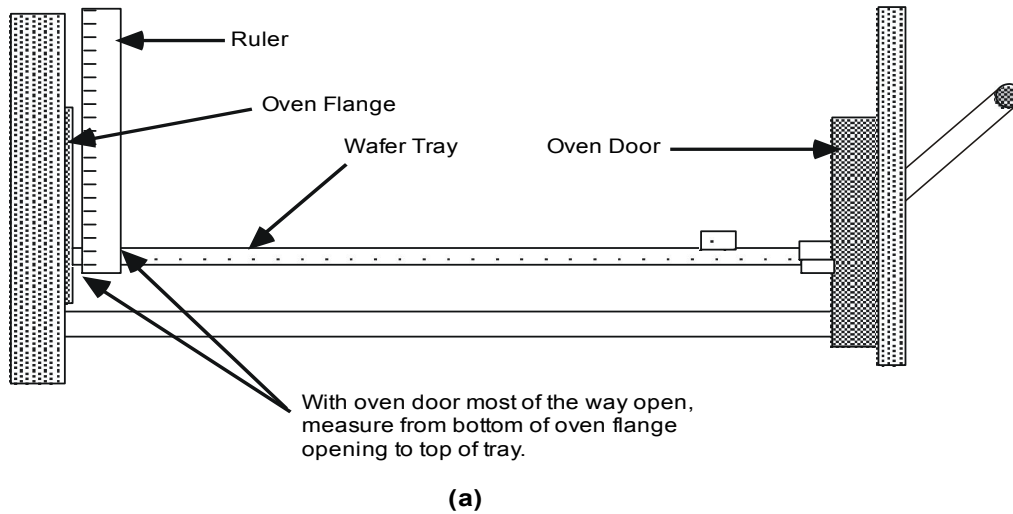
Figure 10-8: *Leveling the Wafer Tray*

Step 2.   Using a ruler, measure the distance from the bottom of the oven flange to the top edge of the wafer tray. Measure the tray on both sides to verify that it is level from side to side.

Oven Flange
Opening

Wafer Tray
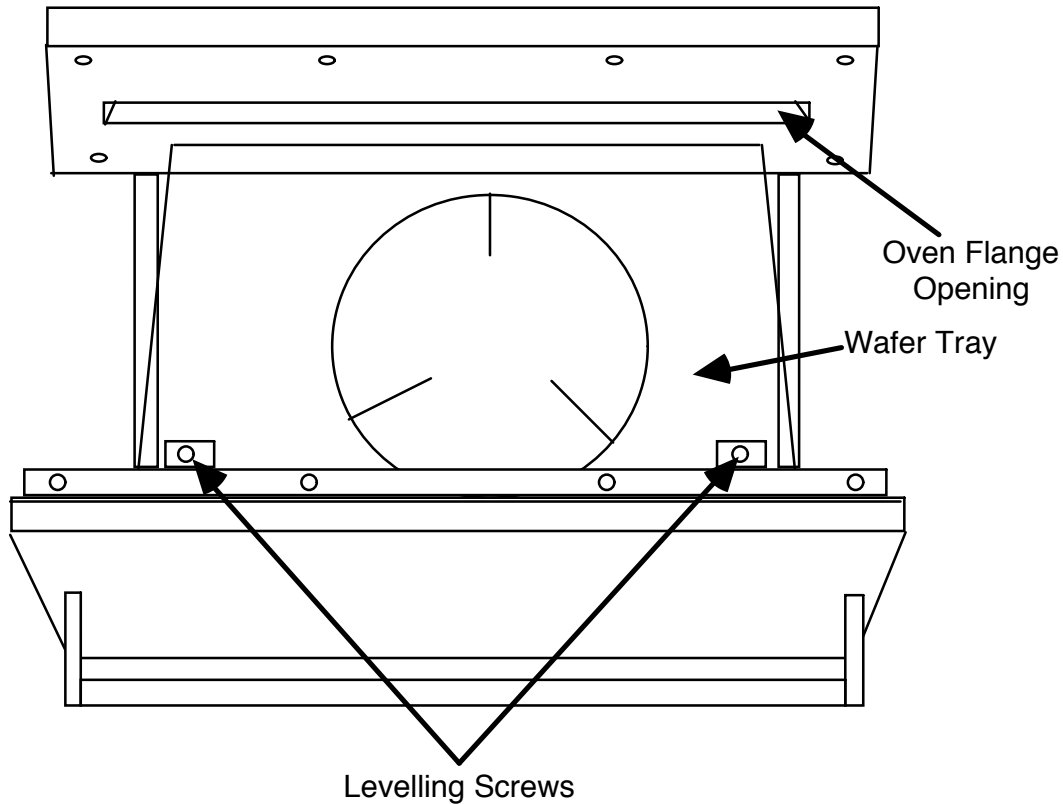
Levelling Screws

Figure 10-9: *Leveling Screw Locations (Top View)*

Step 3.   If the tray is level from side-to-side, go to the next step. If the tray is not level
side-to-side, then adjust the tray using the leveling screws. The level of the tray
should be adjusted so that the end of the tray is centered with the opening in
the oven flange. See Figure 10-9 for location of oven leveling screws. Once the
tray has been leveled from side-to-side, note the distance from the bottom of
the oven flange to the top edge of the wafer tray.

Step 4.   Close the oven door until it is open about 3 inches. See Figure 10-8 (b). Using
a ruler, measure the distance from the bottom of the oven flange to the top
edge of the wafer tray. This distance should be the same as the distance noted
in step 2 or step 3 above. If it is the same, then the wafer tray is level. If it is
not the same, then the tray will need to be leveled from front-to-back using the
leveling screws. See Figure 10-8 for leveling screw locations.

Step 5.   Repeat steps 1 through 4, above, to verify that the wafer tray is level. The
distance should be the same between the bottom of the oven flange and the top
of the wafer tray on both sides of the tray with the door almost open and near
the front of the tray with the door open only 3 inches.

☞ **NOTE**

There may be some movement of the tray from left to right. This movement is normal and should not be a reason for concern.

Step 6.   Place a wafer on the tray. Slowly close the door of the heating chamber. Listen for any scraping sounds that may indicate that the quartz is not properly aligned. If you notice any scraping sounds or resistance to door movement, realign the tray and repeat this step.

☞ **CAUTION**

To avoid damaging the quartz tray, do NOT force the chamber door.

Step 7.   Reinstall the top cover on the AccuThermo RTP system if it has been removed.

10.4.4   QUARTZWARE CLEANING

To ensure uniform wafer heating, the quartz isolation tube and wafer tray must be kept clean. Thin films deposited on the quartzware may not be visible. If there is a loss of heating uniformity, clean the isolation tube and wafer tray, even if no deposits are visible. The quartzware should also be cleaned prior to performing a temperature calibration. How frequently the quartzware needs cleaning depends upon the amount and type of processing being performed. Generally, it should be cleaned at least once per month. Check the tube frequently to see if any films or other deposits can be observed.

☠ **WARNING**

Always use caution when handling chemicals to prevent injury or burns.

Step 1.   Gather the following cleaning materials that are needed to clean the quartzware:

➢ Cleanroom wipes

➢ Hydrogen Peroxide

➢ Ammonia Hydroxide

➢ Buffered Oxide Etch Solution

➢ Distilled Water

➢ DI Water

Step 2.   Place the quartzware in a container of boiling distilled water and gently rub the quartzware with cleanroom wipes.

ᘓ **CAUTION**

Be very careful not to break the pins when cleaning and handling quartz wafer trays.

Step 3.   Rinse the quartzware in distilled water.

Step 4.   Soak the quartzware in a solution of Ammonia Hydroxide/Hydrogen
           Peroxide/DI Water (1:1:4) for 10 minutes.

Step 5.   Rinse the quartzware under running DI Water for 10 minutes.

Step 6.   Soak the quartzware in a solution of Buffered Oxide Etch (6:1) for 10 minutes.

Step 7.   Rinse under running DI Water for 10 minutes.

Step 8.   Blow quartzware dry with clean, dry nitrogen.

10.4.5   QUARTZWARE STORAGE

The quartz isolation tube and the quartz wafer support tray must be handled with lint-free gloves to avoid contamination. When storing the quartzware, it is extremely important to do so with the minimum possibility of contamination. AllWin21 recommends that all quartzware be stored in a storage container. Typically, such a container comprises a plastic cube, with a locking hinged door, that contains separate Plexiglas shelves for tube and tray storage. Optionally, this container can be purged using a continuous flow of nitrogen.

10.5   <u>THERMOCOUPLE INSTALLATION AND TESTING</u>

The Cantilever thermocouple assembly may be used in place of the pyrometer for the measurement of oven temperature. The Cantilever thermocouple assembly, shown in Figure 9-4, uses a small thermocouple bead in contact with the backside of the wafer.

10.5.1   **INSTALLING THE THERMOCOUPLE**

It has been noted that the Cantilever thermocouple may be used in place of the pyrometer, and it should be removed when the pyrometer is in use. When the thermocouple is installed, its operation should be checked before it is used for processing wafers.

The tools and supplies needed to install the thermocouple are:

➢ small screwdriver

➢ tweezers

➢ small permanent magnet of any type

➢ a pair of Latex gloves. Wear the gloves when you are handling oven quartz or thermocouple.

The procedure for installing and checking the thermocouple is as follows:

Step 1.   Open the oven door.

Step 2.   Using tweezers, remove the quartz lock-pin from the wafer tray.

Step 3.   Place the thermocouple holder between the two fixed pins on the wafer tray, as shown in Figure 10-10. The holder should be placed so the ends of the thermocouple leads emerge from the bottom of the holder. The holder should fit into the grooves in the pins.
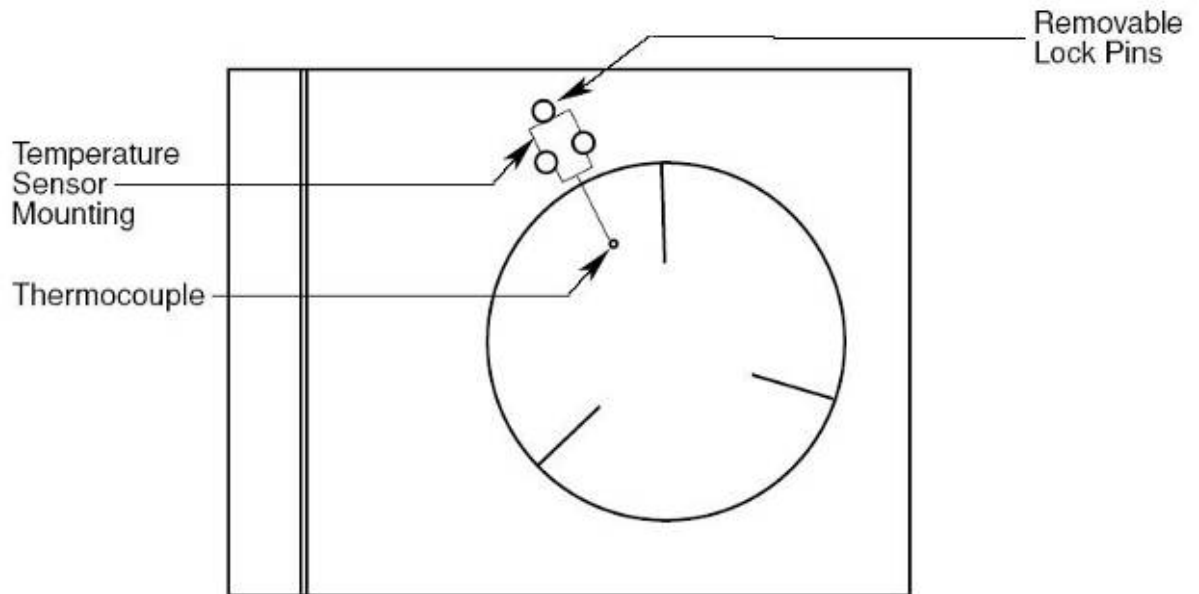
Figure 10-10: *Thermocouple Placement (showing Cantilever thermocouple)*

Step 4.   Using tweezers, install the quartz lock-pin. This keeps the holder in place.

Step 5.   Position the thermocouple holder so the ceramic tubing is as close as possible to the edge of the wafer tray.

Step 6.   Attach the thermocouple leads to the type K terminals on the inside of the oven door. First, find which lead is attracted to a magnet. Attach this lead to the wider terminal, labeled "AL". Attach the other lead to the terminal labeled "CH". (If the leads are connected in reverse, the temperature feedback will go down when the wafer is heated.)

Step 7.   Cut off surplus lead wire, leaving a little excess in case it will be necessary to reverse the leads.

Step 8.   Install a test wafer on the tray. Be sure the backside of the wafer is down. Position the bead so it presses against the backside of the wafer.

Step 9.   Close the oven door.

10.5.2   TESTING THE THERMOCOUPLE

When the thermocouple has been installed in the oven, check its operation as follows:

Step 1.   Power-up the system, if it is off

Step 2.   Go to the Diagnostics screen.

Step 3.   If the system is set up for pyrometer operation, configure for thermocouple.

Step 4.   Increase the lamp intensity to 20%.

Step 5.   Observe the temperature feedback. If the temperature indication goes down (i.e., if temperature is negative) as heat increases, the thermocouple leads have been connected in reverse. Change the lead connections at the oven door and repeat steps 2 to 4.

10.5.3   INSTALL AND TEST THE TC WAFER

Step 1.   Install the thermocouple (TC) monitor wafer, making sure the polished side is down and the leads are connected using the correct polarity to the TC connectors, as described in the section "Installing the Thermocouple".

Step 2.   Check the functionality of the TC using the following procedure:

➢ Purge the chamber by running 10 SLPM of N2 for 30 seconds prior to running the tool in manual mode.

➢ Test the operation of the TC wafer as described in the section *Installing the Thermocouple*.

10.6 LAMP REPLACEMENT PROCEDURE

☞ **NOTE**

If you have not already done so, be sure to turn off all power to the heating chamber and remove the cover.

〰 **CAUTION**

Also, wear lint free gloves while handling the lamps. When installing a new lamp, be sure first to clean it with ethanol.

To replace a lamp, follow the procedures below:

Step 1.   Remove the lamp lead harnesses on the lamp to be replaced.

Step 2.   Loosen the lamp socket screw on the right side of the oven (as you face the front panel). Gently remove the lamp from the heating chamber.

Step 3.   Notice the bump on the lamp: on the top bank of lamps the bump must point up; on the bottom bank of lamps the bump must point down. Gently slide the lamp into the socket hole, making sure it slides into the socket hole on the far side. Make sure the lamp is seated in the corresponding lamp socket.

Step 4.   Retighten screws so they fit snugly. Do not over tighten. Check lamp continuity to ensure proper installation.

Step 5.   Replace harnesses and the cover.

10.7   <u>DRAINING THE COOLING WATER FROM THE OVEN UNIT</u>

The control computer must be running with the AW-900 control software. AC Power must be applied to the Oven Unit. Enter into the Diagnostics screen. This will open the water solenoid valve and keep it open. Blow out the water from the inlet with CDA until no more water drains out of the outlet.

10.8   <u>CALIBRATION</u>

10.8.1   **OVERVIEW**

Calibration of the AccuThermo RTP system is done entirely from within the software for maximum performance and accuracy. The calibration functions are automated which means less time is spent calibrating the system. There are calibration routines for the pyrometer, thermocouple circuit, LED display circuit and gas flow circuits, along with calibrating the chamber dynamics, as presented on the *Calibration Menu* (Figure 10-11). Calibration is done at the factory and does not need to be repeated for installation.

Calibration of the system does not need to be done unless something that affects the temperature or gas flow has changed, such as the pyrometer, quartz tube, the chamber or the control board.

If there is a change in the temperature, uniformity or gas flow, do not immediately suspect the system needs to be calibrated. Make sure there is no mechanical problem first. See the respective *Diagnostics & Troubleshooting* sections for possible other problems with the system that could affect temperature, uniformity, gas flow, etc. before suspecting a calibration problem.

The AW-900 software has the ability to calibrate the AccuThermo RTP system for maximum performance and accuracy. The calibration functions are automated which means less time is spent calibrating the system. The calibration routines in the AW-900 software are for calibrating the thermocouple, pyrometer, chamber, and gas feedback, as presented on the *Calibration Menu* (Figure 10-11).
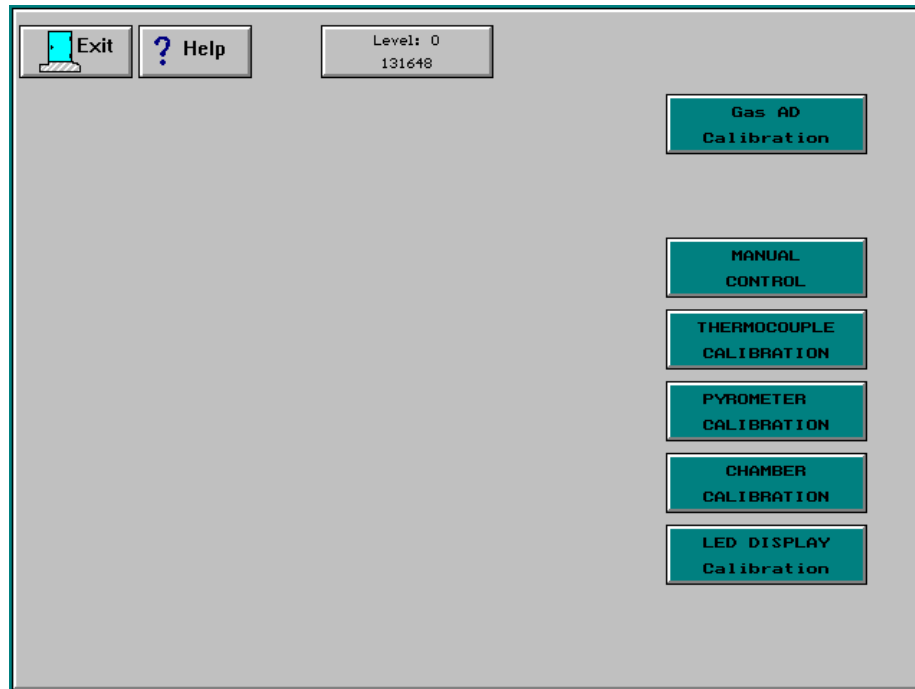
Figure 10-11: *Calibration Menu*

Location: Main Menu ➔ Calibration Menu

TEMPERATURE FEEDBACK DEVICES

The AccuThermo RTP system is equipped with two types of temperature monitoring devices: a thermocouple and an optical pyrometer.

The optical pyrometer can be used throughout the recommended process temperature range of 400°C to 1200 °C. The thermocouple is used for controlling processes at temperatures below 800 °C.

Refer to chapter *Temperature Monitoring* for an extensive discussion on the pyrometer and thermocouple.

The temperature feedback system needs to be calibrated in the following order:
1) LED Temperature Display
2) R40
3) Thermocouple
4) Pyrometer

The order of calibrating the temperature circuits is important, because the later items depend on the proper calibration of the previous items.

10.8.2   LED TEMPERATURE DISPLAY CALIBRATION

The LED display on the front of the AccuThermo RTP system shows the current temperature in real-time. The LED can display the temperature from either the pyrometer or the thermocouple. Selecting one or the other is done either when a recipe is run where the pyrometer or the thermocouple is selected as the sensor type, or from the *Diagnostics* screen.

The LED display calibration is used to help the software understand the characteristics of the LED display analog circuit.
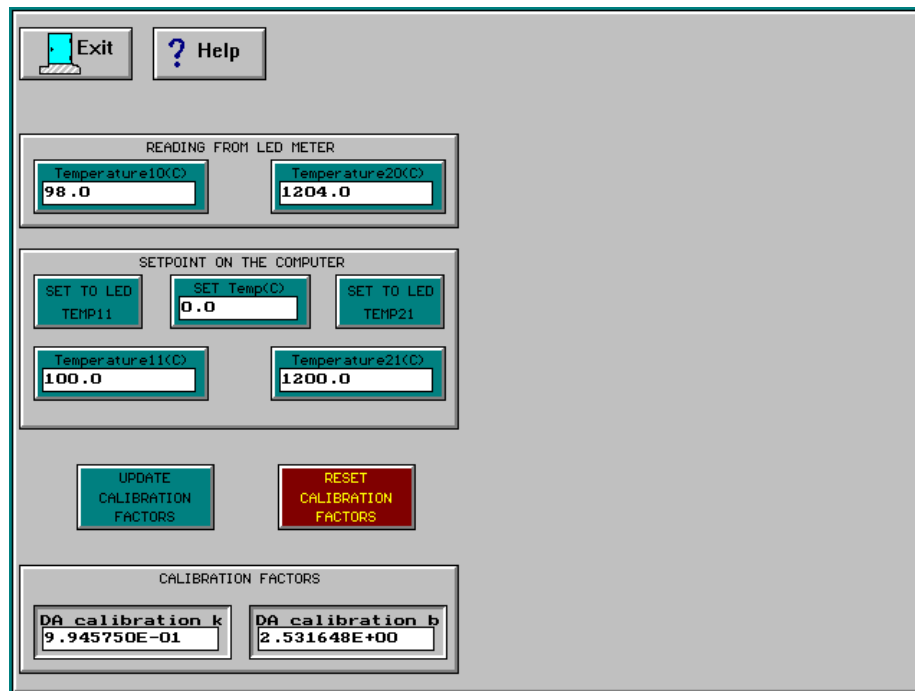
Figure 10-12: *LED Display Calibration*

Location: Main Menu ➔ Calibration Menu ➔ LED Display Calibration

LED Calibration, figure 10-7, is used to correct for any offset that might develop in the thermocouple circuitry. There are 2 kinds of offset: the zero offset (k) and the linear offset (b).

The AW-900 software uses the following equation to correct the offsets:

$$y = (k * x) + b$$

where x is the reading from the computer A/D converter, and y is the calibrated temperature. A thermocouple calibration meter (i.e. Omega Engineering model CL25) is used for the calibration standard. This corrects for any offsets in the computer A/D converter.

The following procedure calibrates the software with the LED display.

Step 1.   Go to the *LED Temperature Display Calibration* screen, figure 10-7, by clicking on the **LED Display** button from the *Calibration Menu*, figure 10-6.

Step 2.   Click on the **Reset Calibration Factors** button to reset the factors to k=1 and b=0.

Step 3.   Set **Temperature11** field to the low temperature value of 100 ºC.

Step 4.   Enter into the **SET Temp** field the same value as in Step 4.

Step 5.   Wait for the LED display to stabilize. Then record the reading from the LED display into the **Temperature10** field.

Step 6.   Set **Temperature21** field to the high temperature value of 1200 ºC.

Step 7.   Enter into the **SET Temp** field the same value as in Step 6.

Step 8.   Wait for the LED display to stabilize. Then record the reading from the LED display into the **Temperature20** field.

Step 9.   Click on the **Update Calibration Factors** button to calculate the factors. If a message-box pops-up saying "Temperature readings on the computer T1 and T2 are too close", record the higher temperature to make the temperature difference at least 100 ºC.

Step 10.   Check the result of the Calibration. Change the **SET Temp** field to several different setpoints to verify the LED display readings are good.

10.8.3   THERMOCOUPLE CALIBRATION

When in use, the thermocouple is situated inside the quartz isolation tube and positioned so that it is in contact with the wafer to be processed. The thermocouple is used typically to control process temperatures below 800°C.

☞ NOTE

Thermocouple life is shortened by operating at temperatures above 800ºC. As a result, the thermocouple should be removed and the pyrometer used for temperature measurement, when the oven is to be operated at temperatures higher than 800ºC.

There is one type of thermocouple that is used in the AccuThermo RTP systems: the K type. The K type is the most common and is readily available. . See *Thermocouple Circuit Testing* for further information.

The linearizing circuit and the analog circuit for the thermocouple have to be calibrated by using a TC calibration meter set to K-type thermocouple. This meter is plugged into TC1, a yellow connector on the control board where the thermocouple is normally plugged into. Set the TC calibration meter to a particular temperature and the meter sends a voltage to the control board that is equivalent to a K-type thermocouple at the temperature that the meter was set at.
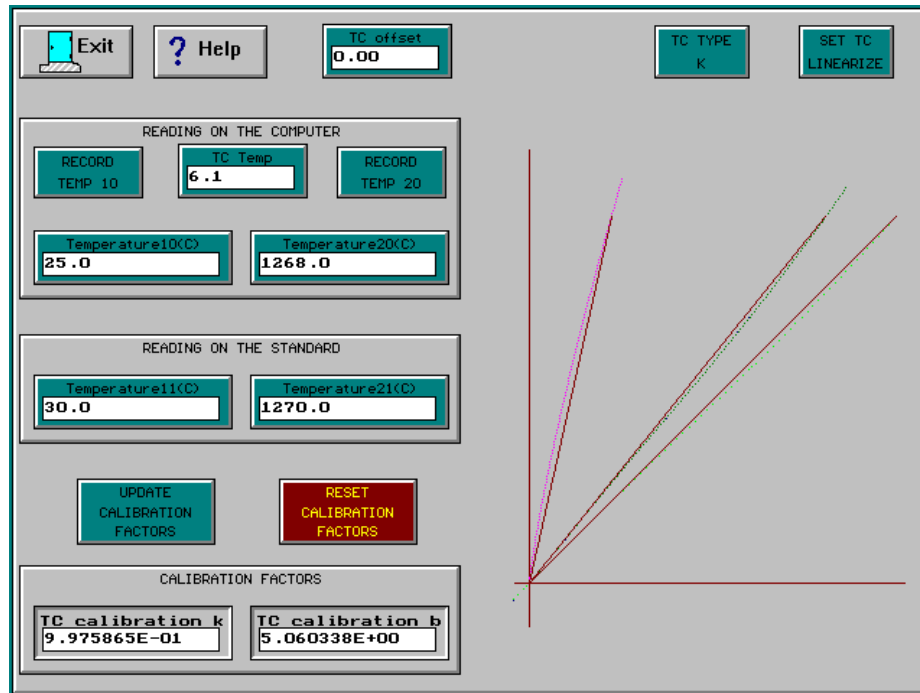
Figure 10-13: *Thermocouple Calibration screen*

Location: Main Menu ➔ Calibration Menu ➔ Thermocouple Calibration

Thermocouple Calibration, figure 10-13, is used to correct for any offset that might develop in the thermocouple circuitry. There are 2 kinds of offset: the zero offset (k) and the linear offset (b).

The AW-900 software uses the following equation to correct the offsets:

$$y = (k * x) + b$$

where x is the reading from the computer A/D converter, and y is the calibrated temperature. A thermocouple calibration meter (i.e. Omega Engineering model CL25) is used for the calibration standard. This corrects for any offsets in the computer A/D converter.

The following is a step-by-step procedure for calibrating the thermocouple. The **TC Temp** field on the *Thermocouple Calibration* screen (figure 10-13) always displays the temperature from the TC A/D channel.

Step 1.   Connect a thermocouple calibration meter to the thermocouple connector TC1 (yellow connector) on the AW-900-058 control board inside of the Oven Unit of the AccuThermo RTP system. Set the calibration meter to the type of thermocouple that is used in the system, typically K-type.

Step 2.   Set the thermocouple calibration meter to 500 ºC.

Step 3.   From the *Main Menu*, adjust potentiometer R40 on the AW-900-058 Control
           Board so the LED display on the front panel shows 500.

Step 4.   Go to the *Thermocouple Calibration screen*, figure 10-13, by clicking on the
           Thermocouple Calibration button from the *Calibration Menu*, figure 10-11.

Step 5.   Select the type of thermocouple (typically K-type) that is used in the system by
           toggling the **TC Type** button until the appropriate type is shown.

Step 6.   Click on the **Reset Calibration Factors** button to reset the factors to k=1 and
           b=0.

Step 7.   Set **Temperature11** field to the appropriate low temperature value for the type
           of thermocouple:

           30 ºC for K type
           100 ºC for R type

Step 8.   Set the thermocouple calibration meter to the same value as in Step 7.

Step 9.   Wait for the temperature to stabilize in the **TC Temp** field. Then click the
           Record Temp 10 button. The temperature will be recorded to the
           Temperature10 field.

Step 10.   Set **Temperature21** field to the appropriate high temperature value for the
           type of thermocouple:

           1270 ºC for K type
           1200 ºC for R type

Step 11.   Set the thermocouple calibration meter to the same value as in Step 10.

Step 12.   Wait for the temperature to stabilize in the **TC Temp** field. Then click the
           Record Temp 20 button. The temperature will be recorded to the
           Temperature20 field.

Step 13.   Click on the **Update Calibration Factors** button to calculate the factors. If a
           message-box pops-up saying "Temperature readings on the computer T1 and
           T2 are too close", record the higher temperature to make the temperature
           difference at least 100 ºC.

Step 14.   Check the result of the TC Calibration. Change the thermocouple calibration
           meter to several different setpoints to verify the TC readings are good.

10.8.4   PYROMETER CALIBRATION

The pyrometer is attached to the bottom plate of the oven and remains permanently in place. The pyrometer measures the radiant light energy from the wafer through a transparent window on the bottom of the quartz isolation tube and through a small opening in the oven floor.

The pyrometer converts light energy to voltage. However, the conversion is non-linear from low temperatures to high temperatures. The pyrometer measures the highest light energy it detects. Normally, the wafer radiates the highest light energy in the AccuThermo RTP system chamber. However, if there is not enough cooling air to keep the quartz tube cool, the quartz isolation tube will begin to radiate too much thermal energy than was originally calibrated. The temperature reading would then be distorted.

To insure consistently accurate temperature measurements throughout all phase of the heating cycle, the quartz tube must be cooled with compressed air, which maintains the temperature within a specified range.

☞ NOTE

Ensure that the cooling air is adequate for the quartz isolation tube cooling.

Optical pyrometer readings are emissive dependent, and are affected by changes in wafer backside surface roughness, deposited backside layers, or variations in substrate materials. When one of these factors changes, the temperature measured by the pyrometer will be distorted.

☞ NOTE

Pyrometer readings are dependent on wafer emissivity. When pyrometer temperature control is used in the AccuThermo RTP System, the EMISSIVITY setting must be adjusted to suit the <u>backside</u> emissivity of the wafers being processed.

The pyrometer is calibrated against a thermocouple (TC) wafer. This ensures the pyrometer measurement is matched to a known accurate source. However, the thermocouple calibration must be done first before the pyrometer calibration.

The thermocouple wafer needs to be made from a good standard wafer. The standard wafer is normally placed top-side up on the quartz tray. Therefore, the thermocouple wafer should also be placed top-side up. This is due to the differences in emissivity between the top-side and bottom-side of the wafer. The thermocouple wafer should be placed on the quartz tray the same way as a normal wafer.

Pyrometer calibration is required when process results indicate a lack of correspondence between actual temperature and programmed temperatures. The pyrometer should also be calibrated whenever the pyrometer has been replaced, adjusted, repaired, etc.

☞ NOTE

Dirty quartz or a bad process can also affect the pyrometer measurement of the wafer temperature.

Pre-checks

Step 1.   Check the cooling air is above 10-15 SCFM and 25 psi.

Step 2.   Check that the filter for the cooling air is clean. Change or clean if necessary.

Step 3.   Check that the quartz tube is clean. Clean if necessary.

Step 4.   Prepare a good standard calibration TC wafer.
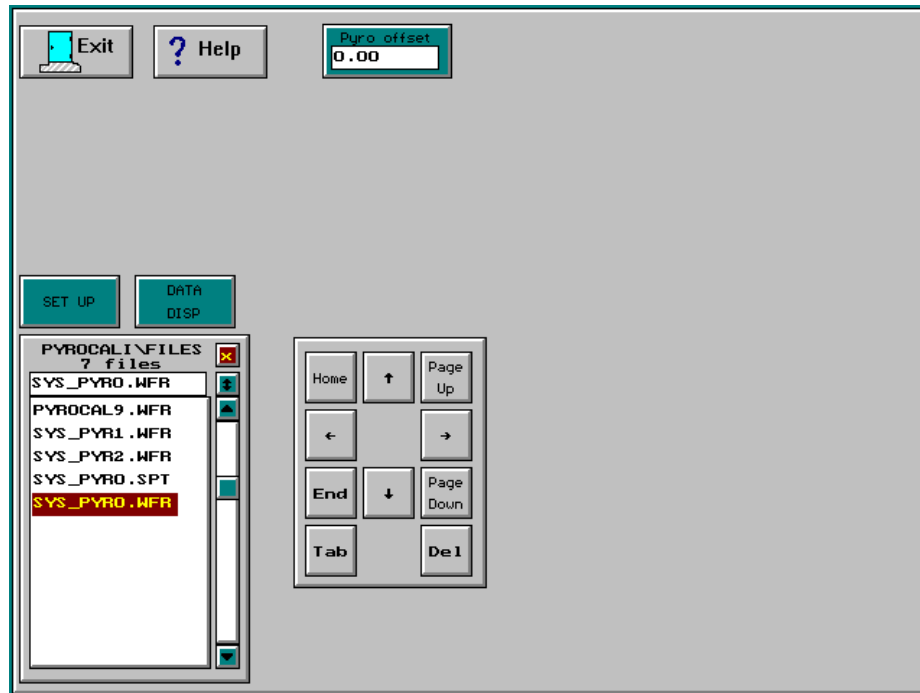
Figure 10-14: *Pyrometer Calibration Menu*

Location: Main Menu ➔ Calibration Menu ➔ Pyrometer Calibration

Step 1.   From the Calibration menu screen, click on the Pyrometer Calibration button. This will display the Pyrometer Calibration List screen, figure 10-14.

Step 2.   Select the appropriate calibration file to use or modify and click on the Set Up button to display the Pyrometer Calibration Setup screen, figure 10-15.

Figure 10-15: *Pyrometer Calibration Setup*

Step 3.   Create a new **File Name** for a new pyrometer calibration. There is a limit of 8 characters in the filename. A recommended filename format is YYMMDDxx (YY=year, MM=month, DD=day, xx=distinguish between multiple calibration files being created on the same day) for easy tracking. For example: 060521A or 060521B. SYS_PYRO.WFR and SYS_PYRO.SPT are default system calibration files. Do not use these filenames, since they may be over-written at any time.

Step 4.   Select the appropriate substrate (Wafer Type). If a wafer is being used for calibration, then the file extension (**File Ext**) should be *WFR*. If a susceptor is being used, then the file extension (**File Ext**) should be *SPT*.

Step 5.   Enter in the engineer's name for the Engineer field.

Step 6.   Enter into the **Title** field the filename. This allows tracking the original calibration file that was used for the system pyrometer calibration.

Step 7.   Enter in the proper values for the following fields:

Intensity Init	The initial intensity when the calibration starts.

Intensity Step	The amount the intensity is to be increased every tick. A tick occurs approximately every 18.2 times per second.
Delay Ticks	Delays increasing the intensity by this many ticks. (1 tick occurs every 55 msec)
Max Temp	The maximum allowed temperature during the calibration. The calibration will end once this temperature has been reached. This temperature must be at least 50°C above the highest know process temperature. If the process temperature goes above this "**Max Temp**", the temperature is undefined. NOTE: The maximum allowed temperature for this machine is 1250°C for a limited time. If the measured temperature goes above 1250°C, the process will abort.
Emissivity	Range is 33 – 100. The emissivity compensates for the back side reflectivity of the wafer. For a standard silicone wafer, the emissivity is 77.04%.
pyrometer type	Set this to the type of pyrometer that is installed in your system.
Pyrometer Tube Offset Update	Used only for dual pyrometers After changing the **Tube Offset k**, **Tube 700ºC** or **Tube 1100ºC**, click on this to record them to the pyrometer information memory.
Tube Offset k	Used only for dual pyrometers. Ideally this should be 0.0. Initially, set this to -1.0. It compensates for the drift of the output signal from the wafer pyrometer when the temperature is held steady. The comparison is done by running a recipe using a TC wafer and comparing the pyrometer and the TC. Adjust this value if the pyrometer drifts. If the pyrometer drifts upwards, then reduce this value (a negative value is OK). If the pyrometer drifts downwards, then increase this value. The problem is be caused by the quartz tube getting hot. Using this parameter to compensate for dirty quartzware is not recommended as a permanent fix. See below in section "*Adjusting the k-factors* for the procedure to adjust the **Tube Offset k**.

	Used only for dual pyrometers.
	Initially, set this to 1.0.
Tube 700ºC	This compensates for the pyrometer drift in temperature, like the "Tube Offset k", except it is relative to 700ºC. Run a recipe at 700ºC and compare the pyrometer with the TC. If the pyrometer drifts upwards, then reduce this value (a negative value is OK). If the pyrometer drifts downwards, then increase this value.
	Used only for dual pyrometers.
	Initially, set this to 1.0.
Tube 1100ºC	This compensates for the pyrometer drift in temperature, like the "Tube Offset k", except it is relative to 1000ºC. Run a recipe at 1000ºC and compare the pyrometer with the TC. If the pyrometer drifts upwards, then reduce this value (a negative value is OK). If the pyrometer drifts downwards, then increase this value.
gas flow	The type and flow rate for the gas to be used during the calibration process.

Step 8.   Click on the **Calibrate** button to start the pyrometer calibration process. This will take you to the *Pyrometer Calibration Graph* screen, figure 10-15. It allows monitoring the calibration process. During the process, the following curves will be generated:

Red	The intensity of the lamps. This should be linear.
Blue	The real temperature (ºC) reading from the TC wafer.
Yellow	The output (mV) from the pyrometer that is looking at the wafer (wafer pyrometer).
White	The output (mV) from the pyrometer that is looking at the quartz tube (tube pyrometer).
Black	The difference between the wafer pyrometer and the tube pyrometer, using the **Tube-Offset-k** factor.

These curves should be smooth. If they aren't, then there is something wrong. See the *Troubleshooting the Pyrometer Calibration* section below.

☞ **NOTE**

Start the Calibration when the wafer temperature is below 100°C. If the calibration is started at a higher temperature, then the full range of the pyrometer will not be recorded and the pyrometer may not be useful at its lowest reliable temperature.
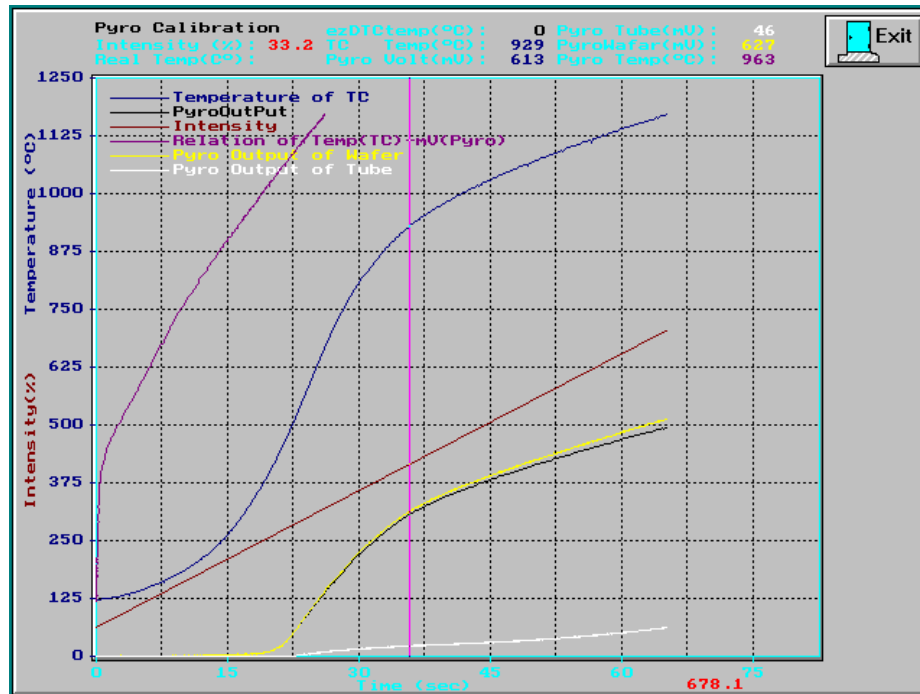
Figure 10-16: *Pyrometer Calibration Graph*

☞ **NOTE**

The TC curve should be smooth, like creating an S-curve on a drafting program. If it is jittery or poor, then refer to the troubleshooting section.

Step 9.   From the *Pyrometer Calibration Setup* screen, click the **Save** button to save the results to the hard disk.

Step 10.   Click on the **View** button to view the calibration result for the TC/Pyrometer
relationship curve, figure 10-15. This curve is magenta in color and shows the
relationship between the TC and the pyrometer.

Step 11.   If the calibration was successful, save the results to the system by clicking on
the **Save To System** button. This will copy the calibration data to the
SYS_PYRO.WFR calibration file.

Check the Result of the Pyrometer Calibration

Checking the pyrometer calibration needs to be done to ensure the calibration results perform correctly. When checking the calibration results, there are a few things to keep in mind. The measured temperature of the TC and the pyrometer may be several degrees different. This is because the pyrometer responds faster than the thermocouple and the points on the wafer they are measuring are different. However, the temperature between them should not exceed 100ºC. There is an exception to this. During cool-down, there could be a difference of 450ºC or more.

There are two ways to check the calibration. One is from the *Manual* screen. This is a simple and fast verification of the calibration. Another, and much more precise method, is to use a process recipe to verify the calibration and then test the resistivity of the wafer.
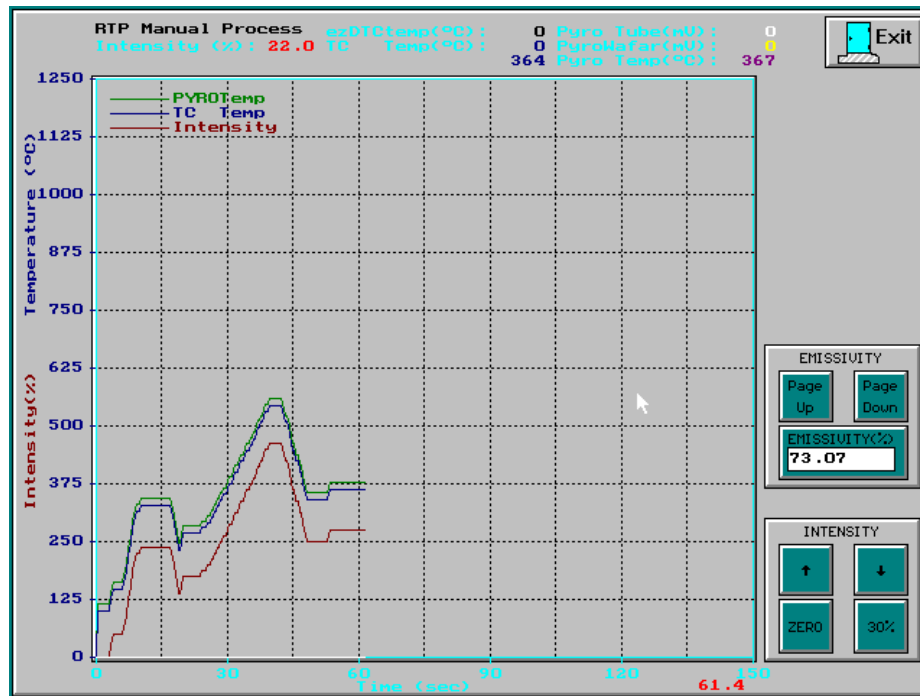
Figure 10-17: *Manual Control screen*

Location: Main Menu ➔ Calibration Menu ➔ Manual Control

The first method mentioned is done from the *Manual Control* screen, figure 10-16. This is a preliminary check. With a TC wafer in the oven and the pyrometer calibrated, click on the **Manual Control** button from the *Calibration Menu* screen. Use the **Up** and **Down** arrow keys on the keyboard to increase and decrease, respectively, the lamp intensity. Observe the difference between the TC and the pyrometer measurements. If

the difference is acceptable, then run a process wafer with a process recipe and check the resistivity.

Minimum Reliable Temperature

The pyrometer depends on the amount of infrared radiation from the wafer to determine the temperature of the wafer. At low temperatures, this radiation is very small, thus the pyrometer is not sensitive enough to determine the temperature of the wafer. Every pyrometer is different. Doing a pyrometer calibration also allows the process engineer to determine the minimum temperature to reliably use the pyrometer.

As depicted in figure 10-15, the minimum reliable temperature for this pyrometer is 375 ºC. To determine this, move the vertical pink line to the point the pyrometer curve starts to increase, by using the left and right arrow keys on the keyboard. Where this line intersects the blue TC temperature curve, note the TC temperature at the top of the screen. This is the minimum reliable temperature for the pyrometer.

Pyrometer Calibration Adjustment

This procedure explains how to adjust the pyrometer calibration.

Step 1.   Do a Pyrometer Calibration as described in the manual.

Step 2.   Adjust the **Tube-Offset-k**. This allows the adjustment of the Pyrometer
           Calibration Tube-Offset-k.

    a. Manually run the recipe 900TC.RCP with a TC wafer in the chamber.
    Make sure it is using only **LOCAL** parameters. The temperature sensor
    that will be used is the thermocouple.

sensor type	TC			
emissivity	77.04			
sensitivity	1.50			
gain	1.00			
DELAY	1.00			
STEP	**TIME**	**TEMP**	**Factor**	**N2**
delay	5			10
intensity	14	25		5
ramp	20	900	1.00	5
steady	60	900	0.90	5
delay	120			10

    b. Adjust the **Steady Intn Factor** and other recipe control parameters, as
    explained in the manual, to get a good profile for the thermocouple.
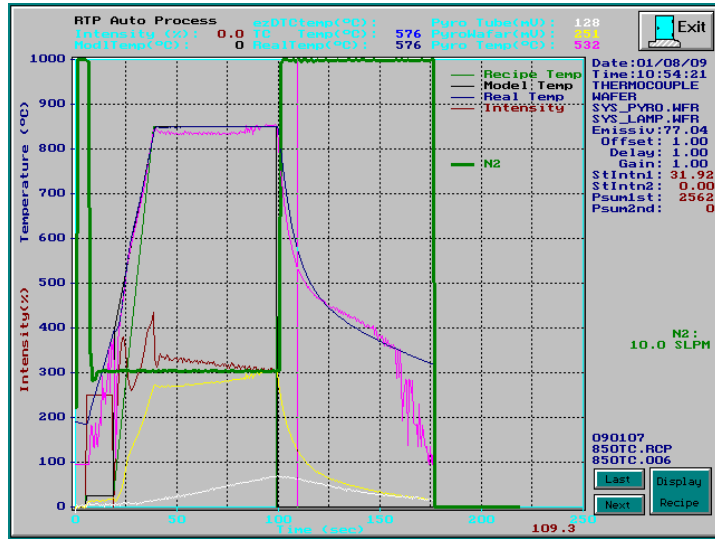
c. Adjust the pyrometer **Tube-Offset-k** factor so the pyrometer does not drift. ALWAYS use the file that was used to calibrate the pyrometer. NEVER change SYS_PYRO.WFR directly.

Step 3. 700°C, 900°C and 1100°C Multistep Run with **Thermocouple**. This test allows the adjustment of **Tube 700°C** and **Tube 1100°C** for the Pyrometer Calibration. It also verifies the adjustment of the **Tube-Offset-k**.

a. Run recipe 7911TC.RCP. Make sure it is using only **LOCAL** parameters. The temperature sensor that will be used is the thermocouple.

sensor type	TC			
emissivity	77.04			
sensitivity	1.00			
gain	1.00			
DELAY	1.00			
STEP	**TIME**	**TEMP**	**Factor**	**N2**
delay	10			10
intensity	15	25		5
ramp	20	700	1.00	5
steady	30	700	1.27	5
ramp	15	900	1.00	5
steady	30	900	1.21	5
ramp	15	1100	1.00	5
steady	30	1100	1.16	5
delay	120			10

b. Adjust the **Steady Intn Factor** and other recipe control parameters, as explained in the manual, to get a good profile for the thermocouple.

c. Adjust the **Tube 700°C** and **Tube 1100°C** for the Pyrometer Calibration.

Step 4. 700°C, 900°C and 1100°C Multistep Run with **Pyrometer**. This test verifies controlling the temperature with the pyrometer.

a. Run recipe 7911PY.RCP. Make sure it is using only **LOCAL** parameters. The temperature sensor that will be used is the pyrometer.

sensor type	pyrometer			
emissivity	77.04			
sensitivity	0.80			
gain	0.60			
DELAY	1.00			
STEP	**TIME**	**TEMP**	**Factor**	**N2**
delay	10			10
intensity	15	25		5
ramp	20	700	1.00	5
steady	30	700	1.27	5
ramp	15	900	1.00	5
steady	30	900	1.21	5
ramp	15	1100	1.00	5
steady	30	1100	1.16	5
delay	120			10

b. Adjust the Steady Intn Factor and other recipe control parameters, as explained in the manual, to get a good profile for the pyrometer.

c. Adjust the **Pyrometer Offset** in the recipe. Make sure the **Use PYRO Offset** is set to **LOCAL**.

Adjusting the Pyrometer Offset

Adjust the **Pyrometer Offset** in the *Recipe*. Make sure the **Use PYRO Offset** is set to <u>LOCAL</u>.

Run a recipe with a TC wafer inside the chamber.

Select the **Sensor Type** as **Pyrometer**.

While running the recipe, how does the performance of the pyrometer compare to the thermocouple? If the difference is acceptable, then run a process wafer with the process recipe and check the resistivity for temperature correctness.

Troubleshooting the Pyrometer Calibration

The pyrometer calibration problem might be caused by one of the following reasons:

➢ Check the calibration setup. The initial temperature should be less than 100ºC.

➢ Check the cooling air pressure. The pressure of the cooling air should be greater than 10-15 SCFM and 50 PSI. A loud noise can be heard by the airflow.

➢ The quartz tube is dirty. Check to be sure the cooling air is filtered. A dirty tube blocks the amount of the light energy from the wafer. Clean the quartz tube.

➢ The calibration wafer is not good. Either the thermocouple contact is not good or the backside of the wafer is too rough.

➢ Check to make sure the pyrometer chiller is set to 20 °C and has stabilized.

1) If the TC temperature curve:

➢ is going down (negative), then the TC leads are reversed.

➢ doesn't change, then the TC is disconnected or a lead is broken.

➢ changes very little, then a lead is grounding to something.

➢ spikes up or down, then a lead is not making good contact.

➢ rises too fast, then the TC is not making good contact with the wafer.

2) If the pyrometer curve (wafer or tube):

➢ is going down (negative), then the pyrometer connector is not wired properly.

➢ doesn't change, then the pyrometer is disconnected.

➢ changes very little, then the pyrometer gain is too low or the pyrometer may be bad.

➢ spikes up or down, then the pyrometer or the AW-900-058 control board is bad.

➢ The wafer pyrometer curve is too low and the tube pyrometer curve is too high, then the pyrometer connectors need to be swapped.

3) TC/Pyrometer relationship curve does not look like the one depicted in figure 10-15:

➢ Straight: the TC and pyrometer are sharing the same A/D channel. See "Step 10" above.

➢ Rough (not smooth): one of the pyrometers is bad.

10.8.5   CHAMBER CALIBRATION

This unit is a Rapid Thermal Processing (RTP) system. To process wafers with good results, the system needs to have good temperature control at all times, this includes ramping up to the desired temperature. To accomplish this, the Chamber Calibration tries to understand the thermal characteristics of the chamber system and wafer.

The thermal network circuit of the RTP system usually includes:

- Water Cooled Chamber

- Quartz Isolation Tube

- Quartz Wafer Tray

- Wafer to be Thermally Processed.

- Susceptor (optional)

When the lamps in the chamber are applied a constant power, the temperature of the wafer increases rapidly for the first few seconds and then is in an equilibrium state after a while. This is done because the power dissipated and the power applied are balanced.

Cooling is done with water cooling of the oven walls and air cooling of the quartz isolation tube. Also, a constant gas flow in the chamber helps cool the wafer. The water cooling and the air cooling also helps keep the differential expansion rate between the outer chamber and the quartz tube to a minimum. This is to prevent breaking the quartz isolation tube.

☞ CAUTION

Make sure both Water Cooling and Air Cooling are on before doing anything where the lamps will come on. Cooling both the chamber and quartz isolation tube is very important to prevent breaking the quartz isolation tube and destroying the water seals.

☞ NOTE

Before doing a Chamber Calibration, make sure the pyrometer is calibrated and all of the lamps work well. The lamps can be checked with the *Zone Control*.
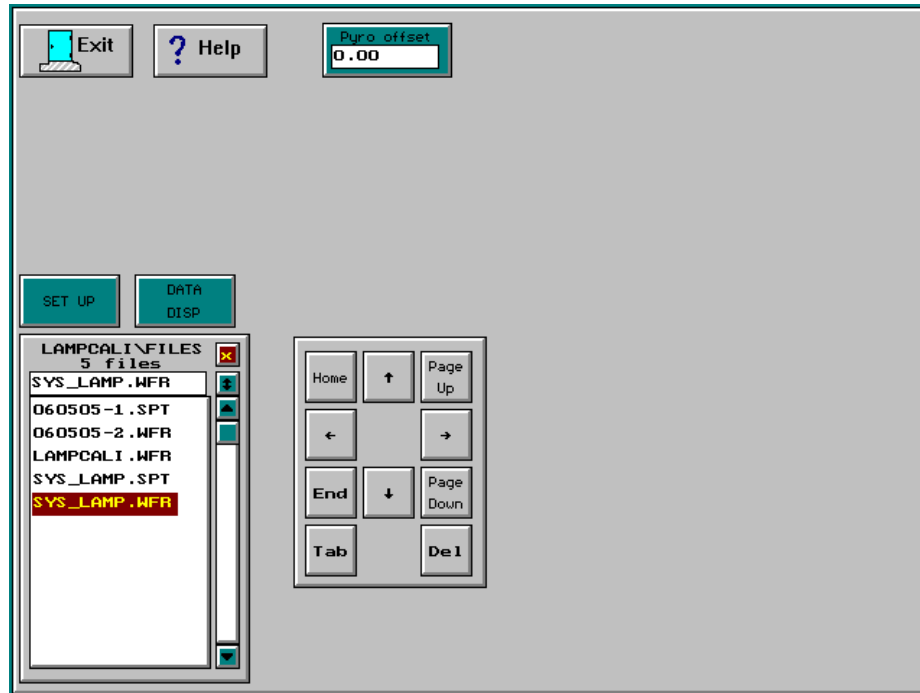
Figure 10-18: *Chamber Calibration Menu*

Location: Main Menu ➔ Calibration Menu ➔ Chamber Calibration

There may be several calibration files listed. Those ending in **WFR** are calibration files for wafers. Those ending in **SPT** are calibration files for susceptors. SYS_LAMP.WFR and SYS_LAMP.SPT are system calibration files. Do not edit these files, since they can be over-written at anytime.

Select one of the calibration files in the list and click on **Set Up**.

Figure 10-19: *Chamber Calibration Setup*

For the chamber calibration 0%, 5%, 10%, 15%, 20%, 25%, 30%, 35% and 40% intensities are usually used. Here the Intensity is not the real light intensity of the lamp, but the power applied to the lamps.

Edit the fields appropriately.

Save	Saves the generated calibration data to the file named in "File Name" and "File Ext"
SAVE TO SYSTEM	Saves the generated data to the System.
Calibrate	Starts the lamp calibration.
View	View the generated calibration data on a graph.
File Name	The name of the file the generated calibration data will be saved in. The filename is limited to 8 characters. A good name is derived from the current date. For example, 060215 mean 2006, February, 15.

File Ext	The extension of the filename for the generated calibration data If the wafer type is a wafer, use WFR, else if it is a susceptor, use SPT.
Wafer Type	WAFER, SUSCEPTOR
Engineer	The name of the person doing the calibration
Title	A description of the calibration
Curve Begin	The first intensity curve to <u>start</u> the calibration. .Initially, the first run of the calibration process is set to use intensity curve #1. However, if intensity curve #3 is faulty, then set "Curve Begin" to 3 and "Curve End" to 3. Then re-run the calibration. The calibration process will only run intensity curve #3 and leave the other curves alone. It will then create a new set of calibration data utilizing the new intensity curve #3 information.
Curve End	The last intensity curve to <u>end</u> the calibration. Initially, the last run of the calibration process is set to use intensity curve #8. *(see "Curve Begin" for an exception.)*
Curve Num	The number of intensity curves to perform for the calibration. This is the total number of curves to use for the chamber calibration. It is not, necessarily, the number of curves between "Curve Begin" and "Curve End".
Max Temp(ºC)	The temperature at which the calibration will abort
Init Temp(ºC)	The temperature at which to start recording data for each calibration curve. As the temperature increases and passes this point. When using a pyrometer make sure the temperature is not too low.
End Temp(ºC)	Once the temperature reaches this value, the calibration will end when the current intensity curve finishes.
Temp sensor	THERMOCOUPLE, PYROMETER
Gas x	Enter in a value for the amount of gas flow to enter into the chamber during the calibration. This is usually the purging gas.
Intensity(x)	The amount to set the intensity for intensity curve x.
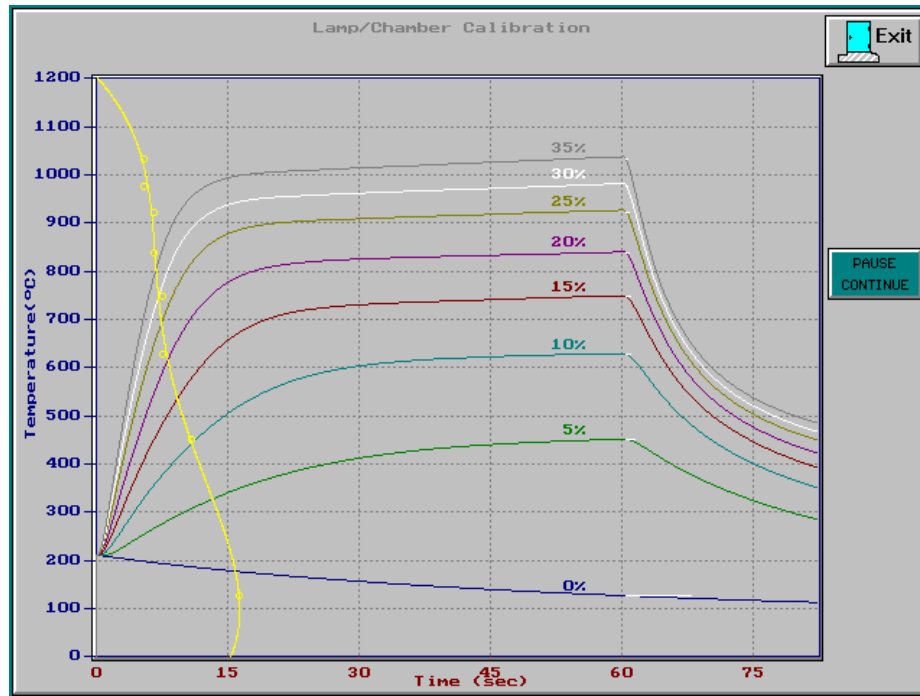
Figure 10-20: *Chamber Calibration Curve Graph*

The calibration starts by warming the wafer to a temperature that is specified in the **Init Temp** field. Once this temperature has been reached, the lamp intensity is changed to a value specified in the **Intensity (1)** field.

The temperature of the wafer increases rapidly for the first few seconds and saturates after 50 seconds. After 60 seconds has elapsed, the lamps are turned off. The temperature of the wafer decreases.

The calibration software now waits for 82.5 seconds before starting the next intensity curve. If the temperature is below **Init Temp**, the wafer is warmed up. Otherwise the system waits for the temperature to cool to this temperature.

This process is repeated for each of the intensity curves specified.
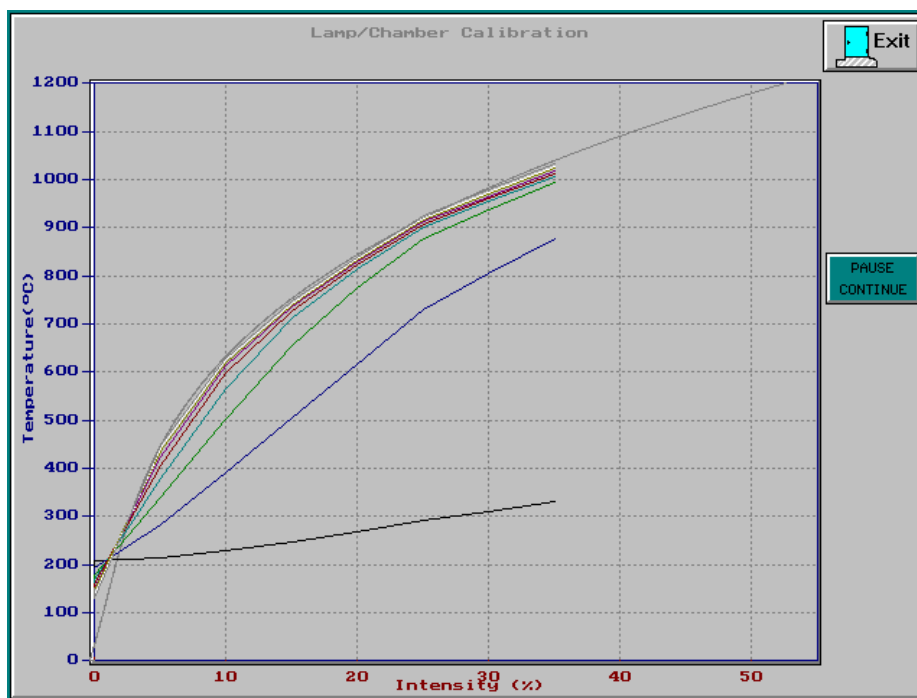
Figure 10-21: *Chamber Calibration Curve Graph 2*

10.8.6   GAS A/D CALIBRATION

This calibrates the analog and digital circuits for the feedback of each of the MFC's.

The procedure is very similar to the thermocouple calibration routine.
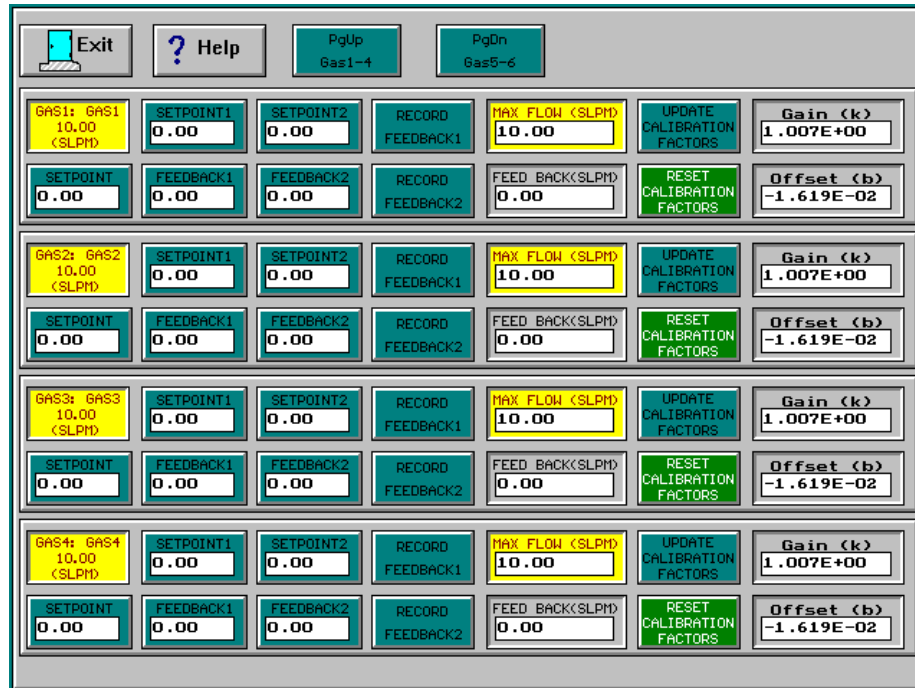
Figure 10-22: *Gas Calibration screen*

Location: Main Menu ➔ Calibration Menu ➔ Gas Calibration

Gas Calibration, figure 10-22, is used to correct for any offset that might develop in the gas flow circuitry. There are 2 kinds of offset: the zero offset (k) and the linear offset (b).

The AW-901 software uses the following equation to correct the offsets:

$$y = (k * x) + b$$

where x is the reading from the computer A/D converter, and y is the calibrated gas flow.

The following is a step-by-step procedure for calibrating the gas flow. The **Gas Feedback** field on the *Gas Calibration* screen (Figure 10-21) always displays the gas flow rate from the gas A/D channel.

The following steps are for one gas flow. The other gas flows are calibrated in exactly the same manor.

Step 1.   Click on the Reset Calibration Factors button to reset the factors to k=1 and b=0.

Step 2.   Set Setpoint 1 field to the appropriate low gas flow rate, usually 20% of the max flow rate. (For example: if the maximum flow rate is 200 sccm, then 40 should be entered into this field.) If this field already has the correct value, click on it and press Enter. This will set the setpoint.

Step 3.   Wait for the flow rate to stabilize in the Feedback field (2-3 seconds). Then click the Record Feedback 1 button. The flow rate will be recorded to the Feedback 1 field.

Step 4.   Set Setpoint 2 field to the appropriate high gas flow rate, usually 80% of the max flow rate. . (For example: if the maximum flow rate is 200 sccm, then 160 should be entered into this field.) If this field already has the correct value, click on it and press Enter. This will set the setpoint.

Step 5.   Wait for the flow rate to stabilize in the Feedback field (2-3 seconds). Then click the Record Feedback 2 button. The flow rate will be recorded to the Feedback 2 field.

Step 6.   Click on the Update Calibration Factors button to calculate the factors.

Step 7.   Check the result of the Gas Calibration. Change the gas flow rate to several different setpoints in the Setpoint field to verify the gas flow rate factors are good.

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11. DIAGNOSTICS & TROUBLESHOOTING

11.1 <u>OVERVIEW</u>

This guide is intended to help you fix some of the common problems that may occur. If you need further help, contact AllWin21 Field Service. Telephone numbers are listed in the front of this manual. More details on returning parts and contacting AllWin21 for assistance are listed in Appendix B.

☠ WARNING

For your safety , all power must be OFF at the AC power distribution panel before opening the AccuThermo RTP system cover to perform any diagnostic or service procedures inside the system. Even when the AC power switch on the front panel is OFF, high voltage still exists on various components inside the system. When the cover has been removed and personnel are clear of the tool, power may be reapplied, but only if strictly necessary to complete the procedure. After these procedures are completed, the cover should be replaced (with power removed) before returning to normal operation.

☞ NOTE

Position of a part is relative to the machine. "Front" is in the direction of the front of the machine. "Left" is the left side when looking at the machine while standing in front of the machine.

☞ **NOTE**

At least 85% of all problems can be attributed to connectors. At AllWin21 we have these simple rules which we follow.

1) Do not drop connectors. It can bend and damage pins and crack the housing, etc. Treat connectors like "eggs". Treat PCB like "glass".

2) Take the time to tighten all holding screws. A loose connector may not have good contact. It may also bend the pins.

3) Do not plug connectors in & out too many times.

4) Fix the connector correctly the first time. A bad "fix" can further damage the connector.

11.2 **ALARM LIST**

Alarm ID	Alarm Definition	Comments
0000	Communication Down	Check the cable between the computer and the oven unit
0001	Illegal Recipe Structure	
0002	Upload Non-existent Recipe	
0003	Air/N_2 Cooling Flow is too Low	Make sure the air flow is adequate. Check the machine specifications.
0004	Cooling Water Flow is too Low	Make sure the water flow is adequate. Check the machine specifications.
0005	Gas Panel Power Failure	
0006	Oven Temperature Interlock On	
0007	Wafer Over Temperature	This would happen if the software was using the thermocouple to monitor the temperature and the TC was disconnected or it broke. Then the temperature would rise above 1300 C. Just replace the TC and everything should be OK.
0008	Over Temperature, Bottom Plate	1) Make sure there is sufficient water flow. 2) Make sure the water is not blocked for the bottom plate. 3) Make sure the process time is not too long and the setpoint temperature is not too high.
0009	Over Temperature, Top Plate	1) Make sure there is sufficient water flow. 2) Make sure the water is not blocked for the top plate. 3) Make sure the process time is not too long and the setpoint temperature is not too high.
0010	Over Temperature, Triac Plate	1) Make sure there is sufficient water flow. 2) Make sure the water is not blocked for the triac plate. 3) Make sure the process time is not too long and the setpoint temperature is not too high.

Alarm ID	Alarm Definition	Comments
0011	Water Leak	A water leak has been detected around the chamber.
0012	Oven Door Is Open When It Should Be Closed	1) Make sure the pneumatic pressure for the oven door is sufficient. 2) Make sure the oven door is not blocked. 3) Make sure the Oven door open/closed sensors are adjusted properly.
0013	Smoke Detector is On	
0014	Gas 2 Leaking	
0015	Gas 3 Leaking	
0016	Gas 5b Leaking	
0017	Gas 5b Interlock Is On	
0018	Gas 5a Interlock Is On	
0019	Gas 3 Interlock Is On	
0020	Gas 2 Interlock Is On	
0021	Gas 4 Interlock Is On	
0022	Low Pyrometer Flow Level	The cooling water flow for the pyrometer is too low.
0023	Low Pyrometer Cooling Tank Water Level	
0024	Incompatible Valve Opened/Closed	
0025	(not used)	
0026	A to D (analog to digital) Time Out Error	The sensor took too long to change.
0027	ATP does not Exist	
0028	ATP Time Out Error	
0029	Gas 2 Flow Out Of Range	The gas flow for Gas #2 is either too high or too low from the setpoint.
0030	Gas 4 Flow Out Of Range	The gas flow for Gas #4 is either too high or too low from the setpoint.
0031	Gas 3 Flow Out Of Range	The gas flow for Gas #3 is either too high or too low from the setpoint.
0032	Gas 5a Flow Out Of Range	The gas flow for Gas #5a is either too high or too low from the setpoint.
0033	Gas 1 Flow Out Of Range	The gas flow for Gas #1 is either too high or too low from the setpoint.

Alarm ID	Alarm Definition	Comments
0034	Gas 5b Flow Out Of Range	The gas flow for Gas #5b is either too high or too low from the setpoint.
0035	Purge Gas 3 Flow Out Of Range	The gas flow for Gas #3 Purge is either too high or too low from the setpoint.
0036	Purge Gas 2 Flow Out Of Range	The gas flow for Gas #2 Purge is either too high or too low from the setpoint.
0037	Gas 9 Flow Out Of Range	The gas flow for Gas #9 is either too high or too low from the setpoint.
0038	Gas 10 Flow Out Of Range	The gas flow for Gas #10 is either too high or too low from the setpoint.
0039	Illegal Gas Mixture	
0040	Purge Flow Too Low	
0041	Purge Sequence Error	
0042	EMS Error	
0043	Can't Reach Temperature	Unable to get to the setpoint temperature.
0044	Vacuum Pressure Is Outside Tolerance Window	
0045	Bad Temperature Reading	The temperature sensor (pyrometer or thermocouple) might have a problem.
0046	Temperature Out Of Tolerance Window	The temperature is either too high or too low when it entered the steady step. The temperature must be under control during the ramp step.
0047	(not used)	
0048	Lamp Check Error	1) Check all lamps to make sure they are all working. 2) Make sure there is sufficient voltage for the lamps.
0049	Lamp Calibration Error	1) Check all lamps to make sure they are all working. 2) Make sure there is sufficient voltage for the lamps.
0050	Door Check Error	The chamber door is open. Make sure the door is closed and locked.
0051	(not used)	
0052	Can't Close Door	
0053	Can't Open Door	

Alarm ID	Alarm Definition	Comments
0054	Unspecified System Error	
0055	Send Not Ready	There is no cassette on the Send Cassette Station.
0056	Receive Not Ready	There is no cassette on the Receive Cassette Station.
0057	Receive Cassette Full Error	
0058	Send Cassette Empty Error	
0059	Wafer On Cool Position Error	There is a wafer on the cooling station when there should not be one.
0060	Wafer Not On Cool Position Error	There is no wafer on the cooling station when there should be one.
0061	Wafer In Oven Error	There is a wafer in the oven when there should not be one.
0062	Door Open Time-out Error	The oven door took too long to open. Make sure the door pneumatic pressure is sufficient.
0063	Door Closed Time-out Error	The oven door took too long to open. Make sure the door pneumatic pressure is sufficient.
0064	Door Can't Close Because Arm Is Extended In Oven	The oven door cannot close, because the robot arm is in the oven. Remove the robot arm.
0065	No Wafer On Aligner Error	There is no wafer on the aligner when there should be one.
0066	Wafer On Aligner Error	There is a wafer on the aligner when there should not be one.
0067	(not used)	
0068	(not used)	
0069	Door Can't Close Because Arm Is Extended In Oven	The oven door cannot close, because the robot arm is in the oven. Remove the robot arm.
0070	Robot Time-out Error	The robot took too long to move to the expected position. 1) Make sure there is nothing blocking the robot. 2) Make sure the robot cables are well seated in their connectors.
0071	CMD Not Accepted	

Alarm ID	Alarm Definition	Comments
0072	Send Command Communication Error	
0073	Communication Buffer Flush Error	
0074	Non-digit Error	
0075	User Abort	The user aborted the process.
0076	Limit Switch Activated	
0077	Extend/Retract Axis Motion Error	
0078	Theta Motion Error	
0079	Z Motion Error	
0080	Extend/Retract Axis Error	
0081	Theta Axis Error	
0082	Z Axis Error	
0083	Axis De-servo Error	
0084	External Triggered Hard Stop	
0085	Robot Teach parameters Not Accepted	
0086	Wafer Not On Pan Error	The wafer is not on the robot end-effector.
0087	Wafer On Pan Error	The wafer is on the robot end-effector.
0088	Robot Not Ready	
0089	Different Version Between S/W and Low Level Command	
0090	Robot Params.	
0091	Robot Cycle Time-out Error	
0092	Robot High Level Command Cycle Error	
0093	Wafer Exist In Station	
0094	Arm Axis R Is In Unknown State	
0095	Open Robot Param File Failed	
0096	Robot Task Unknown State	
0097	Wafer Not Aligned	
0098	Aligner Not On or Not Installed	
0099	Wafer Characterization Error	
0100	Aligner Communication Error	
0101	No Wafer To Align	There is no wafer on the aligner.

Alarm ID	Alarm Definition	Comments
0704	MFC Max Gas Flow is too low	With the MFC set to maximum flow, the gas flow is not within the tolerance.
0719	Initial Temp of the step is too high!	The initial temperature of the steady step is too high.
0721	Over Temperature or connecting problem!	The temperature inside the chamber is greater than 1250°C or the thermocouple is disconnected.
0722	Temp sensor problem TC connect Reversed	The temperature is going down when the wafer is being heated. The thermocouple leads have been connected in reverse.
0723	Psum out of limit. Sensor or lamp bad! Software Protecting	Use of the PSum has been implemented. It has been determined the average intensity is too high. This is caused by either a lamp not working or a dirty quartz tube or a bad pyrometer or thermocouple.
0725	Temperature Sensor Broken or Lamp Power Is Not On or Chamber Door is open	The control software is trying to increase the temperature of the wafer, but the temperature is not changing. Either the thermocouple is broken or the lamp power has not been turned on or the chamber door is open, which will prevent the lamps from coming on. Refer to the section on Lamp troubleshooting.
0726	"No AW-RTP-900-008 card or card connection not good!"	There is a bad connection between the computer and the control board in the AccuThermo RTP system. Refer to section "Computer Problems in Diagnostics & Troubleshooting".
0727	Analog board problem Check DB25 cable or address switch setup	
0728	Temperature out of limit at ramp	Adjust the control parameters for the recipe.
0729	Temperature out of limit at steady	Adjust the control parameters for the recipe.
0730	Intensity out of limit at steady!	Adjust the control parameters for the recipe. Refer to the PSum section for possible reasons the intensity would be out of limit.

0731	ezDTC and Pyrometer Tolerance out of limit at steady!	
0737	Gas Power is off. Please turn it on	
0738	AC Power is off Please turn it on	Control software cannot detect the Oven Unit.
0739	Chamber Door Is Open or Water Flow Too Low	1) Make sure the Chamber Door is closed and locked. 2) Make sure the water flow is adequate. Check the machine specifications. 3) See "Interlocks Troubleshooting"
0745	Robot could not place wafer to the cassette	After the robot finished doing a "place wafer on cassette station" the robot detected the wafer was still on the end-effector. Make sure the robot is aligned properly with the cassette station.
0747	The Robot motor can not move to the zero position	
0750	The Robot can not reach the setpoint position	
0753		
0755	Wrong A/D factor	System Check
0759	Pyrometer A/D setup Error	The pyrometer A/D channel may be set wrong. Refer to the section "System Setup".
0760	Thermocouple A/D setup Error	The thermocouple A/D channel may be set wrong. Refer to the section "System Setup".
0761	Bank number out of range	This sounds like the setup file has been corrupted. It may be best to reload the software from the backup.
0765	Wrong pyrometer calibration file	
0766	Wrong Lamp calibration file	
0768	The temperature of the Water 2 for pyrometer is	
0789	Pyrometer Error or Disabled	
0790	Thermocouple Error	
0791	Pneumatic Valve Problem	
0792	Front Panel Display Error	

0793	RS-232 (Front Panel) Error	The control computer cannot communicate with the front video panel. Check the communication cable. Make sure the connectors are seated properly and firmly.
0794	There is a problem with the Robot RS-232.	The control computer cannot communicate with the robot controller. Check the communication cable. Make sure the connectors are seated properly and firmly.
0795	RS-232 (Aligner) Error	The control computer cannot communicate with the aligner. Check the communication cable. Make sure the connectors are seated properly and firmly.

11.3 <u>SOFTWARE DIAGNOSTICS</u>

Software Diagnostics are used to monitor and test the performance of different functions of the AccuThermo RTP system independently of each other. The tools that are provided in the software for monitoring and testing are:

➢ **Diagnostics** for checking the operation of each device in the system.

➢ **Manual Control** for checking the operation of the lamps, thermocouple and pyrometers.

➢ **Lamp Zone Control** for checking the individual zones of lamps and their circuits.

➢ **Board Test** for all analog and digital signals. It is used for checking the individual hardware channels. This is to be used in the most extreme cases where it is unclear if the problem is with the input or output channel of the device.

A safety feature that is built into the AccuThermo RTP system control board is a watchdog timer. This watchdog timer shuts off the lamps if it is not reset by the software every two seconds. If the computer "locks up" or the communication cable is not securely connected, the lamps will shut down so there will not be a run-away condition of the lamps heating the wafer.

The software diagnostics allows the operator to test the following with either a manual or automatic method:

* The gas flow can be set for one or more of the gases.

* The lamps can be turned on and the intensity adjusted.

* The temperature from the thermocouple is displayed graphically in real-time.

* The temperature from the pyrometer is displayed graphically in real-time.

* The status of the door interlock and the water flow interlock.

* The status of the AC power line.

* The status of the over-heat condition.

11.3.1   DIAGNOSTICS SCREEN

The system *Diagnostics* screen can be used to diagnose many problems with the AccuThermo RTP system. It is used to check the proper operation of each device in the system independently of other devices. The lamp power and each gas flow can be manually set to any desired value within the limits of the device. It can also be used to determine if the software is communicating with the oven unit.

---

᠔ CAUTION

It is possible to damage the machine if the user does not follow proper safety Error! Bookmark not defined. **precautions with the gases, gas flows and temperature.**

---

᠔ CAUTION

It is not recommended to exceed a steady state temperature greater than 1250 ºC. The melting substrate will destroy the quartz tray and quartz isolation tube. The high temperature can also damage the chamber.
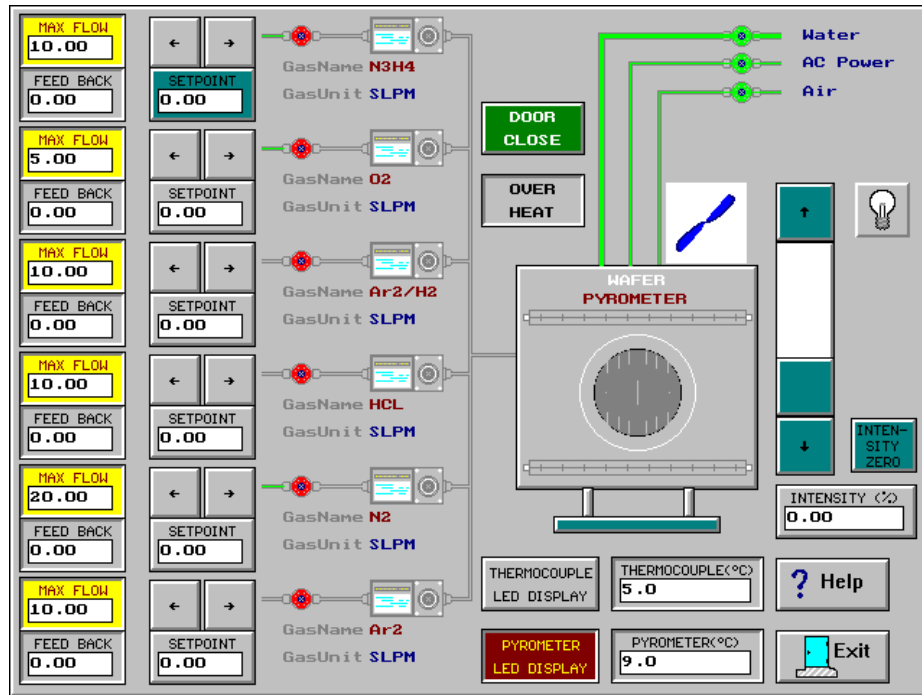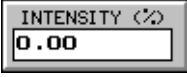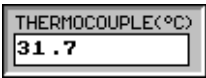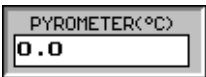
Figure 11-1: *System Diagnostics Screen*

Location: Main Menu ➔ Diagnostics

MAX FLOW 10.00	The maximum allowable flow rate for the gas
FEED BACK 0.00	The current flow rate of the gas as controlled by the MFC
←	Increase the setpoint of the gas flow rate by 1%
→	Decrease the setpoint of the gas flow rate by 1%
SETPOINT 0.00	The setpoint for the MFC to control the gas flow rate
(gas flow icon)	Gas flow icon Enables (green) / Disables (red) the gas flow. Sets the setpoint to 0 and closes the gas pneumatic valve.
GasName	The name of the gas for that line
GasUnit	The units of gas flow for that line

DOOR	Shows the status of the Chamber door position.
	  green the chamber door is closed
	  red the chamber door is open

OVER HEAT	Indicates if the chamber has overheated.
Water	The valve icon turns the cooling water valve on and off. A green line indicates water is flowing. A red line indicates no water flow.
AC Power	Checks AC power if it is being supplied to the machine. (This is a status indicator only.)
Air	
(lamp icon)	Enables / Disables the lamps. Allows the lamps to be controlled manually.
(slider)	Increases / Decreases the lamp intensity
INTEN-SITY ZERO	Sets the intensity to zero (0)
INTENSITY (%) 0.00	Displays the current intensity
THERMOCOUPLE LED DISPLAY	Displays the temperature the TC measures on the front panel LED display
THERMOCOUPLE(°C) 31.7	The temperature the TC measures
PYROMETER LED DISPLAY	Displays the temperature the pyrometer measures on the front panel LED display
PYROMETER(°C) 0.0	The temperature the pyrometer measures

11.3.2   MANUAL CONTROL

The *Manual Control* screen allows the manual control of the lamp intensity. The intensity, temperature from the thermocouple and pyrometer, and the pyrometer output voltages are plotted in real-time on a graph on the screen. This allows the observation of the temperature and pyrometer output voltage for signs of abnormalities in the signal. As depicted in figure 8-2, the TC and Pyrometer feedback can be viewed and compared for accuracy and if it follows the changes in the lamp intensity.
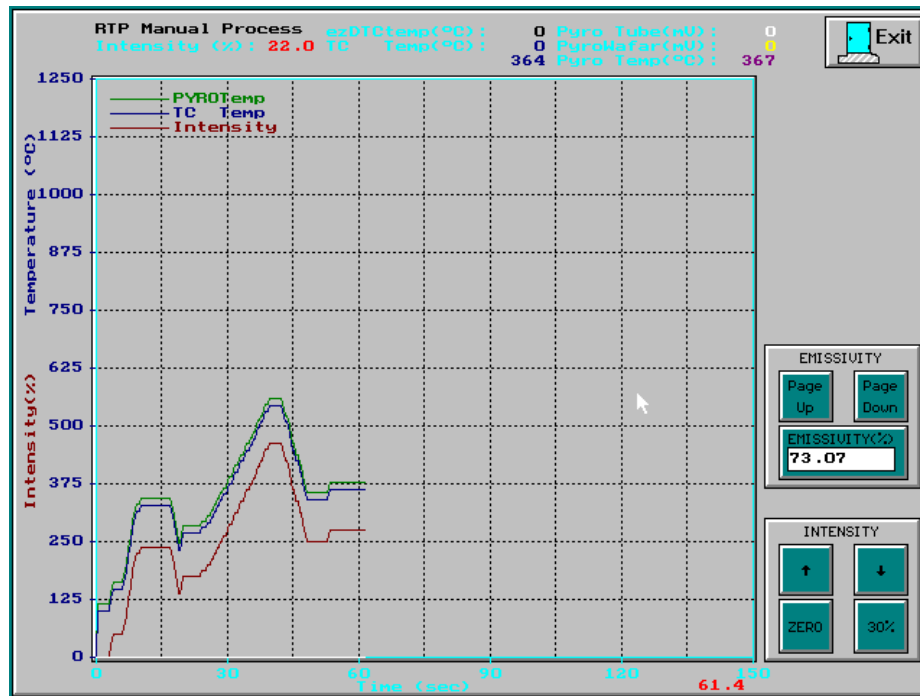
Figure 11-2: *Manual Control screen*

Location #1: Main Menu ➔ Maintenance Menu ➔ Manual Control
Location #2: Main Menu ➔ Calibration Menu ➔ Manual Control

The Manual Control can be accessed from two different places, the *Calibration menu* and the *Maintenance menu*.

Use the up and down arrow keys from the keyboard to adjust the intensity. If there is a TC wafer inside the chamber, the temperature from the TC and Pyrometer should show they are reading the same temperature, as shown above. Also, they should follow the lamp intensity curve.

11.3.3   LAMP ZONE CONTROL

The *Lamp Zone Control* screen, figure 8-3, is used to check the performance of the AccuThermo RTP system tungsten halogen lamps. By applying a predefined voltage, the current through the lamp filament is measured. The resulting values can be used to determine:

➢ the resistance of the lamps

➢ if one or several lamps are not functioning correctly

➢ if there is a need to replace one or more lamps.

Each zone of the lamps can be adjusted independently of the others. This ability helps the maintenance person to diagnose, troubleshoot and aid in the isolation of a particular zone problem with the lamps.

Generally the tungsten halogen lamps last more than three years with constant use and a great deal longer if in a pre-production or R&D environment.
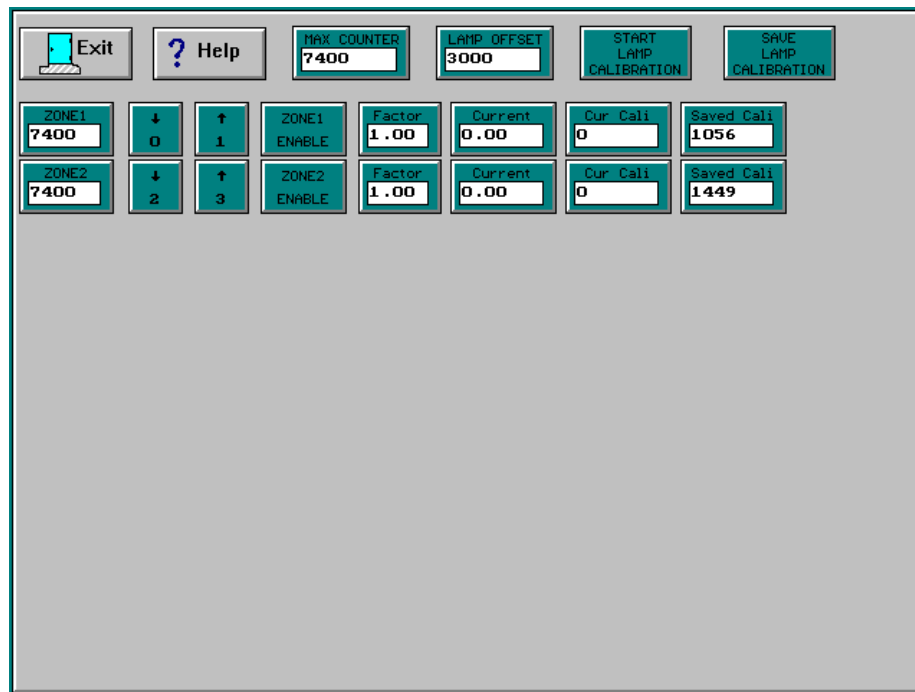
Figure 11-3: *Lamp Zone Control screen*

Location: Main Menu ➔ Maintenance Menu ➔ Zone Control

Lamp Theory of Operation

Each zone has a set of components making up a circuit and is connected to a certain phase in the electrical line frequency. Each zone circuit consists of zero crossing detection circuit, a timer/counter, a voltage/current isolation circuit, a triac (SCR), and lamps.

The theory behind controlling the brightness of the lamps is the same as a digital lamp dimmer. The line voltage oscillates in a sine wave fashion, figure 7.1, going from positive to negative and then back to positive.
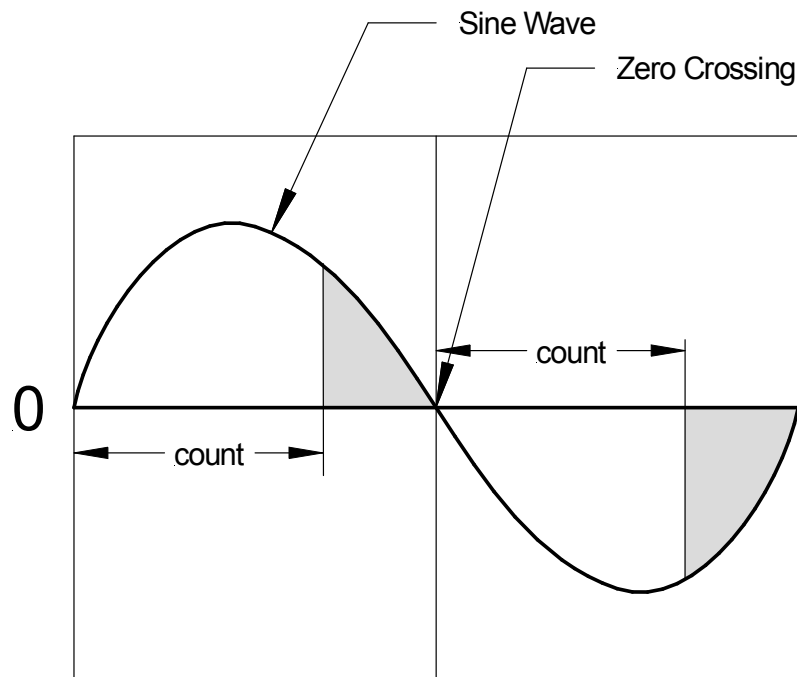
Figure 11-4: *Sinusoidal Wave*

When the voltage goes from positive to negative, or from negative to positive, it becomes 0 (zero) volts momentarily. This is called "crossing the zero boundary". The "Zero Crossing" board detects the voltage as it momentarily becomes zero. When the "Zero Crossing" board detects zero volts, it sends a pulse to a digital counter to the timer/counter circuit. A count from the register in the digital counter is loaded and the counter starts counting down. A 1MHz oscillator is used to generate the clock pulse for the counter. Once the count reaches 0 (zero) it will send a trigger pulse to the Oven Control circuit. The Oven Control then triggers a triac (SCR), which is like a high voltage switch, to turn on the lamps. The Oven Control circuit isolates the low voltage and low current of the timer/counter signal from the high voltage and high current necessary to trigger the triacs. Now the lamps are on, but only for a very short time. When the voltage becomes zero again, the triacs turn off. This entire cycle is repeated

over and over. Because this happens 100 or 120 times per second, depending on the line frequency, there is no flickering (a noticeable on/off pulsation) of the lamps.

With a large count, the lamps only receive a small fraction of the total line voltage. This makes the lamps less bright (intense) than if they use the full sine wave of the line voltage. As can be deduced from the theory above, the greater the count that is in the register of the counter, the less intense the lamps, because the lamps are off during the count down. If the count is large, then the intensity is small, because the lamps are on from the time the counter reaches zero until the next "Zero Crossing".

☞ NOTE

Remember: The smaller the count, the brighter the lamps get. The larger the count, the dimmer the lamps.

The intensity is a percent of the range of the count and not a percent of power output to the lamps. So 25% intensity is not 1/4 of the power at 100% intensity. The range of the count is not exactly from zero crossing to zero crossing (0 to 8333 for 60Hz), because of latency in the circuit. If the count is too close to the zero crossing, the lamps could flicker uncontrollably. This flickering can be very bright. The maximum and minimum counts are determined so the lamps will not flicker, yet can be considered essentially full off or full on. (Full on is rarely used, though.)
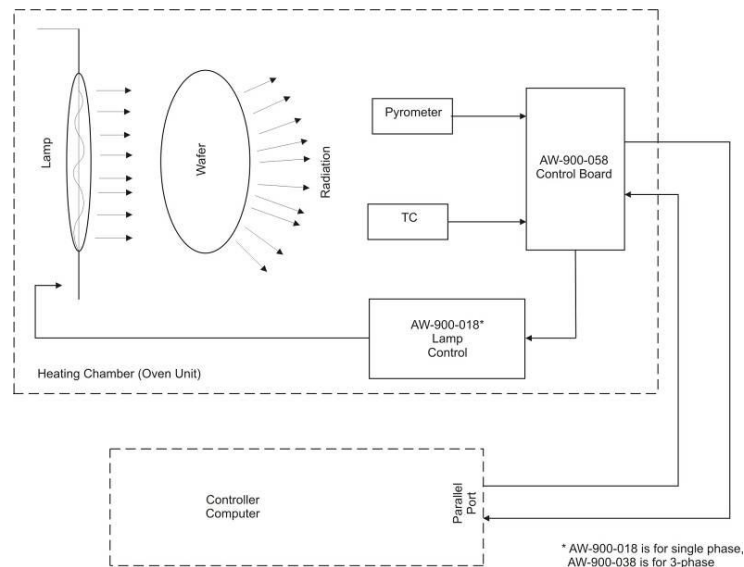
Figure 11-5: *Temperature Control Interconnect*

Controlling the Lamp Zone

The "Zone" field displays a value (count) that is downloaded to the register on the digital counter. The counter is setup to count down (counts down from X to 0). The "Zone" field can be directly edited, but it is highly recommended to change the value incrementally, using the up/down arrow buttons adjacent to this field.

☞ NOTE

Remember, the smaller the count, the brighter the lamps get.

☞ NOTE

Pressing the ESC key or Exiting the screen will turn off the lamps immediately.

	The count that is in the timer/counter register (for that zone of lamps) to control the intensity of the lamps. Larger the value, the lower the lamp intensity. The smaller the value, the higher the lamp intensity.
ZONE x	To change the count, click on the up and down arrow buttons adjacent to the zone count field, or press the key that is indicated on the up or down arrow button. For example, to decrease the count for zone #1, press key 0 (zero). This will increase the intensity of the lamps for zone #1. Press key 1 (one) to increase the count or decrease the intensity.
	Gradually decrease the count for that zone until the lamps come on. With the chamber door open, visually inspect all of the lamps for that zone. If one is off, replace it.
Zone Enable	The "Zone Enable/Disable" buttons allow the user to turn off a certain zone of lamps. This action is a system wide effect. If the button is blue, then the zone is enabled. If the button is red, then the zone is disabled.

Factor	The system uses this factor to modify the lamp intensity during a process run. In the recipe, this value can be changed for the specific recipe. Refer to the "Lamp Zone Control in the Recipe Editor.
Current	The line current being measured in real-time.
Cur Cali	The current measurement of that bank when it was set to the **Lamp Offset** value and after the **Start Lamp Calibration** button was clicked.
Saved Cali	The calibrated measurement of that bank after it was saved by clicking on the **Save Lamp Calibration** button.

Doing any changes in the Zone Control screen does not change any calibration of the software.

The AccuThermo RTP system has the ability to sense the line current of each zone. Given the measured value for a zone and knowing the theoretical value, the software can compensate for any irregularities, thus making the temperature more uniform over the entire wafer.

Using the Zone Calibration, over time the maintenance person can determine if a lamp failed and determine from which bank it failed from.

11.3.4   BOARD TEST

The *Board Test* screen, figure 8-4, allows the maintenance person to inspect each individual A/D, D/A and digital channel in the system. It can also be used to diagnose problems at the digital or analog channel level. This is the lowest level of the software to control and monitor the hardware. This is very helpful to determine if a device and its cabling are working properly.
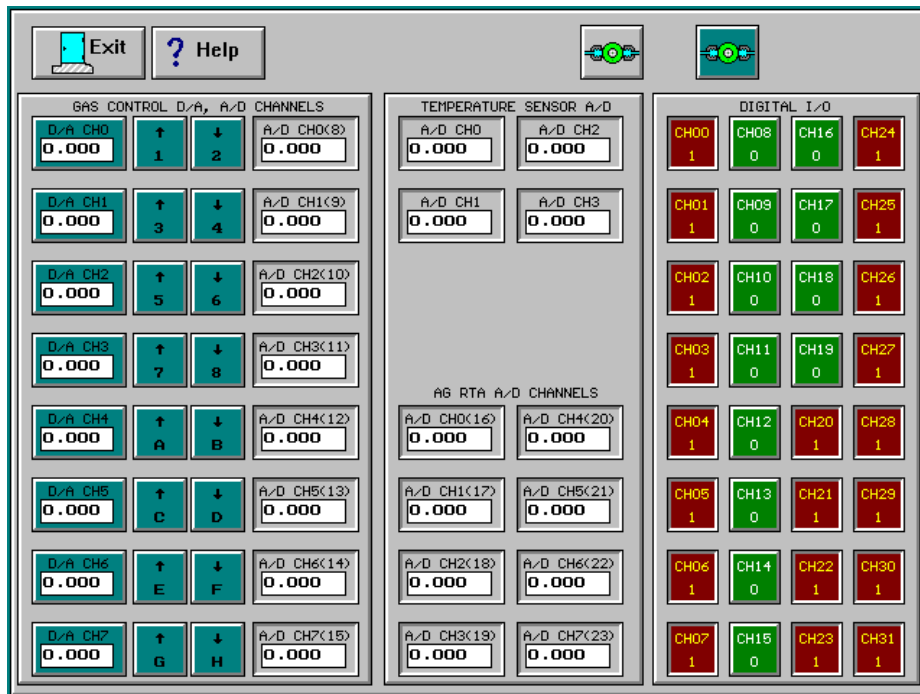
Figure 11-6: *Board Test screen*

Location: Main Menu ➔ Maintenance Menu ➔ Board Test

D/A channels 0 – 7 are to control the gas MFC's. Channel 0 is for gas #1, and channel 7 is for gas #6.

A/D channel	Description
1	pyrometer
3	thermocouple
4	water flow sensor and door closed sensor. When door is closed, the voltage should be about 3.5 V.

6	AC Power. When the AC Power is on, the voltage should be about 2.75 V.
8 - 15	Feedback from gas MFC's. Channel 8 for gas #1, channel 15 for gas #6. If proper gas is connected to gas line and a value is entered into D/A field, then there would be an equivalent value being displayed in A/D field.

11.4 <u>USING THE DIAGNOSTICS SCREEN</u>

Go to the Diagnostics screen from the Main Menu. In the upper right of the Diagnostics screen are interlock status indicators. The line color tells the status of the device.

1) Is the "AC Power" line RED? The computer does not detect AC power.

    a.   Check the "120 VAC" troubleshooting section.

    b.   Check the "Computer Problems" troubleshooting section.

2) Is the Water line color RED? This indicates either the water is not flowing or the chamber door is open.

3) Is the "Over Heat" indicator RED? This means the oven has overheated and needs to cool down. Check the "Overheat" troubleshooting section.

11.5 <u>INTERLOCKS TROUBLESHOOTING</u>

Remove the Cabinet Cover (heed the warning above) and pull up the Cabinet Cover Interlock switch into the maintenance (full up) position. It is located on the top of the oven cabinet divider.

1) Is LED D1 on the AW-900-058 control board on? This indicates all of the interlocks are satisfied. If it is off, then check the following:

    a.   Door closed switch (This is also indicated in the Diagnostics screen.). Close and lock the chamber door.

    b.   Water flow sensor: Unplug the water sensor connector P21 and test for continuity when the water is flowing. The water should be flowing if you see the cabinet exhaust fan on.

    c.   Over cooling sensor: if the chamber wall is below 75 °F, this switch is closed. It is in parallel to the water flow sensor. Unplug P10/C10 (3x3 connector on the right rear side of the chassis, behind the chamber). Test continuity between pins C10-7 & C10-9 going to the sensor under the chamber.

    d.   Does D1 go on and off if any of the above items are disturbed? If yes, then repair.

11.6 <u>TESTING FUSES</u>
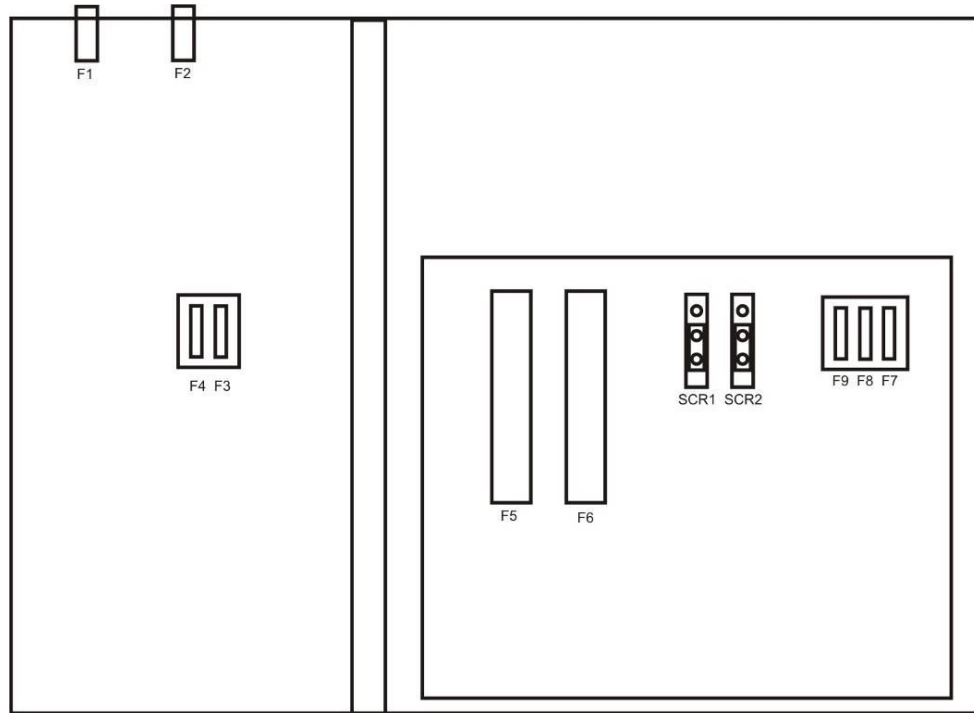
Figure 11-7: *Location of Fuses*

Fuse	Testing Procedure
F1, F2	These fuses protect the transformer. There is 208 VAC across them. Remove the fuse from the fuse holder and inspect the filament. Use a multimeter and test for continuity. If there is no continuity, replace the fuse.

F3	F3 is to protect the power control and interlock circuits.
	With the AC power applied, test for voltage from chassis ground to each end of the fuse . Each end should have 24 VAC.
	If there is no voltage for F3, then refer to section on Lamp troubleshooting.
	Test between the ends of the fuse while in the socket. The voltage should be 0 volts. If the voltage between the ends of the fuse was not 0 volts, then the fuse may be bad.
	Remove the fuse from the socket and test for continuity. If there is no continuity, replace the fuse.
F4	F4 is to protect the cabinet exhaust fan and water solenoid.
	With the AC power applied, test for voltage from chassis ground to each end of the fuse . Each end should have 120 VAC.
	If there is no voltage for F4, then refer to section on 120 VAC troubleshooting.
	Test between the ends of the fuse while in the socket. The voltage should be 0 volts. If the voltage between the ends of the fuse was not 0 volts, then the fuse may be bad.
	Remove the fuse from the socket and test for continuity. If there is no continuity, replace the fuse.
F5, F6	F5 and F6 protect the lamp power circuit.
	With the AC power switched off, the lamp circuit is open. Test the ends of the fuse for continuity. If there is no continuity, replace the fuse.
F7, F8, F9	F7, F8 and F9 protect the oven control circuits.
	With the AC power switched off, the lamp circuit is open. Remove P2 from the AW-900-018 oven control board. Test the ends of each fuse for continuity. If there is no continuity, replace the fuse.

11.7   <u>**TEMPERATURE**</u>

Refer to either the *Pyrometer* or *Thermocouple* troubleshooting sections.

11.8   <u>UNIFORMITY</u>

The uniformity is not as good as before.

This is caused by either dirty quartzware or a bad lamp.

Clean the quartzware according to the section "Quartzware Cleaning".

Check the lamps according to the section "Identifying Which Lamp is Bad".

Consider using the PSum parameter in the recipe if the same type of production wafers are being processed using the same recipe. Refer to section "Process Control Alarms" for a discussion on how to use PSum. Run several wafers with clean quartzware to determine the proper PSum values.

11.9 <u>CONTAMINATION</u>

Contamination of the wafer can come from different sections of the machine. Here are a few possibilities:

1) Process Gas Lines
2) Quartz chamber is dirty
3) Pyrometer window is dirty
4) Quartz Tray is dirty
5) Slip-free Ring pieces
6) Something external to the AccuThermo RTP system

➢ It is assumed the process gas is of sufficient quality.

➢ If the gas lines have particles in them, blowing them out should remove the particles. To do this, open the MFC full flow for one gas at a time. Let the gas flow for 10 minutes or more. Do not do this with a clean quartz chamber window, tray or slip-free ring inside the chamber. It is OK if they are going to be cleaned after blowing out the gas lines.

➢ If this is a new quartz chamber window, quartz tray or slip-free ring, it is always best to clean it before using it. The manufacturer may not have cleaned it sufficiently.

➢ Previous processes could have contaminated the quartz chamber, quartz tray, pyrometer window and slip-free ring.

➢ Dirty gas could have contaminated the quartz chamber, quartz tray, pyrometer window and slip-free ring.

It is recommended to clean the quartzware at least once per month. See the *Preventative Maintenance Schedule* section of this manual.

➢ Make sure the surrounding area is free of contamination.

➢ Check for contamination before and after processing.

11.10 <u>LAMPS</u>

Refer to the "Lamp Theory of Operation" for further information on lamp operation.

11.10.1 LAMP DIAGNOSTICS

The Lamp Diagnostics is used to test the functionality and stability of the lamp control by allowing the user to manually turn on and off the lamps.   It also allows checking the communication between the controller and the oven.

If the lamps are controllable, then the communication between the controller and oven is functioning correctly. Otherwise there is a problem between the lamps and the controller and maintenance is required. See the troubleshooting section for help.

There are three methods for testing the functionality of the lamps and the lamp control.

1) Lamp diagnostics in the ***Diagnostics*** screen is used to enable the lamp control and to adjust the intensity of the lamps. It is a simple method to determine the functionality of the lamps control.

To enable the lamp control, click on the lamp icon .

Use the slider to adjust the lamp intensity. Clicking on the up or down arrows increases or decreases the lamp intensity by 0.5%. Clicking on the white part of the slider increases or decreases the lamp intensity by 5%.

There are four ways to turn off the lamps.
1. Decrease the slider until the lamp intensity is 0%.
2. Click on the button that says "Intensity Zero".
3. Click on the lamp icon .
4. Exit the ***Diagnostics*** screen.

The stability of the lamp intensity can be measured across the SCR's. Set the intensity to 5% and measure the voltage across the SCR's. The voltage should be less than the line voltage (US=208 VAC). The voltage for each SCR should be very similar and the fluctuation in voltage should not be more than 0.25 VAC.

2)   The *Manual Control* screen can also be used to test the functionality and stability of the lamp control.

         Entering into this screen automatically enables the lamp control. Use the up and down arrow keys on the keyboard to change the lamp intensity by 1% increments. Exiting the screen disables the lamp control and turns off the lamps.

         Like with the previous lamp control method, the stability of the lamp control can be checked by measuring the voltage across the SCR's.

3)   On the AccuThermo RTP system there are 2 zones (or groups) of lamps, the top 10 lamps and the bottom 11 lamps. Each zone has a set of components making up a control circuit. Each zone circuit consists of a zero crossing detection circuit, a timer/counter, a voltage/current isolation circuit, a triac (SCR), and lamps.

         The *Lamp Zone Control* screen tests the condition of each zone of the lamps. This is done by having the software set the lamp zone intensity to a predefined value and taking a current reading. Over time, the lamps can degrade or a lamp may fail. If this happens, the current level will drop.

         The predefined value is defined in the *System Setup* screen as **LampCheckIntn.**

         Generally the tungsten halogen lamps last more than three years with constant use and a great deal longer if in a pre-production or R&D environment.

         The lamp intensity for each zone can be controlled individually from this screen. Use the up and down arrow buttons to adjust the count. The count is the delay value before the SCR's are triggered. Therefore, the larger the count, the lower the intensity. (See "Lamp Theory of Operation" above.)

         Do a Lamp Calibration. Do this several times and compare the measured value for each zone with the recorded value. If the measured value is beyond the recorded value by 400-500, then there may be something wrong with one or more of the lamps for that zone.

11.10.2 IDENTIFYING WHICH LAMP IS BAD

A sudden change in process results (uniformity) may indicate a lamp failure. (Air cooling flow and dirty quartzware may also affect uniformity.) If PSum has been setup properly, these problems will be caught before they become a problem. In order to check for lamp failure, use the *Lamp Diagnostics* of the AW-900 software. Unexpected values of currents and voltages returned by the Lamp Diagnostics indicate a lamp failure. Check lamp continuity to verify that all lamps are in operation. Verify that there are no wafers in the oven.

> ### ☠ WARNING
>
> **There is high voltage within the AccuThermo RTP system cabinet. Please use proper lockout/tagout procedures.**

Step 1.   Shut off the system's power by turning off its Power switch and shutting off the wall circuit breaker to the system. Use lockout/tagout procedures.

Step 2.   Remove the cover of the AccuThermo RTP unit. The cover is held in place by nine screws.

Step 3.   Remove the lamp harnesses from the lamps on the right side of the machine (those lamps closest to the outside cover).

Step 4.   With an ohmmeter, ground 1 lead to fuse F5 connecting to the lamp sockets on the left side of the oven. Use the other lead to measure each individual lamp on the right side of the machine.

> ➢ The average resistance should be: 5 ohms.

Step 5.   Any lamp with no continuity (infinite resistance) needs to be replaced. If no lamp is found with continuity broken call Allwin21 Corporation Customer Support for assistance.

11.10.3   **LAMPS DO NOT COME ON**

➢ Check the "Lamp Power" troubleshooting section.

➢ Check the "Overheat" troubleshooting section.

➢ Check the "Computer Problems" troubleshooting section.

➢ Check "Using the Diagnostics Screen" section.

➢ Check the "120 VAC" troubleshooting section.

➢ Check the "Interlock" troubleshooting section.

➢ Test the 5 fuses on top of the oven.

   o Check fuses F5, F6, F7, F8 and F9 as noted above.

   o Check between F5 and F6, both the front position and the rear position. There should be line voltage (208/240 VAC).

   o Check between F7 and F9, both the front position and the rear position. There should be 120 VAC.

   o Check between F8 and F9, both the front position and the rear position. There should be 120 VAC.

   o If the fuses are good, then contact AllWin21 for assistance

➢ Enable the lamps and set the lamp intensity to 5%. There should be visible light coming from the oven, around the lamp sockets.

➢ Contact AllWin21 for assistance.

11.10.4 LAMPS FLICKER.

Step 1.   Go to the *System Setup* screen and make sure the button "**Line Frequency**" is set to the proper value (50 Hz or 60 Hz). This is the frequency of the AC power.

Step 2.   Go to the *Diagnostics* screen and enable the lamps. Test the voltage across the 2 main terminals on each of the SCR's. They should not vary more than ± 0.10 VAC. Set the lamp intensity to 5%. The voltage across the SCR's should not vary more than ± 0.10 VAC. Either:

   a. Go to the *Lamp Zone Control* screen. The "**Max Counter**" field should be set between 7200 and 7800? Decrease this value until the lamps stop flickering or until this value is less than 7200. The smaller the value the less chance the lamps will come on.

   b. A control IC is bad and must be replaced.

11.10.5 LAMPS GO ON WHEN THE POWER SWITCH IS TURNED ON.

Step 1.   Go to the *Lamp Zone Control* screen. The "**Max Counter**" field should be set between 7300 and 7800? If the lamps came on very bright, then reduce this value. The smaller the value the less chance the lamps will come on. If the lamps came on and they were dim, then increase this value.

Step 2.   With the power off, test for continuity between the main terminals on the SCR's (1 & 3, and 1 & 2). If there is a short or very low resistance, the SCR is bad and needs to be replaced. Contact Allwin21 Corp. for a replacement SCR.

11.10.6 LAMP POWER TROUBLESHOOTING

➢ Is the Lamp Power switch ON? Turn on the power switch, located on the front panel.

☞ NOTE

The green light on the front panel should be on and there should be a "clunk" sound when the Power switch is turned on (this noise means the lamp power contactor has closed).

Is the GREEN power light ON?	Was there a "clunk" noise?	go to step
YES	YES	a
NO	NO	b
NO	YES	c
YES	NO	d

➢ The Lamp Power is **good**. Continue to another section for further troubleshooting.

➢ The GREEN power light is **off**, and there was **no** "clunk" noise.

   o Is the Main Power (208/240 VAC) for the oven unit on? Turn on the Main Power for the oven unit.

   o Is the EMO reset? Reset the EMO.

   o Are fuses F1 & F2 good? See section Testing Fuses.

   o Remove the Cabinet Cover (heed the warning above about removing the cover) and pull up the Cabinet Cover Interlock switch into the maintenance (full up) position. It is located on the top of the oven cabinet divider. Turn on the Main Power after the removal of the cover.

   o Is the Power switch on? The power switch is on the front panel.

   o Is there Main Power (208/240 VAC) reaching the contactor?

   o Is fuse F3 good? See section Testing Fuses. Is there 24 VAC at each end of the fuse? This fuse is for the 24 VAC circuit. It consists of the lamp contactor, green Power light, Power switch, Cabinet Cover Interlock switch, EMO, and the Overheat Interlock thermostat. Any of these switches will prevent the contactor from closing.

   o Is the RED Overheat light on? Check the Overheat troubleshooting section.

➢ If the GREEN power light is **off**, but you **do** hear the "clunk" noise, then the GREEN power light has a problem. Contact AllWin21 for a replacement LED circuit.

➢ If the GREEN power light is **<u>on</u>**, but you **<u>do not</u>** hear the "clunk" noise, then contact AllWin21 for assistance.

11.11 <u>120 VAC TROUBLESHOOTING</u>

120 VAC circuit controls the cabinet exhaust fan and the water solenoid valve. The transformer converts the 208/240 VAC to 120 VAC.

➢ Is the AC Power for the oven unit on? Turn on the AC Power for the oven unit.

➢ Are fuses F1 & F2 on the back of the oven unit good?

➢ Is there 208/240 VAC reaching the contactor?

➢ Is fuse F4 good? This is located on the floor of the oven unit chassis, in front of the AW-900-002 control board.

➢ Make sure P3 on the AW-900-018 control board is plugged in and Exit the Diagnostics screen (if in it) and then go back into it.

➢ Is the cabinet exhaust fan on? This indicates there is 120 VAC and the water solenoid is open to allow water to flow.

➢ Is water flowing? Measure voltage at connector P20 for the water solenoid. Is there 120 VAC at connector P20?

   o If there is no water flow, but there is 120 VAC at P20, then the water solenoid valve is bad. Replace the valve.

   o If there is no water flow and there is no 120 VAC at P20, then the "Over Cooling Switch" on P10-1 & P10-3 is open. This means the chamber is too cold due to the cooling water temperature < 45 °F (7 °C).

   o The water may be turned off by the software if the oven unit has been idle for about 5 minutes. If it is desirable to have the water on continuously, then go to the *System Setup* screen and click on the "Air & Water During Idle" button until it says **YES**. This will always keep the water flowing.

11.12 <u>OVERHEAT</u>

Whenever the oven overheats, the Overheat Light (Red) will be on. This indicates the oven walls have overheated or there is a wafer over temperature condition. Let the chamber cool down. The cooling water and air must be on while chamber is cooling down. Go to the *System Setup* screen and make "**Air & Water During Idle**" ON.

If the chamber overheated, then:

➢ The cooling water flow is insufficient. Make sure there is sufficient flow rate. Either the chiller has insufficient flow or there is a blockage in the cooling water system. Consult with the Installation manual for proper cooling water flow rate. It also has a section on how to check the cooling water flow rate.

➢ The chiller is not maintaining a water temperature below 35°C. Either the temperature setpoint for the chiller is too high or the chiller is insufficient to maintain the cooling water temperature. The cooling water should be maintained between 15°C and 21°C. The cooling water temperature should be at least 3°C above the dew point.

➢ The process time is too long for the high process temperature. The heat cannot be dissipated fast enough. Sometimes if the temperature is increased, the process time can be dramatically reduced. This may give the same process results, yet produce a smaller amount of total heat energy. Thus, the chamber walls will not get as hot.

➢ Check the wires on the thermostats on the bottom of the oven to make sure they are secure.

➢ Cycle power on the AccuThermo RTP system tool to reset the Wafer Overtemp Interlock.

11.13 GAS CONTROL

11.13.1 MFC GAS FLOW DIAGNOSTICS

If the AccuThermo RTP system does not have MFC's installed and is running with a Purge Flow Valve (rotometer) then these checks will not be valid.

There are three methods to determine the health of the gas flow control. All three methods check the communication between the MFC's and the controller.

If the gas flow can be controlled, then the communication between the controller and oven is functioning correctly. Otherwise there is a problem between the MFC and the controller and maintenance is required.

1)   Gas flow diagnostics in the ***Diagnostics*** screen is used to turn on and set the gas flow. This is the simplest method to determine if a gas flow can be controlled properly.

Input a specific MFC flow rate and monitor the feedback to determine MFC functionality and flow rate accuracy.

To start checking the gas flow:

Step 1.   Click on the gas shutoff valve icon [icon] so it is green.

Step 2.   Enter in a value in the SETPOINT field that is greater than zero (0), but less than the max flow rate specified for that MFC (i.e. 5 SLPM).

Step 3.   Observe the feedback gas flow rate in the FEEDBACK field.

Step 4.   To turn off the gas flow, click on the gas shutoff valve icon [icon] so it is red.

2) Writing and running a recipe for the gas to be tested allows observation of the response graphically of the MFC to setpoint commands.

Write the recipe so only the gas is controlled. Create several steps with different setpoints. Allow at least 5 seconds for the MFC to stabilize before going onto another step and changing the setpoint.

> ☞ **NOTE**
>
> **Remember: The   height   of   the   graph represents 100% of the maximum flow rate of the MFC.**

3) Using the *Board Test* screen to test the gas control is the most direct method. It allows setting a specific voltage for the setpoint and measuring the voltage at the MFC. Conversely, the output (feedback) voltage from the MFC can be measured and compared to the input analogue channel value displayed for that gas.

The *Gas Setup* screen defines the input and output analogue channels for the gases.

11.13.2 GAS DID NOT SHUT OFF AFTER PROCESS ENDED.

➤ In the recipe, make the button "**Turn Off Gas After Process**" say "YES".

11.13.3 GAS FLOW RATE AND PRESSURE DECREASES

➤ Are all the gas valves turned on?

➤ Long gas lines need to be greater than ¼" if the flow rate is at a high volume.

11.13.4 GAS FEEDBACK DOES NOT MATCH GAS SETPOINT.

➤ Gas calibration needs to be performed.

11.13.5 GAS LEAK CHECK FAILURE

If the system is not leak tight, perform the following checks:

➢ Inspect all O-rings. Check for proper placement. Check for nicks and cuts. Check for twists.

➢ Tighten the gas inlet and purge outlet connectors.

  o The 'L' shape gas input connector behind the chamber. Be careful when tightening this connector. It is connected directly to the gas nipple on the quartz isolation tube .

  o The VCR fitting above the gas input connector. Be careful when tightening this fitting. It is connected directly to the gas nipple on the quartz isolation tube.

  o All VCR fittings from the MFC to the back of the process chamber and the VCR gaskets are good.

➢ Ensure that the door is closed and locked. Make sure it seals properly and securely.

➢ Check the quartz isolation tube flange for polished smoothness. There should be no cracks or rough surfaces.

➢ Check to ensure that the screws are tight on the flange. Tighten all screws evenly in a star pattern a little at a time.

➢ If the process is sensitive to water vapor, purge out the gas lines for several hours.

Once you have verified all fittings and connections are tight, run another TiSi process to make sure the fittings do not leak. Make sure you have sufficiently purged the chamber.

☞ NOTE

A Titanium Silicide wafer, when processed at 700-1000°C for 30-40 secs, will turn blue (discolor) in the presence of O2 in the chamber.

11.14 <u>LED DISPLAY</u>

The LED Display indicates the temperature of the wafer inside the chamber. It only indicates the temperature if the "Power" switch is turned on.

The LED display may indicate the temperature from the TC or the pyrometer. There are 2 methods to switch between the TC and pyrometer:

Step 1.   Go to the Diagnostics screen and select either the thermocouple or the pyrometer.

Step 2.   Run a process that requires the temperature feedback device you want.

11.14.1 LED DISPLAY GOES "CRAZY"

➤ If the LED Display goes "crazy", check the cables from the computer to the AW-900-058 control board in the oven unit. There may be a bad connection.

11.14.2 TEMPERATURE ON THE LED DISPLAY AND COMPUTER MONITOR DIFFER

Temperatures on the LED display and computer monitor differ. The temperature that is displayed on the LED display is far off from the temperature that is shown on the computer monitor.

➤ Go to the "LED Display Calibration" screen and calibrate the LED display circuit, as described in the section *LED Temperature Display Calibration*.

11.15 <u>COMPUTER PROBLEMS</u>

11.15.1   COMPUTER COMMUNICATION AND OVEN CONTROL TEST PROCEDURE

This test verifies that your AccuThermo RTP system lamps are turning on properly and that there is communication between the controller computer and the AccuThermo RTP oven unit.

Step 1.   Make certain that the computer is on and the AccuThermo control software is running.

Step 2.   Load a TC wafer into the oven and connect it to the TC connectors on the inside of the doors, observing proper polarity (magnetic leads connected to left terminal).

Step 3.   Turn on the water cooling and tube air or nitrogen cooling.

Step 4.   Select **Diagnostics** from the *Main Menu*. Set 3 to 5 slpm of nitrogen flow to ensure chamber purging. Observe that there is gas flow being displayed on the *Diagnostics* screen.
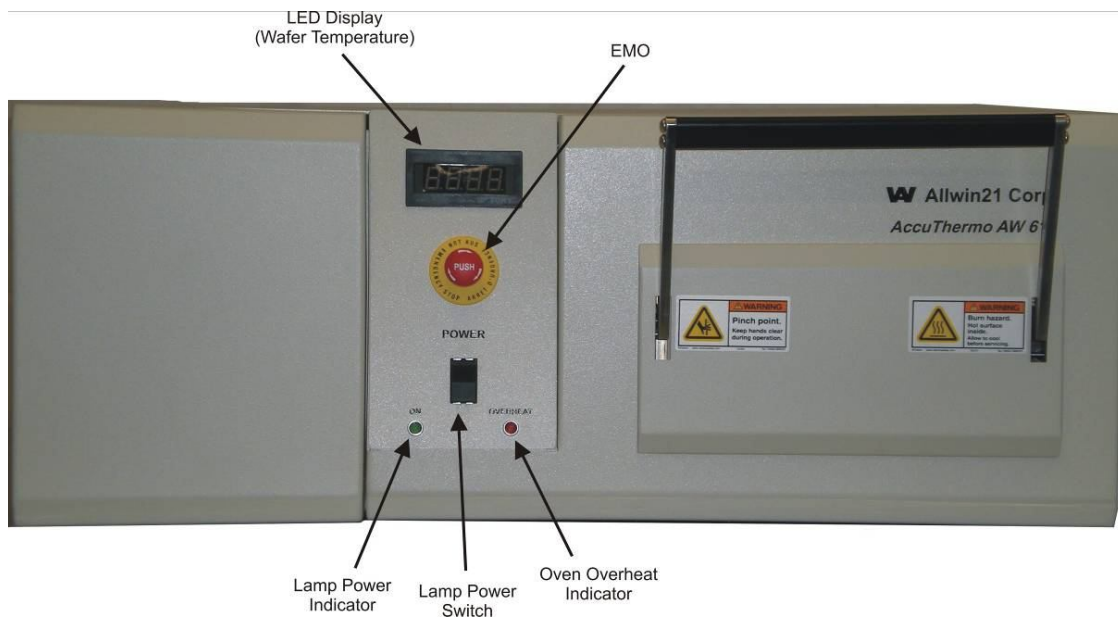
Figure 11-8: *Front Panel Controls*

11.15.2   COMPUTER WILL NOT POWER UP

➢ Check to ensure that the power cables are connected and plugged into the power source.

➢ Make sure that the monitor and the PC are turned on.

➢ Make sure that the power source is turned on.

11.15.3   NO COMMUNICATION BETWEEN THE OVEN UNIT AND THE COMPUTER

➢ Make sure the communication cables between the computer and the AccuThermo RTP oven unit are plugged in correctly and securely. For information on connecting the computer and the AccuThermo RTP Oven Unit together, refer to the Installation Chapter in the section *Installing the Computer*.

➢ Make sure the cables are plugged into the correct connectors.

➢ Make sure the oven unit is turned ON.

For the AW-900-002 control board:

➢ Are LED's CR11, CR13, CR14 and CR15 on the AW-900-002 control board ON? Check all cables between P14 on the AW-900-002 control board and the DB-25 connector on the AW-900-008 computer interface board (not the printer port). Make sure they are connected properly and are secured.

➢ Is LED CR12 on? CR12 indicates AC power has been detected. If it is off, then check the "120 VAC" troubleshooting section.

➢ Go to the *Diagnostics* screen. Is the "AC Power" line RED? The computer does not detect AC power. Check the section "Using the Diagnostics Screen".

➢ Go to the *Board Configure* screen. AW-900-008 needs to be selected. AW-900-002 needs to be selected.

➢ Contact Allwin21 for assistance.

For the AW-900-058 and AW-900-018 (or AW-900-038) control boards:

➢ Are LED's D1 – D6 on the AW-900-058 control board ON? Check all cables between J5 on the AW-900-058 control board and the parallel port on the computer. Make sure they are connected properly and are secured.

➢ Is LED D5 on the AW-900-018 oven control board (behind AW-900-058) ON? D5 indicates AC power has been detected. If it is off, then check the "120 VAC" troubleshooting section.

➢ Are LED's D2 – D4 on the AW-900-018 oven control board ON? These indicate if the DC power supply module is operating properly.

➢ Go to the Diagnostics screen. Is the "AC Power" line RED? If RED, then the computer does not detect AC power. Check the section "Using the Diagnostics Screen".

➢ Go to the Board Configure screen. "PRINT PORT" needs to be selected.

➢ Contact Allwin21 for assistance.

11.16 <u>COOLING WATER</u>

The cooling water flow rate needs to be greater than 2 gpm during and immediately after wafer heating, measured on the return water line that goes back to the chiller. There should be approximately 30 psig differential pressure between the supply and return. The maximum supply pressure should not exceed 80 psig. The temperature of the cooling water should be about 20°C or about 3°C above dew point, whichever is greater. The temperature should not exceed 35°C.

☞ NOTE

Refer to the specifications and diagrams in the Installation Manual for proper flow rate, pressures, connections, and instruments and components to help determine problems, causes and solutions.

11.16.1 WATER FLOW RATE IS TOO SLOW

➢ Increase the water flow rate.

➢ Check the differential pressure.

11.16.2 WATER DIFFERENTIAL PRESSURE IS TOO GREAT

➢ This is a sign that the cooling water passages in the chamber are becoming clogged. Contact Allwin21 for service.

11.16.3 WATER TEMPERATURE IS TOO HOT

➢ Set the setpoint to 20°C or 3°C above dew point, whichever is greater.

➢ The outlet temperature may get very warm when high temperature processes with long process times are executed. The inlet temperature should not exceed 35°C. The outlet temperature should not get hot. If high temperature processes are executed, let the system cool down sufficiently before running another high temperature process.

11.16.4 WATER TEMPERATURE IS TOO COLD

➢ This will cause condensation on the walls of the chamber. This condensation can cause corrosion and drip onto some electrical components and create a short. This can cause premature failure of the system. Increase the cooling water temperature to what is specified in the *Installation* section of this manual.

11.16.5 THERE IS NO WATER FLOW.

➢ Check the chiller/heat exchanger for the AccuThermo RTP system. Make sure it is on.

➢ Make sure all valves, supply and return, are open.

➢ This may be caused by the water solenoid valve not opening.

   o If the over cooling switch (S7) is open, this means the oven walls are less than 45°F. This will prevent water flow and keep the oven walls from having condensation. Check the cooling water temperature. Refer to the Water *Temperature is Too Cold* troubleshooting section.

   o If the cabinet exhaust fan is on, then there should be 120 VAC at P20 to open the water solenoid. Check for 120 VAC at P20. Refer to the 120 VAC troubleshooting section.

11.16.6 SOFTWARE INDICATES NO WATER FLOW

Several things have to happen before the software registers a change in water flow.

➢ The water solenoid valve is turned on to let cooling water flow when there is 120 VAC and the over-cooling switch (S7) is closed when the chamber temperature exceeds 65°F.

➢ The software senses the water flow when the chamber temperature exceeds 74°F. This is because the water flow interlock switch and the overcooling switch (S9) are in parallel.

Water Flow Sensor Test

Step 1.   Turn off the chiller for the oven and the cooling CDA.

Step 2.   Set the lamp intensity to 9%.

Step 3.   Wait for about 6 minutes. This should give enough time for the under-cooling thermostat to open. Does the icon water line turn RED when the thermostat opens?

Step 4.   Turn on the chiller. Does the icon water line turn GREEN when the chiller is turned on?

Step 5.   Turn on cooling CDA.

Step 6.   Turn off the lamp intensity.

11.17 <u>COOLING CDA (NITROGEN</u>

➢ Check if the cooling CDA pressure and flow rate are correct. (Refer to the *Installation* Chapter for proper CDA specifications.)

➢ Check if one of the CDA cooling tubes is not connected inside the oven unit.

11.18 <u>PYROMETER CHILLER</u>

11.18.1 CHILLER WILL NOT START

➢ Check the AC power source. Make sure the circuit breakers are On and that the voltage is correct.

➢ Inspect the water level inside the chiller.

11.18.2 LOSS OF COOLING CAPACITY

➢ Check the front and rear ventilation panels to make sure that they are not obstructed.

➢ If the unit was just turned OFF after a refrigeration cycle, leave the power off for five minutes. Then turn the unit back ON and check for proper operation.

11.18.3 NO EXTERNAL CIRCULATION

➢ Make sure that the inlet and outlet pump plates have been removed.

➢ Check for blockage, kinks or leaks in the circulating lines.

11.19 <u>PYROMETER</u>

<div style="border:2px solid black; text-align:center">

☞ NOTE

Refer to the *Temperature Monitoring* section in this manual for further information that may help diagnose problems with the pyrometer.

</div>

11.19.1 PYROMETER DIAGNOSTICS

The pyrometer is used as a non-contact temperature measuring device. It measures temperature by measuring the wavelength of the thermal radiation of the substrate. It is used for temperatures between 600 °C and 1200 °C.

There are a few methods to use to diagnose problems with the pyrometer. Each one tests for different problems. These tests assume the quartzware is clean and free from defects. They also presume the pyrometer has been calibrated properly. (Refer to the *Pyrometer Calibration* section of this manual.)

These tests also check the communication between the computer and the oven.

➢ This test method uses the *Manual Control* screen. It can determine if the pyrometer is connected properly.

   o Go to the *Manual Control* screen. With a wafer in the chamber, increase the lamp intensity above 500 °C. At 30% intensity, there should be a response from the pyrometer within 5 seconds. If the temperature does not get above 500 °C within 10 seconds, abort *Manual Control* by pressing the **ESC** key.

   o If there is no response, make sure the pyrometer is connected properly at P13 on the control board and connectors C48 and C42 in the lower back of the chamber.

➢ This test method uses the *Pyrometer Calibration*.

Step 1.   Setup a new calibration that is exactly the same as the system calibration (SYS_PYRO.WFR). Load the system calibration file into the setup editor and

rename the filename. (I like using the current date with a letter at the end.) Click on the Save button.

Step 2.   Click on the Calibrate button.

Step 3.   When the pyrometer calibration has finished, compare the new calibration graph with the SYS_PYRO.WFR graph. Compare the TC temperature (blue) curves. Compare the PyroWafer mV (yellow) curves.

Step 4.   If these curves are not as strong as the system calibration, then the quartzware may be dirty. Clean the quartzware.

Step 5.   If there still is a difference after the quartzware has been cleaned, then save the one that was just performed as the system calibration.

NOTE: A little difference is not a reason for alarm.

11.19.2 PYROMETER DOES NOT SHOW A TEMPERATURE RISE

> ☜ **NOTE**
>
> **The pyrometer will not indicate a reliable temperature below 400 °C.**

➢ Check the AC power line to the oven unit.

➢ Make sure all connections to the control boards are seated correctly.

➢ Install a thermocouple and verify whether temperature rises under thermocouple control.

➢ Refer to Pyrometer Diagnostics section above.

11.19.3 PYROMETER TEMPERATURE IS EXTREMELY HIGH (>1300°C)

➢ The pyrometer temperature is extremely high (> 1300 °C) when the temperature should be at its minimum. A pyrometer calibration needs to be performed.

11.19.4 POST-PROCESS TEMPERATURE MEASUREMENT IS TOO HIGH

If the Post-Process Temperature Measurement is higher than the Pyrometer reading, then the quartzware is dirty.

A dirty chamber window would restrict light entering the chamber. It would also heat up the window. The intensity would be higher with a dirty window to get the wafer to the same temperature. Since the pyrometer is sensitive to the IR spectrum of light, a dirty pyrometer window would read a cooler temperature for the wafer than the actual temperature. This would compound the pyrometer reading of the wafer, making the temperature lower than it actually is.

The quartzware needs to be cleaned periodically. The preventative maintenance schedule requires the quartzware to be cleaned at least once a month or more.

If the wafers are processed using the same recipe, then consider using the **PSum** alarm parameter in the recipe. This will alert you to a dirty window. Refer to section *Process Control Alarms* for a discussion on how to use PSum. Run several wafers with clean quartzware to determine the proper PSum values.

Also, refer to Lamps, Overheat and the Pyrometer sections for troubleshooting.

11.20 THERMOCOUPLE

11.20.1 OVERVIEW

> ✍ **NOTE**
>
> **Refer to the *Temperature Monitoring* section for further information on diagnosing problems with the thermocouple.**

The thermocouple (TC) is used as a temperature measuring device up to 800 °C.

11.20.2 TC TEMPERATURE IS NOT RESPONDING CORRECTLY

To test the condition of the thermocouple, increase the lamp intensity to 10%. (Refer to the *Lamp Diagnostics* section.) The temperature should increase.

If the TC temperature is:

decreasing	The TC leads are reversed on the door terminal posts. The lead that is attracted to a magnet should be attached to the wider terminal.
not changing	The lamps are not on. Refer to the section *Lamps Do Not Come On*
at a very high temperature	The TC leads are not connected or are broken.

11.20.3 POST-PROCESS TEMPERATURE MEASUREMENT IS TOO COLD

The resistivity test shows the wafer was cooler than the process run indicated.

The thermocouple bead was not touching the wafer. The leads of the thermocouple act as springs, pushing the thermocouple bead against the backside of the wafer.

However, if the leads are heated to a high temperature, then they will droop and fall away from the wafer.

➢ Make sure the TC bead touches the wafer.

➢ Use shorter TC leads that cantilever out from the T-shaped quartz holder. Long leads that cantilever out will droop away from the wafer.

➢ Use the pyrometer.

> ➢ A TC lead is touching the wafer.

11.20.4 TC TEMPERATURE READING IS TOO LOW OR JITTERY

Poor and jittery signals from the thermocouple are caused by poor contacts and shorts.

> ➢ Make sure the TC wires are connected properly (refer to *Thermocouple Circuit Testing*) and do not touch anything, except the quartz. The wires cannot touch the wafer. Only the bead end should touch the wafer. The wires cannot touch anything that is conductive or semi-conductive.

> ➢ Poor TC wire connection can give a jittery signal, because of the poor contact at the junction. Make sure the TC wire is secured tightly on the terminal. Do not twist wires together. This method does not create a good contact. The contacts from the bead to the analog circuit must be solid and secure at all times.

> ➢ Poor TC contact with the wafer. Make sure the bead of the TC has a good contact with the wafer. Momentary contact will look like the TC signal is jittery.

> ➢ If the TC wires come out between the chamber front flange and the door, make sure they do not cross. Closing the door can pitch the wires and create jittery readings.

> ➢ A bad pyrometer could make the TC reading jittery. Do the following test:

Step 1.   Connect a TC calibration meter to TC1 (yellow connector) on the AW-900-058 control board.

Step 2.   Set the meter to output 500 °C.

Step 3.   Go to the Manual Control screen from the Maintenance menu. Observe the thermocouple feedback curve. Is the TC temperature curve straight and smooth, or rough and jittery?

straight and smooth	The TC analog circuit and analog-to-digital circuit is good. Also, the software is responding correctly. There is something wrong between TC1 and the tip of the TC.	
rough and jittery	Power down the AccuThermo RTP system and turn off the circuit breaker. Disconnect the pyrometer from the AW-900-058 control board, P13 (black connector on lower edge of board). Power up the machine. Go to the "*Manual Control* screen. Is the TC temperature curve straight and smooth?	
	YES	The pyrometer is BAD. It is interfering with the TC analog circuit. Replace the pyrometer. Contact Allwin21 for assistance.
	NO	The AW-900-058 control board is BAD. Replace the AW-900-058. Contact Allwin21 for assistance.

11.20.5 THERMOCOUPLE CIRCUIT TESTING

This procedure tests the TC circuit from the terminals at the door to the TC analog circuit on the AW-900-058 control board. When doing these steps, use the *Diagnostics* or *Manual Control* screen to check the reading of the TC circuit.

A thermocouple extension wire is used inside the AccuThermo RTP system between the door terminals and the control board. This wire has a yellow jacket and the NiCr wire is color coded yellow and the NiAl wire is color coded red. Refer to section *The Thermocouple* in the chapter *Temperature Monitoring*.

The terminals on the door and on the connectors are marked either CH (NiCr) or AL (NiAl) according to their metal alloy composition. Also, the AL terminal is wider than the CH terminal.

➢ Check for matching metal alloy leads and terminals. Verify that the same metal alloy is connected together from the door terminals to the TC1 connector on the AW-900-058 control board.

➢ Check for continuity from the terminals on the chamber door to TC1 on the AW-900-058 control board. Make sure the TC is disconnected and the plug is disconnected from TC1.

➢ Test the thermocouple circuit. Use a calibration meter (such as Omega CL23). Connect the calibration meter to TC1 of AW-900-058 with a known good extension cable. Set the meter to different setpoints and observe the computer monitor temperature reading. Recalibrate the TC circuit if necessary according to the "Thermocouple Calibration" section of this manual.

➢ When installing a TC, make sure the TC leads are not touching and make sure the proper metal alloys are connected to the proper terminals, as described above.

11.21 "NO AW-RTP-900-008 CARD OR CARD CONNECTION NOT GOOD!"

➢ If this error message appears on the computer monitor screen, then see alarm 726.

11.22 <u>WHAT IF THE COMPUTER LOCKS UP?</u>

There is a watchdog timer on the AW-900-058. This watchdog timer prevents the lamps from overheating the chamber due to the software locking up. If this watchdog timer is not reset by the AW-900 control software within 2 seconds, it will shut down the lamps.

11.23 <u>WHAT HAPPENS IF THE OVEN OVER HEATS?</u>

There are 4 switches that must be closed before the contactor for the lamps will close.

1) The EMO must be reset.

2) The Power switch on the front panel must be on.

3) The Cabinet Cover Interlock switch must be closed. This is done by either having the cabinet cover on the oven unit or have it pulled up into the maintenance position.

4) The Overheat Thermostat is closed. This means the chamber wall is less than 150°F.

If the heating chamber overheats, then the Overheat Thermostat will open. This does 2 things:

1) The 24 VAC circuit for the lamp contactor is broken and the contactor opens. This turns off power to the lamps and the lamps shut off.

2) The Overheat Detection circuit detects the open circuit and warns the operator on the computer monitor and the overheat light turns on.

☠ WARNING

Do not test Chamber Overheating by raising the temperature of the oven. There are other safety systems to prevent this from happening. Doing so can reduce the life of the machine.

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12. SCHEMATICS

Drawing No.	Description
A1-0002-01	AccuThermo RTP System Wiring Diagram
AW-900-058	System Control Board
AW-900-038	Oven Control Board
AW-900-054	Gas Control Board

CHASSIS WIRING
ACCUTHERMO AW-610

AW-610 Chassis Wiring

SCALE none   SHEET 1 of 1

244

Contactor
600V 60A

240V/100A

DC Power supply

Gas Control PCB
A900-054

OCB/ZCB control PCB
AW900-038

Control/interface PCB
AW900-058

Oven Module

To Pyrometer assy
7000-0010-01
8330-5030

All wires are 18 AWG except otherwise specified

Title	ALLWIN21 CORP RTP610 SYSTEM 3 phase SYSTEM WIRING DIAGRAM		
Size A1	Number A1-0002-01 rev A		Rev A
Date 01/29/2009		Drown by J. H.	
Filename		Sheet 1 of 1	
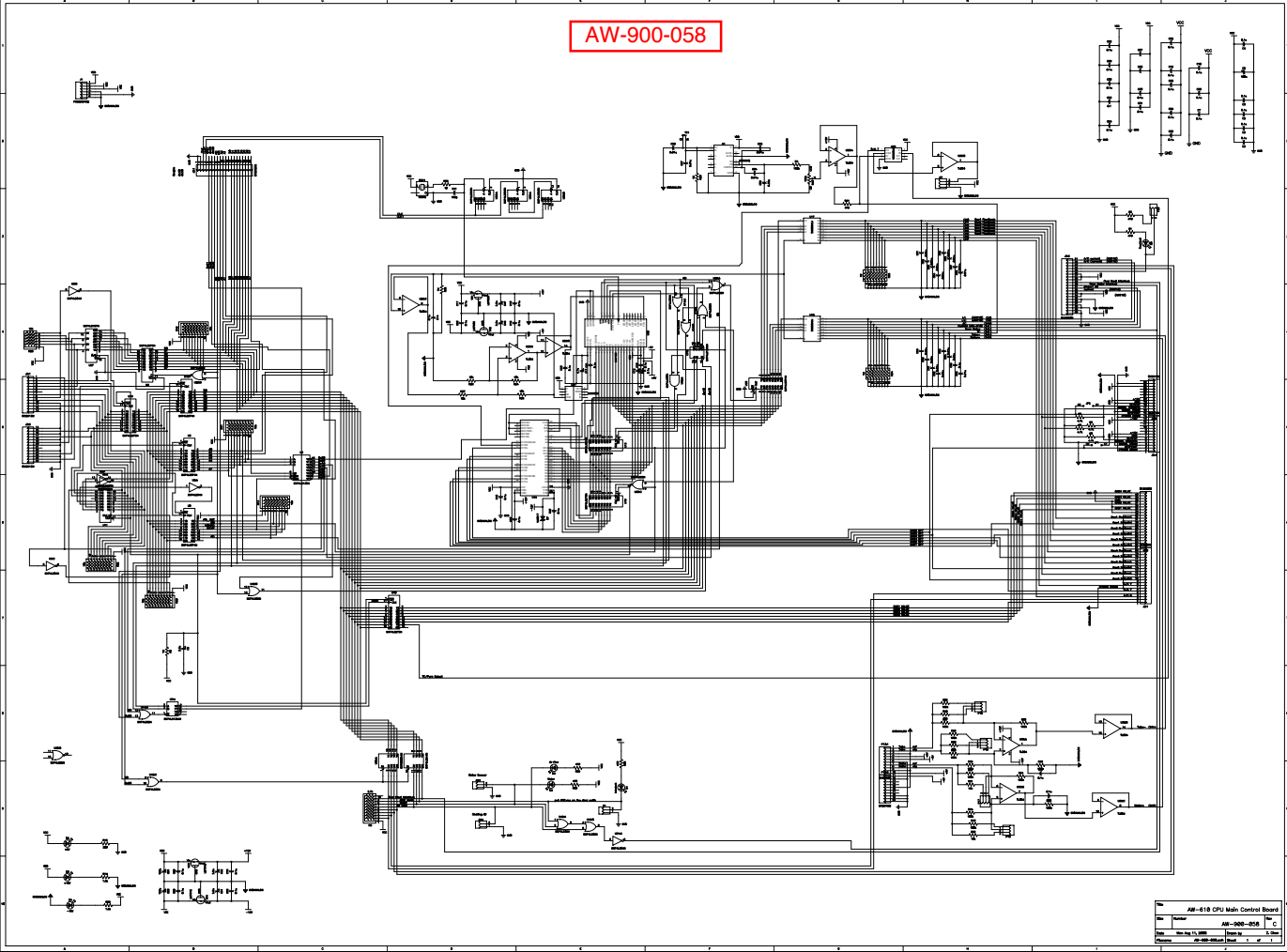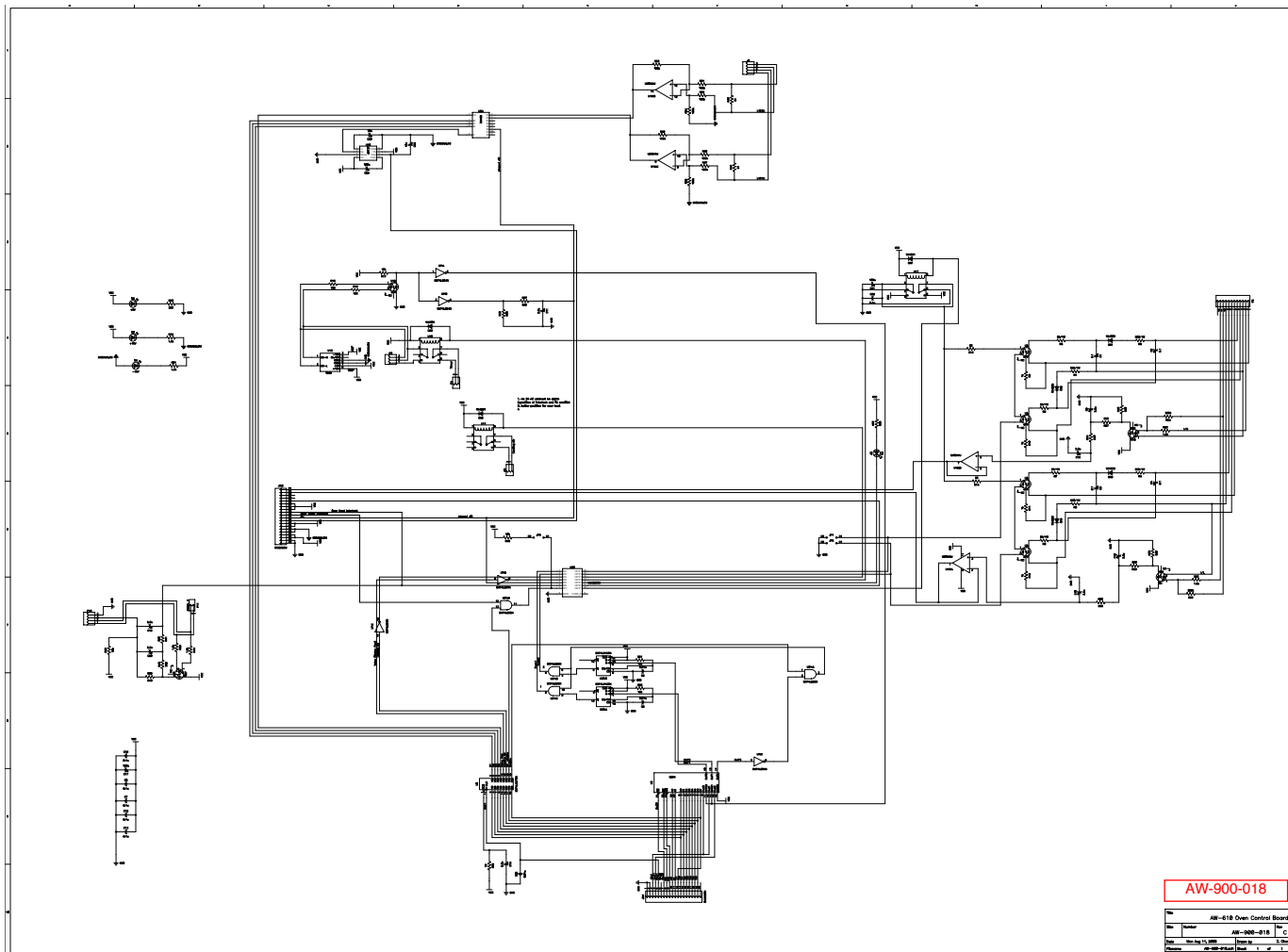
245

AW-900-058

AW-610 CPU Main Control Board		
Size	Number	Rev
	AW-900-058	C
Date	Mon Aug 11, 2008	
Filename	AW-900-058.sch	Sheet 1 of 1

AW-900-018

247

AW-618 Oven Control Board

AW-900-018

AW-900-054

249
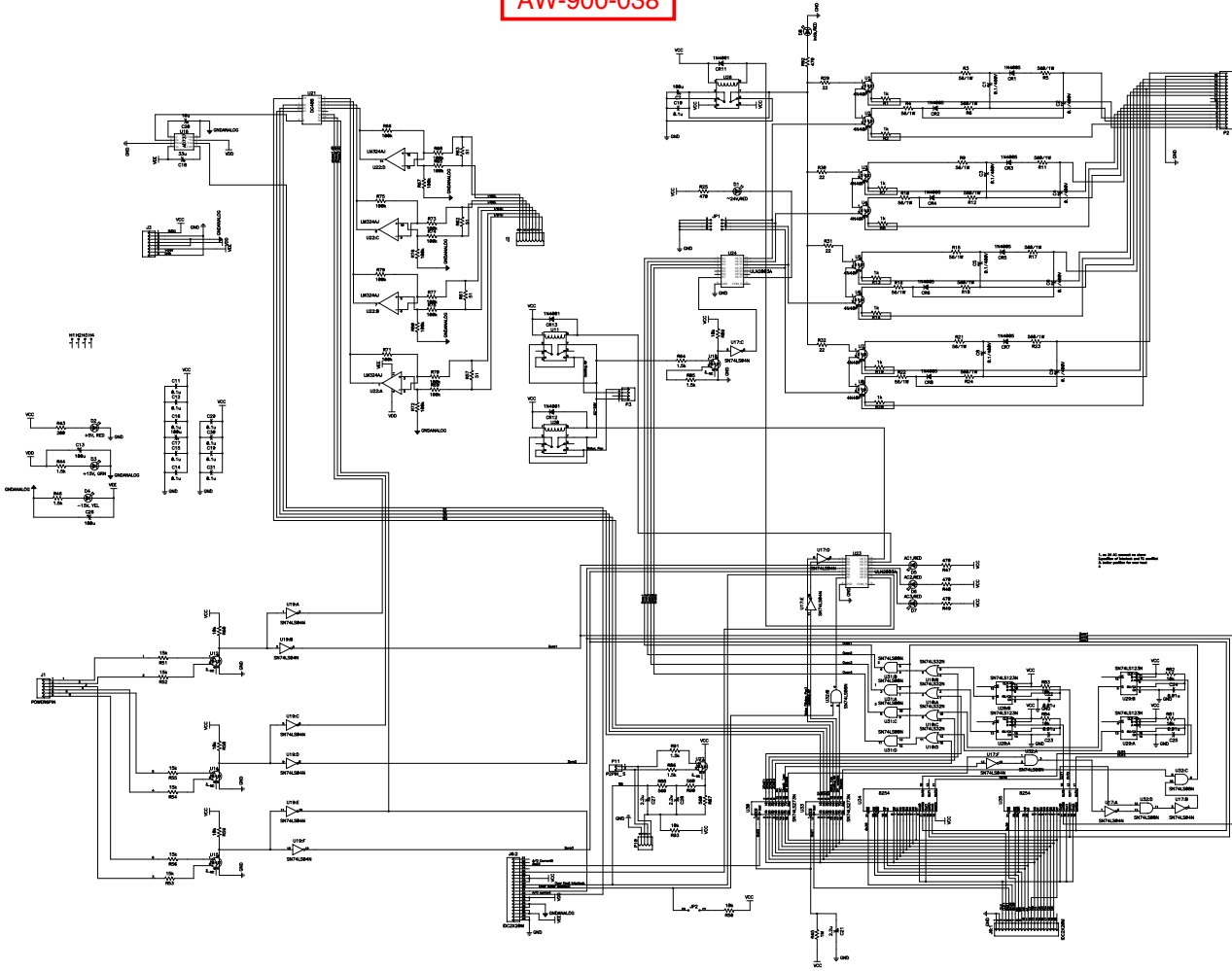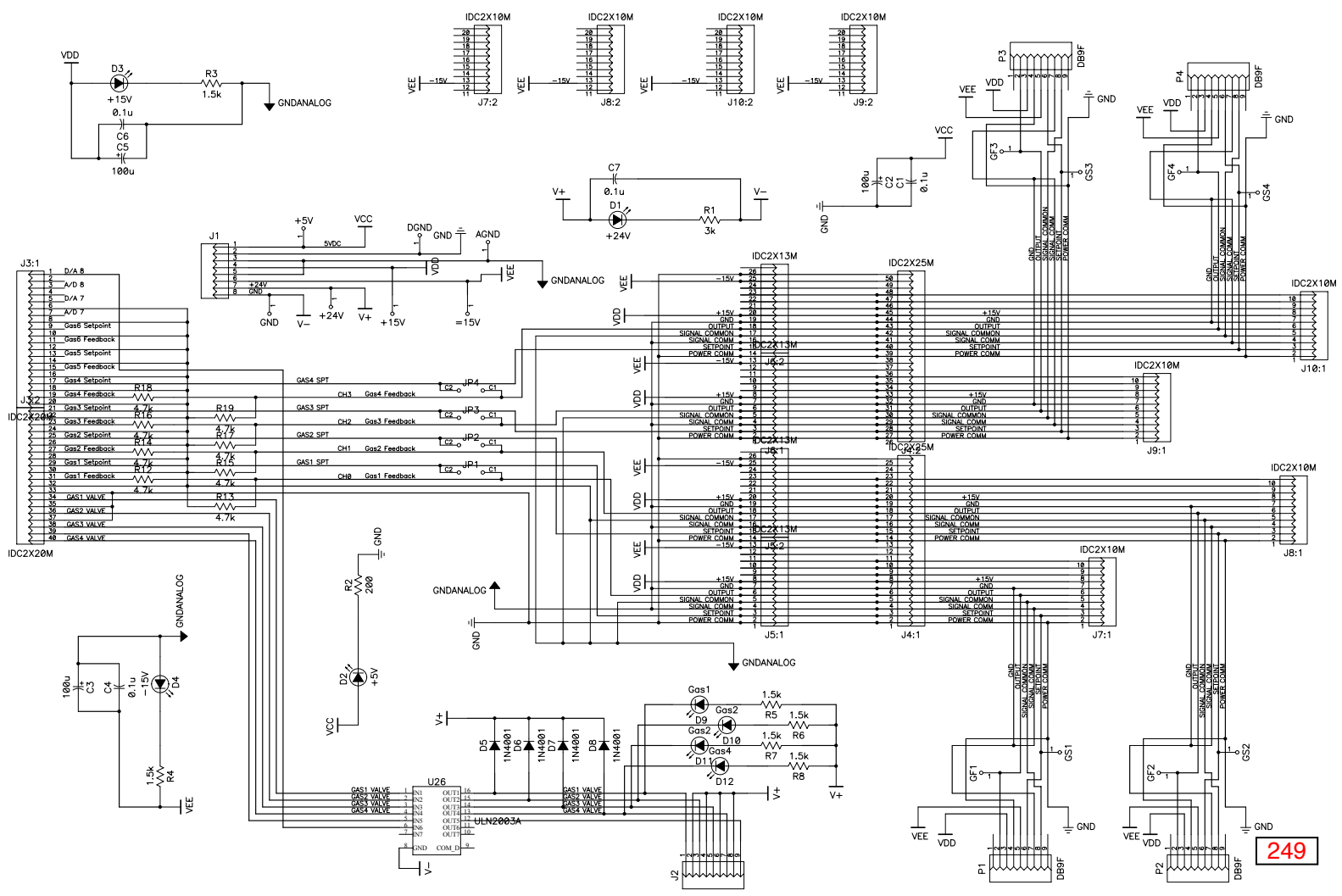
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13. PARTS GUIDE

13.1 <u>OVERVIEW</u>

The AccuThermo AW410 and AccuThermo AW610 Rapid Thermal Processing (RTP) Systems have been designed to be customer-installed and maintained. This illustrated parts guide has been prepared to assist Allwin21 Field Service Department customer service engineers and properly trained customer RTP systems engineers in the maintenance and repair of an AccuThermo Rapid Thermal Processing Systems (AccuThermo RTP system).

The AccuThermo RTP system has evolved significantly since its initial introduction. This parts guide includes only those parts and accessories that relate to the configuration of the AccuThermo RTP system tool as it is presently manufactured by Allwin21.

Each sections, with minor exceptions, is based on and referenced to an exploded view of the parts that precedes the parts listing contained in the section.

13.2   CHASSIS – FRONT VIEW
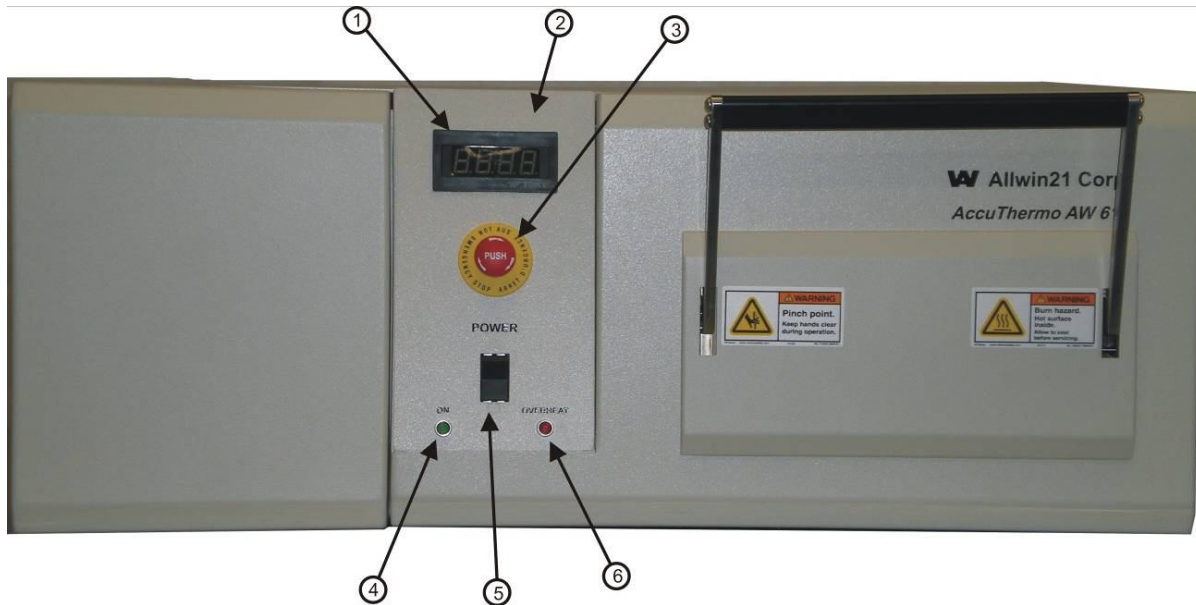
ITEM	PART NUMBER	DESCRIPTION
1	2901-0040	Accessory Kit Hardware
2	G300-0130-05	Panel, Front Control
3	A5-0013	Push Button, EMO
4	3703-0060	LED, Indicator, 5/16" Dia., Green
5	5103-0010	Switch, Rocker, DPDT, 5 A
6	3703-0010	LED, Indicator, 5/16" Dia., Red

13.3   CHASSIS – REAR VIEW
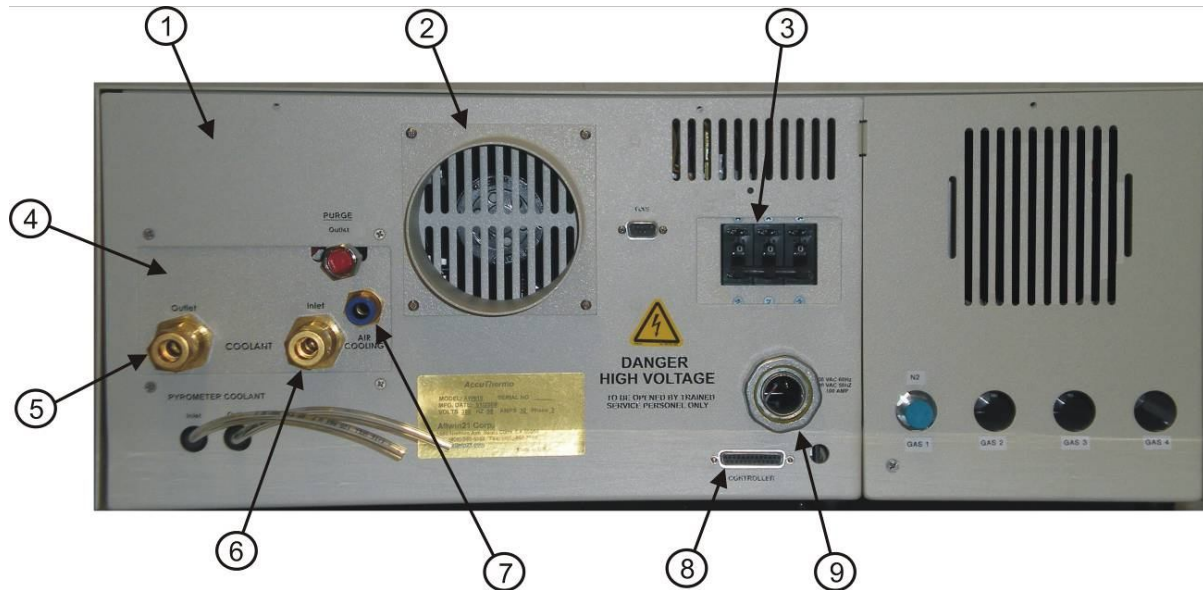
ITEM	PART NUMBER	DESCRIPTION
1	7300-A097	Chassis, Base
2	G300-0070-01	4" Exhaust Outlet, Chassis
3	A5-0172	Circuit Breaker, 3 pole, 30 A
4	7100-0328-02	Plumbing, Interface
5	9000-0470	Bushing, 3/4 – 3/8 NPT
6	(same as 5)	
7	2527-0927-05	Union, Bulkhead, 3/8" Tube, Brass
8	7100-0887-01	Cable, Communication
9	6012-0040	Fitting, Strain Relief

13.4 <u>OVEN ASSEMBLY</u>
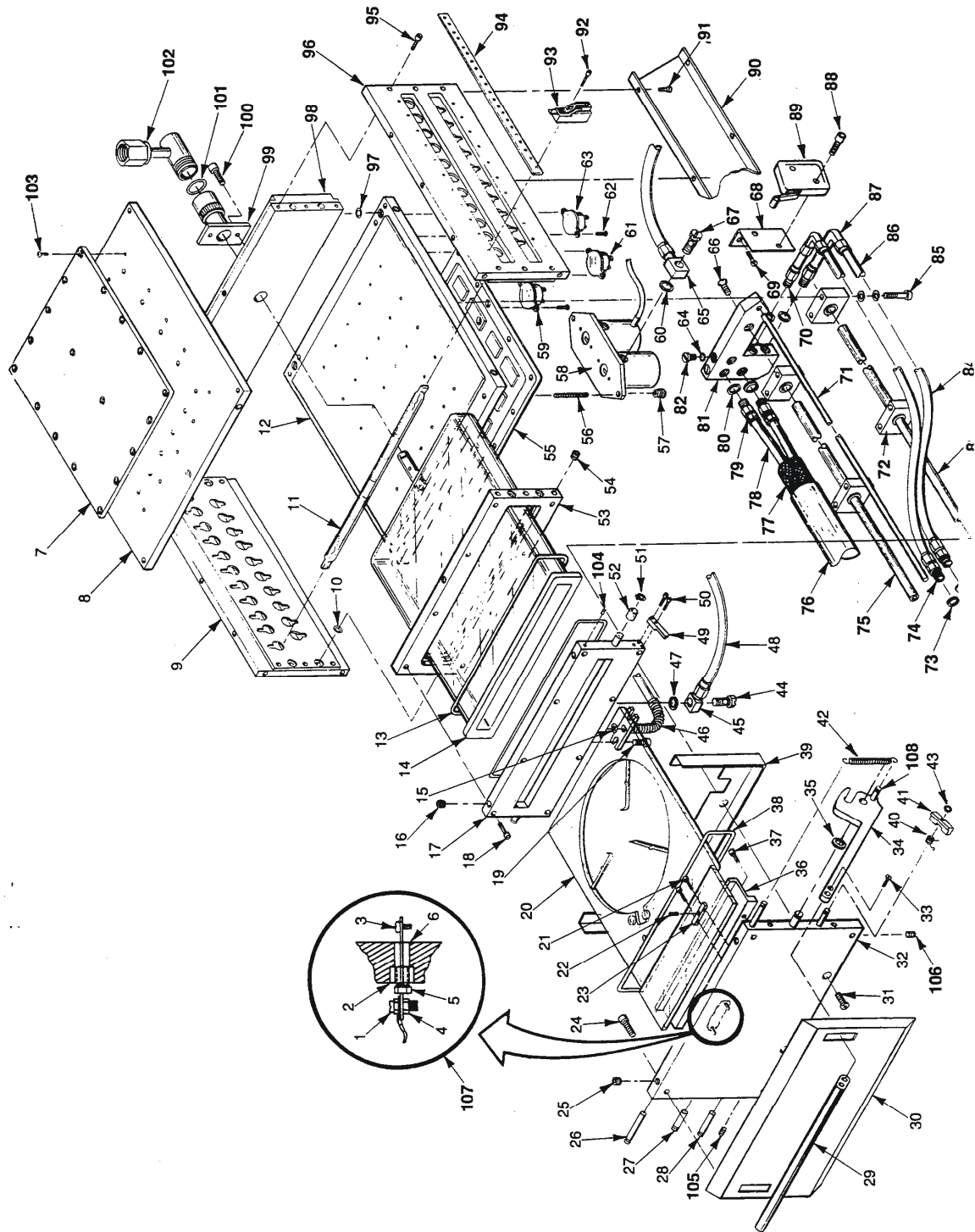
Oven Assembly

ITEM	PART NUMBER	DESCRIPTION
1	2801-0104-04	Screw, XREC, Pan head, 256x1/4
2	7450-0043-01	Plug, Ceramic
	1612-0091-01	Adhesive, Epoxy, High Temp.
	1603-0013-01	Sealant, High Temp.
3	2806-1301-03	Screw, Pan head, SST, 0-80 x 3/16
4	2821-2040	Hex Nut, 2-56 UNC
5	7100-0069	TC Fitting
6	1612-0091-01	Adhesive, Epoxy, High Temp.
	1603-0013-01	Sealant, High Temp.
7	7200-0078-02	Cover, Air Plenum, Top
8	7100-0497-04	Oven Top
9	7200-0289	Oven Side
10	2504-0140	O-Ring Tube
11	2451-0010-02	Lamp, 1200 Watts, 208V
	2451-0010-03	Lamp, 1000 Watts, 208V
	2451-0010-05	Lamp, 1500 Watts, 208V
12	7100-0496-03	Oven Bottom
13	2504-0160	O-Ring Tube
14	7400-0023-01	Single Baffle Isolation Tube
	7400-0068-01	Double Baffle Isolation Tube STD
	7400-0066-02	Single Baffle ERP Isolation Tube
	7400-0068-02	Double Baffle ERP Isolation Tube
15	2504-0071-01	O-Ring, Kalrez, .301 x .441 x .070
16	2806-1017-01	SSCR, SST, Cup Pt. 10-32
	2806-1021-04	SSCR, SST, Cup Pt. l/4-28 x .25
17	7200-0074-02	Flange, C/D 610
18	2806-0412-10	Screw, Hex head, 6-32 x 5/8"
19	2806-0414-06	Screw, SST, Socket head, 8-32 x .38
20	See Page 14	
21	2806-0404-05	Screw, SST, Socket head, 2-56 x .3l
22	2806-1008-04	SSCR, SST, Cup Pt. 4-40 x l/2"
23	7200-0643-01	Block Adjustment
24	2806-0408-08	Screw, Hex head, 4-40 x l/2"
25	2806-1021-04	SSCR, SST, CUP Pt. l/4-28 X .25

ITEM	PART NUMBER	DESCRIPTION
	1612-0110	Sealant, Hydraulic
	1612-0120	Primer, Sealant/Adhesive
26	2509-0110-07	Spring Post, SST, 0.125 x 1.0
27	2509-0080	Dowel Pin SST. .250 x .50L
28	2509-0100	Dowel Pin SST. .125 x .62L
29	7200-0049	Door Handle
30	7300-0013-02	Door Cover 610
31	2806-0114-08	Scr., SST, XREC, Pan head 8-32 x .50
32	7200-0644-01	Door, Manual System
33	2806-0414-08	Screw, SST, Socket head, 8-32 x .50
34	7200-0642-01	Door Lever
35	2502-0130	Bearing Spacer
36	7200-0702-01	Tray Support l/4"
37	2806-0404-05	Screw, SST, Socket head, 2-56 x .31
38	2504-0202-01	O-Ring
39	7300-0027	Subplate, Front Panel
40	2505-0131-01	Spring, Torsion, Rt. Winding
41	7200-0052	Lock Mechanism
42	2505-0120	Spring
43	2505-0003-05	Retaining Ring, 1/8"Dia.
44	2522-0450	Fitting, "C" Brass Adj.
45	(part of 44)	
46	7650-0033	Exhaust Line, VCR
47	2504-0020	Gasket, Nylon, l/8"
48	2519-0130	Tubing, N2, l/4" O.D. x .170 I.D.
49	7200-0050-02	Arm, Door Lock
50	2806-0408-08	Screw, SST, Socket head, 4-40 x .50
51	2505-0003-01	Retaining Ring
52	7200-0047	Sleeve Bearing
53	7200-0296-02	Oven Front, Gold Plated
54	2806-1021-04	Screw, Set, l/4-28 x 114"
55	7200-0276-02	Cover, Air Plenum, Bolt-on
56	2806-1014-02	Ser. SSCR, SST, FL Pt. 8-32 x 1.00
57	2823-6140	Thumb Nut, Brass, 8-32 UNC
58	7100-0874-11	ERP Pyrometer
59	5300-0091-01	Overheat Thermostat

ITEM	PART NUMBER	DESCRIPTION
60	2504-0020	Gasket, Nylon, 118"
61	5300-0060	Overcool Thermostat
62	2806-0108-03	Screw, Pan head, 4-40 x 3/16"
63	5300-0070	Overcool Thermostat
64	2504-0020	Gasket, Nylon, 10-32 x I/8"
65	2522-0450	Fitting, Brass, "L"
66	2806-0114-06	Screw, SST, XREC, Pan head, 8-32
	2802-0514-04	Screw, Blk, Skt, Button head, 8-32
67	2522-0450	Fitting, Brass, "L"
68	7300-0023	Bracket, Interlock Switch
69	2801-0112-06	Screw, Hex head; 6-32 x 3/8"
	2821-2120 *	Nut, 6-32
70	2522-0600	Fitting, Brass, 10-32 x .170- Hex Barb
71	7200-0060	Rod Tube Support
72	7200-0021	Housing Bearing (Front)
	7200-0022	Housing Bearing (Rear)
73	2504-0020	Gasket, Nylon, 1/8"
74	2522-0500	Fitting, Brass, Swivel Hose Barb
75	7200-0063	Shaft Slider
76	3105-0070	Tubing, Heat Shrink, I/2"
77	6011-0400-02	Expandable Sleeving, 1/2"
78	7100-0044-00	Tube, Oven Back Bracket, #1
	7100-0044-01	Tube, Oven Back Bracket, #2
79	2522-0500	Fitting, Brass, Swivel
80	2504-0020	Gasket, Nylon, 1/8"
81	7200-0048	Bracket, Door Tubing
82	2522-0440	Plug, Screw, Brass 10-32
83	7200-0063	Shaft Slider
84	2519-0030	Tubing, Clear Vinyl, I/8 I.D., I/4
85	2806-0414-20	Screw, SST, Socket head, 8-32 x 1.25
86	(part of 84)	
87	2522-0850	Elbow, Un, I/4 Tube O.D. x .1701 I.D.
88	2806-0408-10	Screw, SST, Socket head, 4-40 x .62
	2821-1080	Nut, SST, Kep, 4-40 UNC
89	5107-0010	Switch, Mini V3, 10 A
90	7300-0015	Plate, Left, Oven Support

ITEM	**PART NUMBER**	**DESCRIPTION**
	7300-0016	Plate, Right, Oven Support
91	2806-0114-04	Ser. SST, XREC, Pan head, 8-32x.25
92	2806-0408-06	Screw, Hex head, 4-40 x 3/8"
93	2109-0050	Lamp Holder, Tungsten Halogen, 10A 600V
94	7300-0019	Shim Socket
95	2806-0417-02	Screw, Hex head, 10-32 x 3/4"
96	7200-0289	Oven Side
97	2504-0140	O-Ring
98	7200-0288	Oven Back, Gold Plated
99	7200-0099	Base-Purge Connector
100	2832-1102	Scr. SST, Shoulder, 4-40 x .125 x .188
101	2504-0070	O-Ring
102	7200-0098	Connector, Purge
103	2806-1025-04	SSCR, SST, Cup Pt. 3/8-24 x .25
104	2806-1021-03	SSCR, SST, Cup Pt. l/4-28 x .19
	1612-0110	Sealant, Hydraulic
	1612-0120	Primer, Sealant/Adhesive
105	2806-1021-04	SSCR, SST, Cup Pt. 1/4-28 x .25
	1612-0110	Sealant, Hydraulic
	1612-0120	Primer, Sealant/Adhesive
106	2806-1021-04	SSCR, SST, Cup Pt. 1/4-28 x .25
	1612-0110	Sealant, Hydraulic
	1612-0120	Primer, Sealant/Adhesive
107	7100-0069	TC Fitting Assembly
108	2509-0120-02	Spring Post SST .094 Dia. x .38L

13.5 QUARTZ TRAYS

PART NUMBER	DESCRIPTION
7400-0063-04	2" New Style M-Tray, 610
7400-0063-05	3" New Style M-Tray, 610
7400-0063-06	4" New Style M-Tray, 610
7400-0063-07	5" New Style M-Tray, 610
7400-0082-01	6" New Style M-Tray, 610
A4-0004	100mm to 156mm Square Tray, 610
A4-0017	3" to 6" Tray, 610
A4-0018	3" to 6" Tray, 2 TC Stations, 610
7400-0084-02	Tray, GaAs Susceptor, 610
7400-0097-05	4" Tray, Slip-Free Ring, 610
7400-0097-06	5" Tray, Slip-Free Ring, 610
7400-0097-07	6" Tray, Slip-Free Ring, 610
7400-0010	Tray, Research, 610

13.6 THERMOCOUPLES

PART NUMBER	DESCRIPTION
7100-0947-01	TC, T-Shaped, Manual Systems
or	or
9812-0030	T-Shaped TC
7100-0327-02	Cantilevered TC 4, 5, 6 Inch
7100-0327-04	Cantilevered TC; 2, 3 Inch

13.7 SUSCEPTORS

PART NUMBER	DESCRIPTION
7310-1854-03	Susceptor, 2" Wafer
7310-1854-04	Susceptor, 3" Wafer
7310-1854-05	Cover for 7310-1854-03 & 7310-1854-04
014-0002-01	Susceptor, 4 x 2" Wafers
A4-0015	Susceptor, 4" Wafer
7450-0031-08	4" ID Ring, Slip-Free
7450-0031-09	5" ID Ring, Slip-Free
7450-0031-10	6" ID Ring, Slip-Free

13.8   <u>OVEN – TOP VIEW</u>
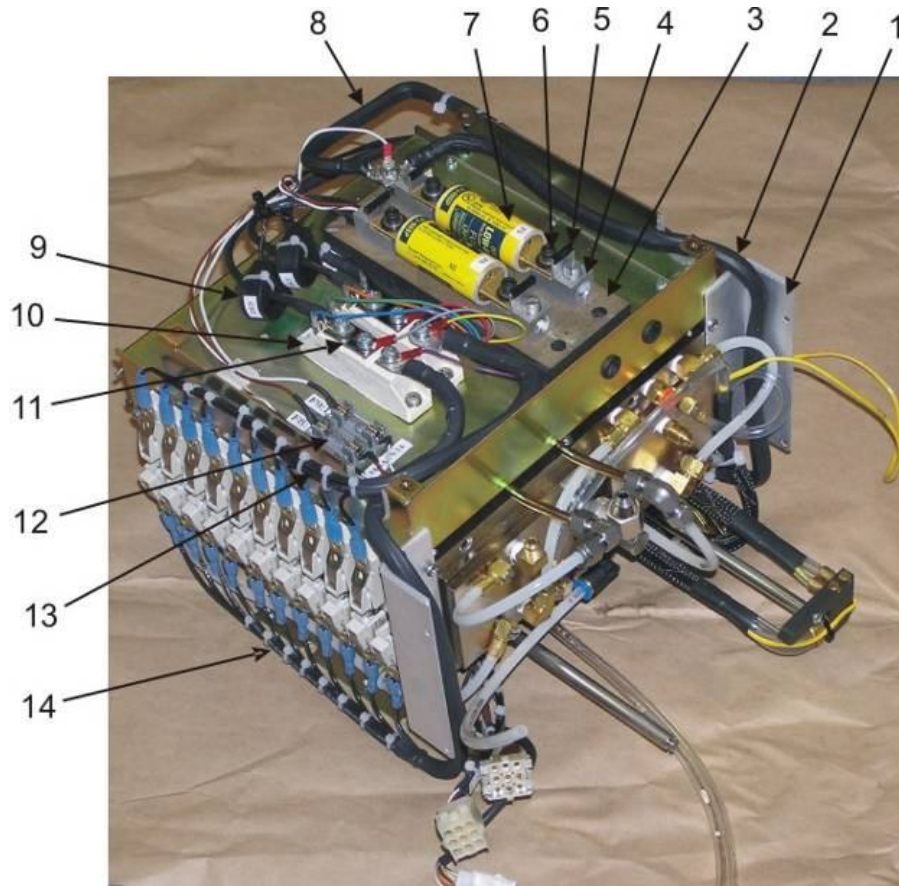
Oven – Top View

ITEM	PART NUMBER	DESCRIPTION
1	013-0020-01	Water Shield, Lamp Sockets
2	7100-0062-02	Lamp Harness
3	7500-0133-01	Plate, Fuse Holder
4	2109-0010.- 0 1	Fuse Block, Modular, 100 A
5	(part of 26)	
6	2802-0420-08	Screw, Hex head, l/4"-20 x l/2"
	2812-1511	Washer, l/4" I.D. x 0.550 O.D.
7	5101-0010-01	Modified Fuse
8	7100-0062-02	Lamp Harness
9	A5-0051	Toroid Transformer
10	4803-0010	SCR, Dual Pair, 90A, 600V
11	9000-0490	Jumper Plate
12	2109-0030	Fuse Holder Phenolic Base, 3 Pos
	A5-0016	Fuse, 1.0A 250V Fast-Blo
	A5-0016	Fuse, 1.0A 250V Fast-Blo
	A5-0016	Fuse, 1.0A 250V Fast-Blo
13	7100-0062-02	Lamp Harness
14	7100-0062-02	Lamp Harness

13.9   OVEN – REAR VIEW
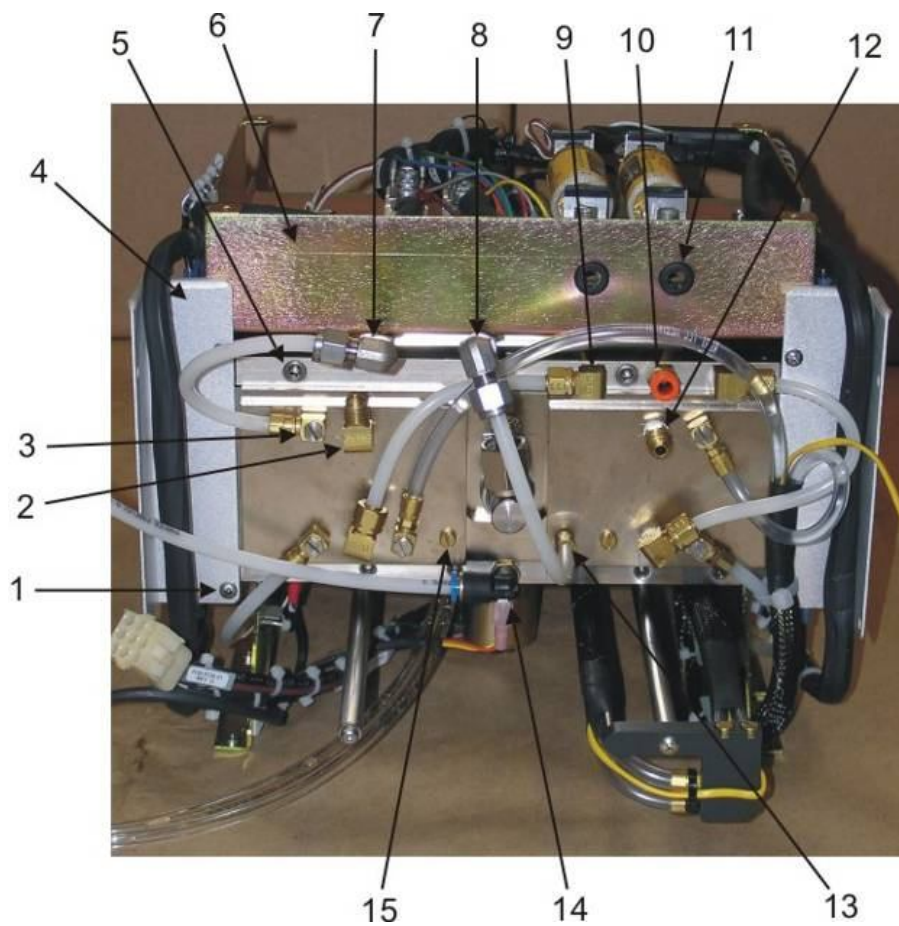
Oven – Rear View

ITEM	PART NUMBER	DESCRIPTION
1	A5-0020	screw, pan head, SST, 8-32 x 3/16"
2		Elbow, 90° Male l/4 ferrule x l/8 NPT
3	2522-0450	Fitting, "L" Adjustable, 10-32
4	013-0020-01	Water Shield, Lamp Sockets
5	2806-1023-04	Plug, Large
6	G300-0014-05	Triac Plate
7	2522-0840	Elbow, 90° Male, Swagelok l/4 Tube
8	2522-0840	Elbow, 90° Male, Swagelok l/4 Tube
9		Elbow, 90° Male l/4 Tube x 1/8NPT
10	2522-0910-07	Straight Union, Male 1/4 Tube OD x 1/8 NPT Brass
11	A5-0021	Grommet, 3/8ID x .415
12	A5-0022	straight, Male l/4 ferrule x l/8 NPT
13	2522-0600	Fitting, Brass, 10-32 x .170- Hex Barb
14	A5-0023	Union Elbow, 90° Male 1/4 Tube OD x 1/8 NPT Brass
15	2806-1017-03	Plug, Small

13.10 <u>CHASSIS – REAR WALL</u>
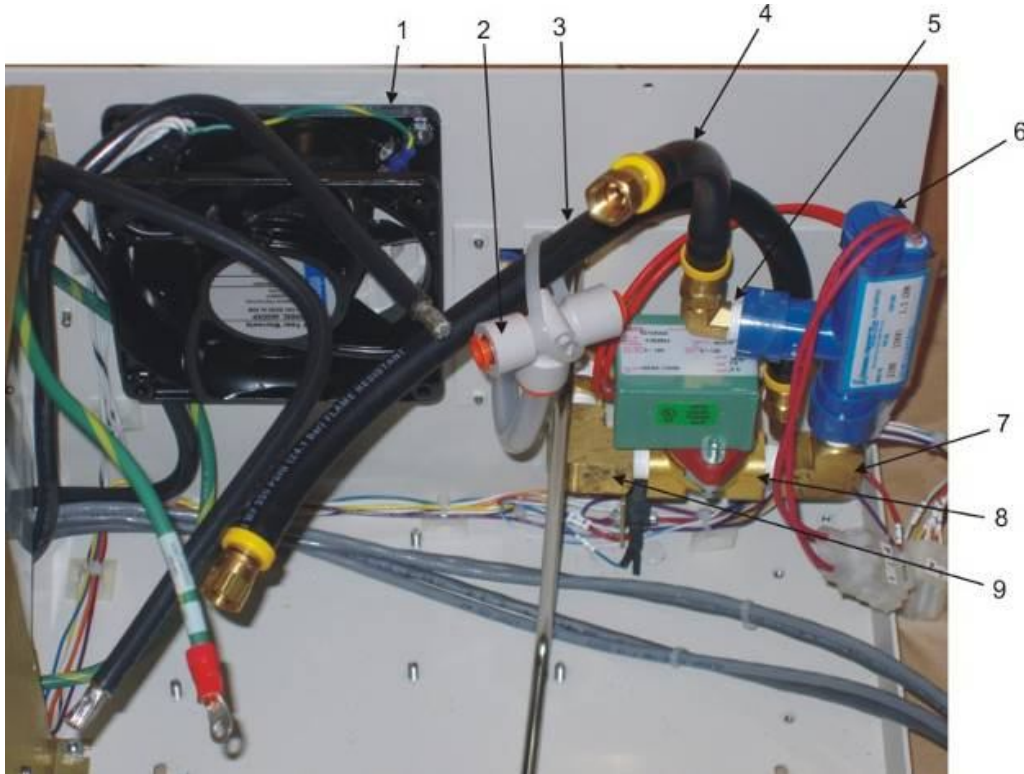
ITEM	PART NUMBER	DESCRIPTION
1	2601-0010	Fan, 115V, 50160 Hz, 20W
2	A5-0024	'T' Fitting, 3/8" Hose
3	A5-0025	Hose, 12"L, 350 PSIG, Swagelok 1/4" (6.4mm) tubing, flame resistant
4	A5-0026	Hose, 6"L, 350 PSIG, Swagelok 1/4" (6.4mm) tubing, flame resistant
5	A5-0027	Elbow, 90° Male, 1/4 NPT x 1/4 flare
6	5108-0010	Switch, Normally No-Flow
7	9000-0460	Elbow, Female, l/4 NPT x 1/4 NPT
8	A5-0028	Water Solenoid, 120 VAC,
9	A5-0029	Elbow, Female, l/4 NPT x 1/4 NPT

13.11 <u>CHASSIS – LEFT VIEW</u>
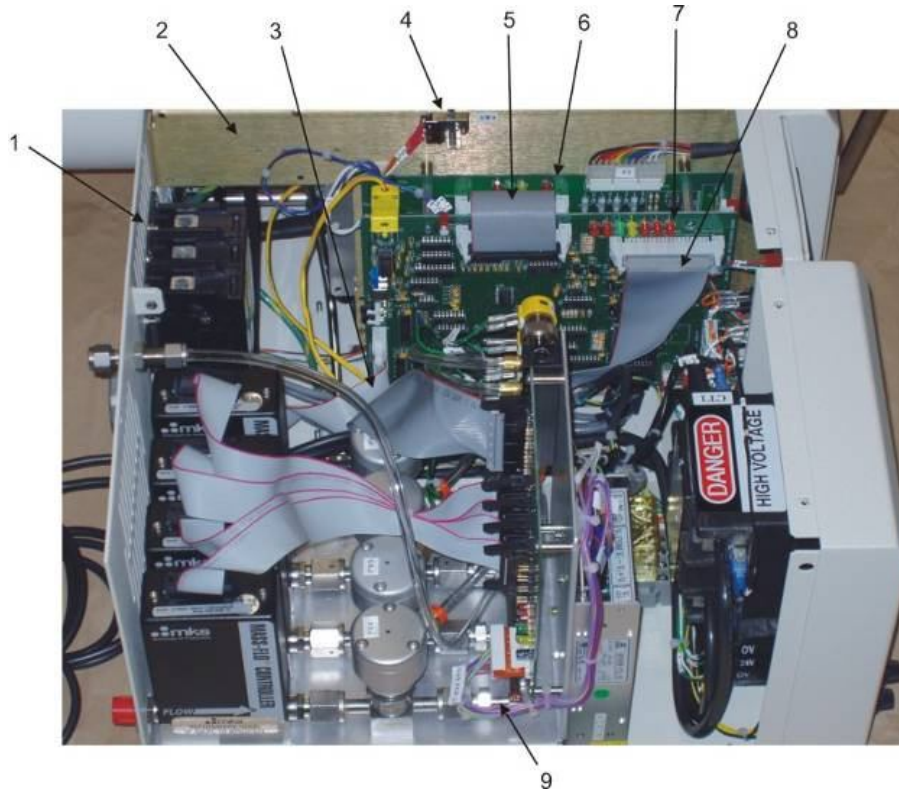
ITEM	PART NUMBER	DESCRIPTION
1	A5-0033	Circuit Breaker, 100 A, 3-phase
2	7300-0017-04	Support Partition
3	7100-0887-01	Cable, Ribbon, Communication
4	5107-0020	Switch, SPDT, Interlock 5A
5	A5-0034	Cable, Ribbon, Board Interconnect
6	AW-900-018	Oven Control Board
7	AW-900-058	Main Control Board
8	A5-0035	Cable, Ribbon, Gas Interface
9	A5-0036	Gas Inlet Manifold

13.12 <u>POWER CONTROL</u>
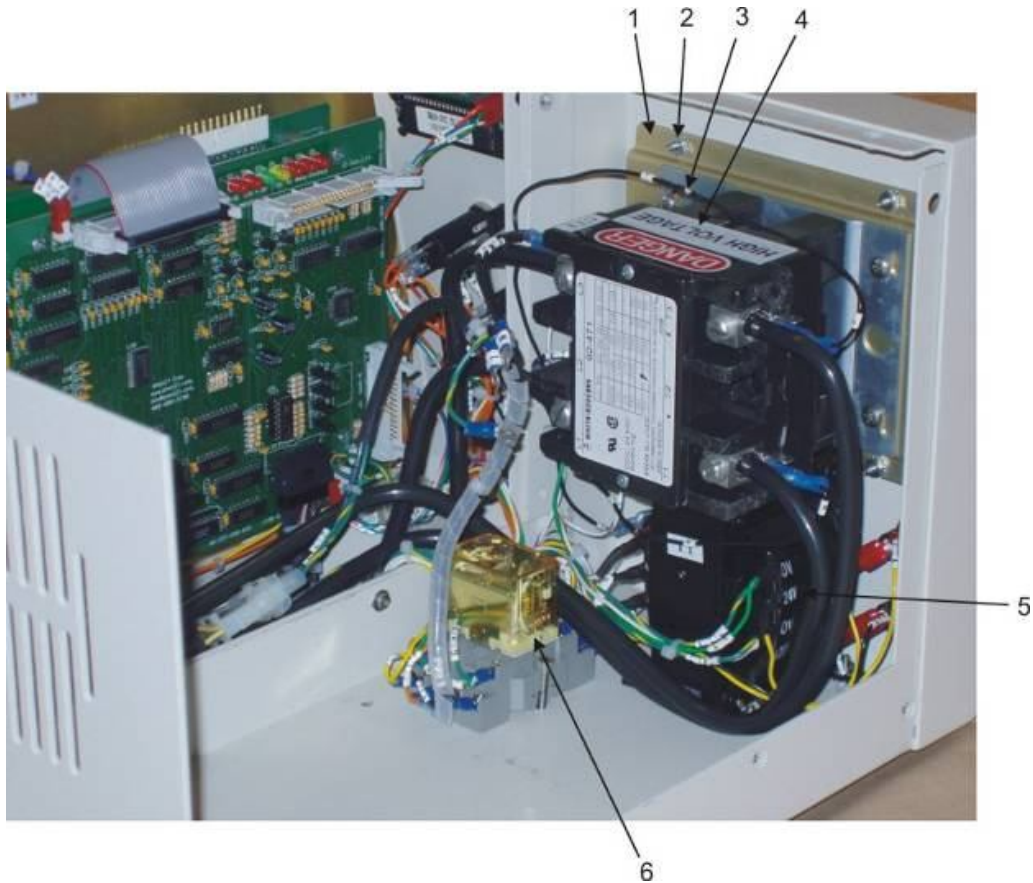
ITEM	PART NUMBER	DESCRIPTION
1	A5-0037	Bracket, Contactor Mounting
2	A5-0038	nut, SST, 6-32
3	4714-0684	Resistor, CC 1/2W 5% 680K
4	A5-0039	Contactor, 100 A, 3-phase, 24 VAC
5	5602-0080	Transformer, 208P, 12OV, 95VA
6	A5-0040	Relay, 4PDT

13.13 <u>GAS MODULE</u>
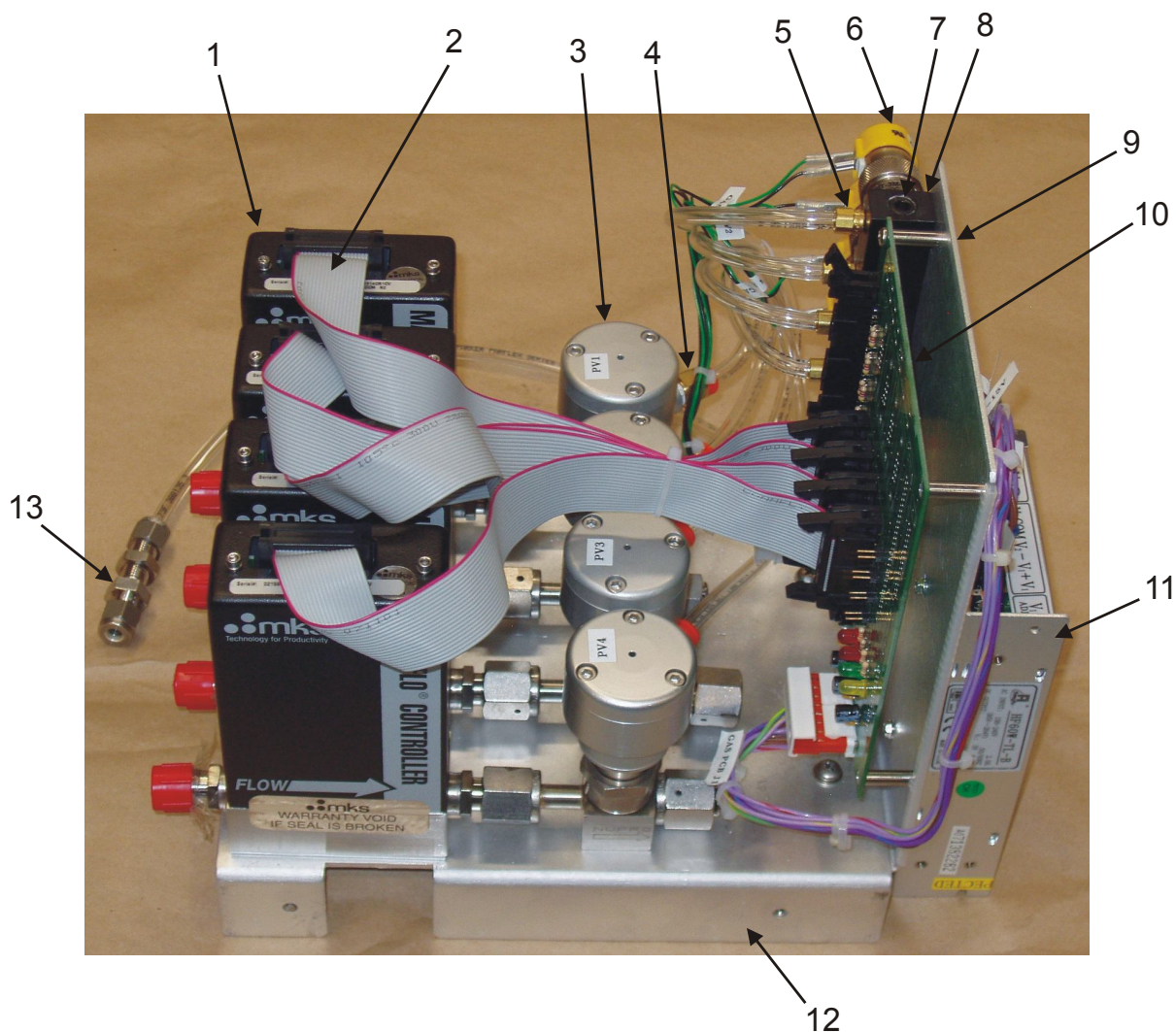
Gas Module

ITEM	PART NUMBER	DESCRIPTION
1	A5-0042	MFC, N2, N.C. 0-10 SLPM
2	A5-0043	Cable, Ribbon, MFC Control
3	A5-0044	Valve, Pneumatic, N.C.
4	2522-0910-07	Connector, Male 1/4 Tube x 1/8 NPT Brass
	3104-0020	TAPE, TEFLON, 1/2 IN
5	2522-0600	Fitting, Brass, 10-32 x .170- Hex Barb
6	4502-0019-01	SOL, N.C. 3 WAY
7	2522-0445	Plug, Hex Head 1/8 NPT
8	2522-9300-01	MANIFOLD,4-POSITION
9	A5-0041	Bracket, Support, Power Supply/ Gas Control Board
10	AW-900-054	Gas Control Board
11	A5-0045	Power Supply
12	7300-A005	Base, Gas Module
13	A5-0018	Bulkhead, Swagelok 1/4"

13.14 <u>OUTER PANELS</u>
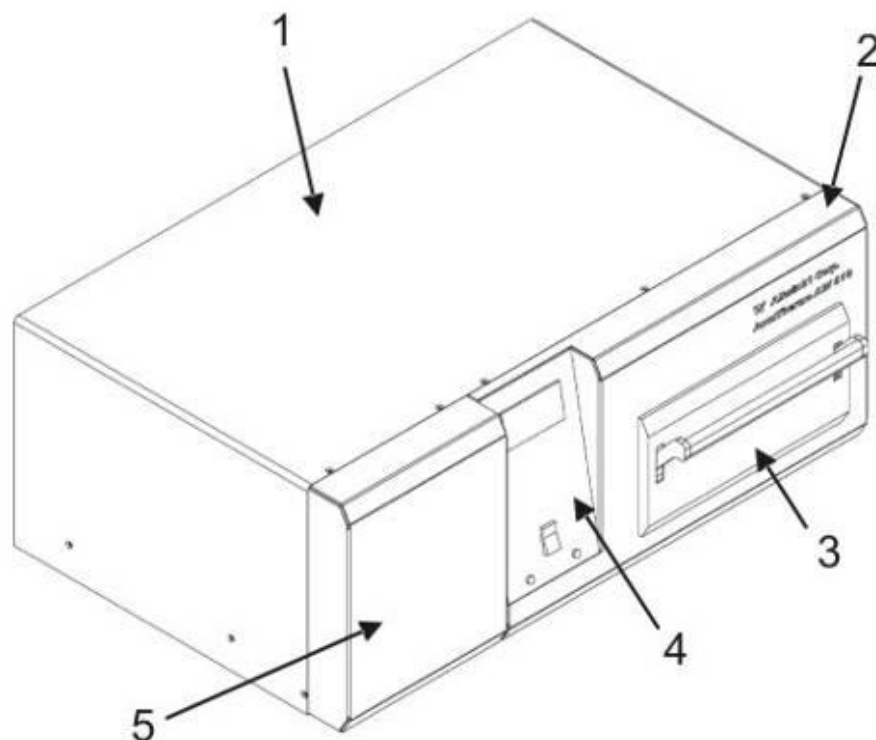
ITEM	PART NUMBER	DESCRIPTION
1	7300-A003	Cover, Top
2	G300-0129-04	Front Panel
3	7300-0013-02	Door Cover 610
4	G300-0130-05	Panel, Control
5	7300-A008	Base Chassis, Extension

13.15 <u>CHILLER ASSEMBLY</u>
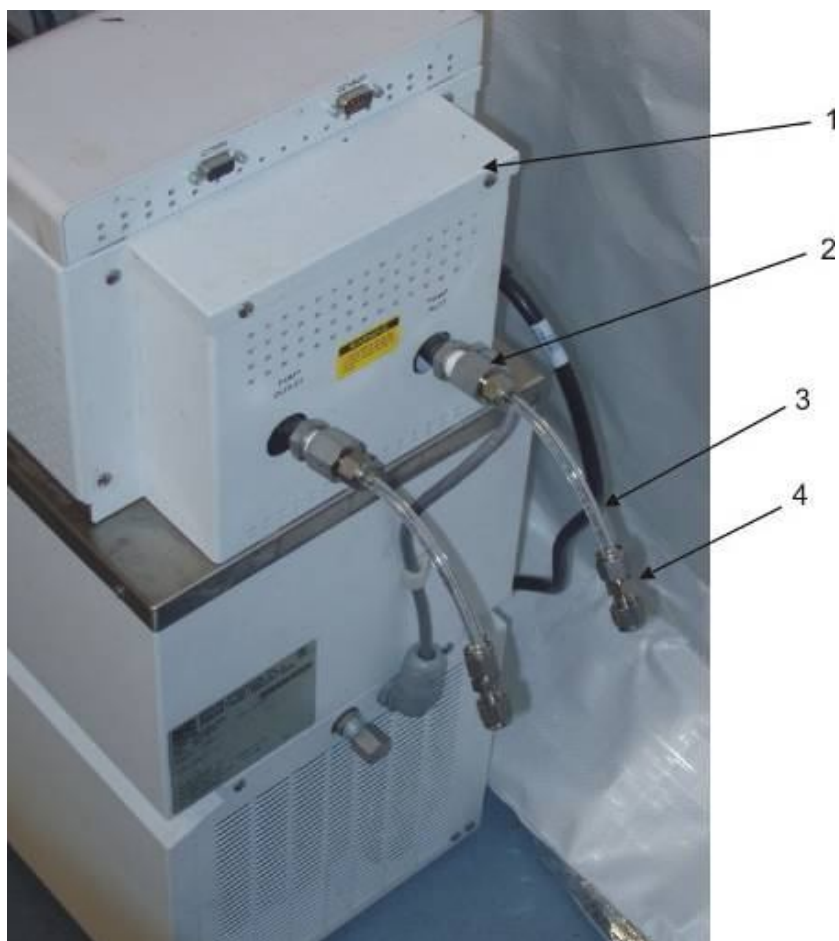
ITEM	PART NUMBER	DESCRIPTION
1	A5-0046 A5-0047	Chiller, Bath Circulator Chiller, Bath Circulator, 220/24OV
2	A5-0048	Coupling, Female 1/4 Tube OD x 1/4 Female NPT
3	A5-0049	Tubing, 1/4 OD x 1/16 wall, 125 psi w.p. at 73F
4	A5-0050	Coupling, Swagelok, 1/4"

13.16 <u>SPARE PARTS KIT, LEVEL 1</u>

Part No. = 0650-0100

<u>ITEM</u>	<u>PART NUMBER</u>	<u>DESCRIPTION</u>	<u>QUANTITY</u>
1	2451-0010-02	Lamp, 1200W 208V	5
2	2504-0070	O-Ring, Purge Inlet	2
3	2504-0202-01	O-Ring, Door	2
4	2504-0160	O-Ring, Flange to Tube	4
5	5101-0030	Fuse, 1A 25OV, Fast-Blo	2
6	5101-0090	Fuse, 1/2A, 25OV, Fast-Blo	2
7	5101-0110	Fuse, 5A, 25OV, Fast-Blo	2
8	7200-0096	Fuse, 90A, Modified	2

13.17 SPARE PARTS KIT, LEVEL 2

Part No. = 0650-0102-03

ITEM	PART NUMBER	DESCRIPTION	QUANTITY
1	0650-0100	Spare Parts Kit, Level 1	1
2	2109-0050	Lamp holder, Tungsten Halogen, 10A 600V	2
3	5108-0010	Water Interlock Switch N.O.	1
4	4502-0050	Valve Solenoid, NC-2 Way I/4"	1
5	7100-5121	Digital Panel Meter Assy	1
6	4808-0020	I.C. IR/Laser 4N40	2
7	5107-0010	Door Interlock Switch	1
8	5107-0020	Cabinet Interlock	1
9	5300-0060	Thermostat Interlock "A"	1
10	5300-0070	Thermostat, Overcool "B"	1
11	5300-0091-01	Thermostat, Open=150F CL=135F	1
12	AW-900-058	Main Control Board	1
13	AW-900-018	Oven Control Board	1
14	AW-900-054	Gas Control Board	1
15	7100-0874-11	ERP Pyro, Water Cooled	1

13.18 <u>SPARE PARTS KIT, LEVEL 3</u>

Part No. = 0650-0141-01

<u>ITEM</u>	<u>PART NUMBER</u>	<u>DESCRIPTION</u>	<u>QUANTITY</u>
1	0650-0102-03	Spare Parts Kit, Level 2	1
2		Contactor, 3-P, 95A, 24/48VAC	1
3	4803-0010	SCR Dual Pair, 90A, 600V (Triac)	1
4	A5-0172	Circuit Breaker, 3 Pole, 30A	1
5	5103-0010	Rocker Switch, DPDT 5A	1
6		Cable Assy, 25 Pos D-Conn 6'L	1
7	7100-0198-01	Leak Tester	1
8	7100-0069	TC Fitting Assy	1
9		PC Controller	1

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APPENDIX

A: SYSTEM REQUIREMENTS

Specification	Equipment	Voltage	Frequency	Current	Phases	# Wires	Notes
USA	Oven	208/240	60 Hz	90 A.	1	3	1, 2, 3, 4
	Chiller	110-120	60 Hz	11 A.	1	3	
	Computer	110-120	60 Hz	Variable	1	3	5
Japan	Oven	200	50/60 Hz	90A.	1	3	1, 2, 3, 4
	Chiller	100	50/60 Hz	11 A.	1	3	
	Computer	100	50/60 Hz	Variable	1	3	5
Europe	Oven	220/240	50 Hz	90 A.	1	3	1, 2, 3, 4
	Chiller	220-240	50 Hz	5.5 A.	1	3	
	Computer	220-240	50 Hz	Variable	1	3	5

Note 1: Use an isolation transformer to reduce interference to other equipment.
Note 2: Locate oven within 25 feet line length of isolation transformer.
Note 3: Locate power-disconnect switch within reach of the system.
Note 4: 2 supply wires and 1 ground wire
Note 5: Computer current will be dependent upon the computer manufacturer.

Table A-1: *AccuThermo RTP System Power Distribution Requirements*

Facilities Requirement	Pressure		Volume	Fittings		Special Requirements & Recommendations
	Min	**Max**		**Inlet**	**Outlet**	
	Typical					
Oven Cooling Water	30 PSIG	60 PSIG	2 GPM (7.5 LPM)	3/8" Male Pipe Swagelok	3/8" Male Pipe Swagelok	Water filtered to 100 microns. Use no Deionized or Distilled Water. Maintain a constant temperature of 20°C (3°C above dew point). Pressure Differential 30 – 50 PSIG. 1/2" tubing
	40 PSIG					
Quartz Isolation Tube Cooling Air (CDA or N$_2$)	15 PSIG	30 PSIG	10 – 15 SCFM (283-425 SLPM)	3/8" Parker Push-Lok	N/A	Nitrogen (N$_2$) or Clean Dry Air (CDA), oil-and-water-free, filtered to 3 microns 3/8" OD nylon tubing
	20 PSIG					
Process Gas Inputs to 1 to 4 MFC's (inert or non-toxic only)	15 PSIG	30 PSIG	0 – 10 SLPM Maximum Accumulated Volume of all Gases	1/4" Female VCR	N/A	The purge gas connected to MFC1 must be N$_2$ or Ar.
	20 PSIG					
Compressed Pneumatic Actuation Gas	75 PSIG	85 PSIG	Less Than 1 SCFM	1/4" Swagelok	NA	The gas used for this application can be either Clean Dry Air (CDA) or Nitrogen (N$_2$)
	80 PSIG					
Chamber Exhaust	-0.5" Water	-1.0" Water	20 SLPM Maximum	N/A	1/4" Male VCR	Connect to Building Scrubber
	-0.75" Water					
Chassis Exhaust and Gas Box Exhaust	N/A	N/A	20 SCFM Maximum	N/A	4" Tubing	Connect to Building Exhaust System
	N/A					

Table A-2: *Summary of AccuThermo RTP System Facilities Requirements*

B: SELECTION OF THE PURITY OF GASES

Gases are available in a range of purity grades. These purity grades are identified by names such as "Research Grade", "Ultra High Purity", "Zero", "Prepurified", etc., which give an indication of relative purity such that "Ultra High Purity" is purer than "Prepurified". These terms, however, are not absolute. "Research Grade" Argon is not the same purity as "Research Grade" Methane or even "Research Grade" Nitrogen. The same purity name may be used for the same gas by different manufacturers, each offering the product with different specifications. The grade name therefore does not tell the user what the actual purity level is – it varies from product to product and manufacturer to manufacturer.

The important measures of purity are the overall percentage purity of the gas and the identity and levels of the impurities present.

A simple system used to signify the percentage purity is a digitized grade system. In this system the first digit signifies that number of 9's in the percentage purity. The second digit indicates the next number that differs from a 9. Thus:

Helium 4.5

There are four 9's in the purity and the next digit is a 5 –

99995 as a purity percentage is 99.995%

Similarly Argon 6.0 is 99.9999% (Six 9's and the next digit is a 0)

Often of more importance in a particular application is knowing what impurities are present and at what level. If Nitrogen is used as a zero gas for a ppm Oxygen analyzer, it is important to know the Oxygen level of each grade of Nitrogen when selecting which to use.

Summary Purity Table

Percentage Purity	Grade	Total Impurities
99.99%	4.0	100 ppm
99.995%	4.5	50 ppm
99.999%	5.0	10 ppm
99.9995%	5.5	5 ppm
99.9999%	6.0	1 ppm

C: DOS COMMANDS AT A GLANCE

Refer to a DOS manual for a full explanation of these and other DOS commands.

C.1   <u>FILENAMES</u>

- Filenames have no more than eight characters.
- Contain only the letters A – Z, the numbers 0 – 9.
- Cannot contain spaces, commas, backslashes, or periods.

C.2   <u>PATH</u>

In DOS, you list the path where a file is stored by separating the directory names with the backslash (\).

For example:

\doc\info

The first backslash represents the root directory. The second backslash separates the INFO directory from its parent directory, DOC.

C.3   <u>WILDCARDS (*, ?)</u>

If you want to perform the same task for a group of files, you don't have to use the same command repeatedly for each filename in the group. You can use wildcards to specify groups of files. A wildcard acts as a substitute for a name or extension.

There are two wildcards:

- The asterisk (*) represents a whole word or group of characters.
- The question mark (?) represents a single character.

For example, list all of the files and directories in the current directory that start with the letter 'c':

dir c*.*

C.4   COPY FILES

copy *source destination*

Copies one or more files to another location.

source
Specifies the location and name of a file from which you want to copy.

destination
Specifies the location and name of a file to which you want to copy.

C.5   XCOPY

xcopy *source destination /s*

Copies files and directories, including subdirectories. This is more powerful than **copy**.
It is able to copy subdirectories.

source
Specifies the location and names of the files you want to copy. Source must include
either a drive or a path.

destination
Specifies the location and names of the files you want to copy.

/s
Copies directories and subdirectories.

C.6   DELETE FILES

del *filename*

Deletes specified files.

filename
Specifies the name of the file you want to delete.

C.7 <u>LIST DIRECTORY</u>

dir

Display a list of a directory's files and subdirectories.

C.8 <u>CHANGE DIRECTORY</u>

cd *path*

Changes the current directory.

path
Specifies the directory to which you want to change.

C.9 <u>MAKE DIRECTORY</u>

md *path*
or
mkdir *path*

Create a new directory.

path
Specifies the name of the new directory.

C.10 <u>CHANGE CURRENT DRIVE</u>

To change the current drive, type the letter of the drive followed by a colon (**:**).

For example, to change the current drive to E, type the following:

e:

C.11 <u>SYS</u>

sys *drive:*

Copies DOS system files and the DOS command interpreter (COMMAND.COM) to the disk in the drive you specify.

drive:
Specifies the drive to which you want to copy the system files. These files can only be copied to the root directory and not to a subdirectory.

C.12 <u>FORMAT</u>

format *drive: /s*

Formats the disk in the specified drive to accept DOS files.

drive:
Specifies the drive containing the disk you want to format.

/s
Copies the operating system files after the disk has been formatted. This works as if you typed the command **sys**.

D: UPDATING THE CONTROL SOFTWARE

The version of the control software is made up of 2 parts: the major and the minor. These parts are separated by a decimal point. The minor part of the version (the right side) follows the decimal point. It is made up of 3 characters. Each character position has a specific meaning as described in the following table.

Character Position	Meaning	Format	Example
1	year	hexadecimal	6=2006 A=2010
2	month	hexadecimal	1=January 2=February 3=March 4=April 5=May 6=June 7=July 8=August. 9 = September A=October B=November C=December
3	release number	hexadecimal	1 - F

Whenever an updated version of the control software has been received, the extension of the filenames will be coded the same as the version of the control software.

For example: If the filename is AW-ASH.7B2, then the minor version of the control software is 7B2.
7 = 2007
B = November
2 = variant #2

This software was released in November, 2007. It is the second variant for the month.

If a notification has been sent that there is an update of the AW900 control software, download the files onto your computer. After downloading the files, copy them onto a USB drive that is 2 GB or smaller, or a 3.5", 1.44 MB floppy disk. Take these files to the machine and load them into the same directory as the control software.

If a USB drive is being used, it will have to be inserted into the USB port and then the computer needs to be rebooted. The USB drive may be assigned as drive B: or E:

Step 1.   Once the computer is showing the Main Menu, **note** what the 3 character minor part of the version is.

Step 2.   Press the 'Q' key to exit the control software and go into DOS.

Step 3.   Copy your existing control software with the file extension being the minor part of the version code. Use the following command substituting the minor part of the version, that was noted as described above, for 123.

         COPY RTAPRO.EXE RTAPRO.123

Step 4.   Copy the files from the floppy disk (drive A:) or the USB drive (drive E:) into the control software directory. For example:

Step 5.   If the source drive is the USB drive, then type the following command:

         COPY E:RTAPRO.* C:RTAPRO.*

Step 6.   If the source drive is the floppy disk, then type the following command:

         COPY A:RTAPRO.* C:RTAPRO.*

Step 7.   Change the extension of the new filenames to EXE. Use the following command substituting 123 for the minor part of the version, as described above.

         COPY RTAPRO.123 RTAPRO.EXE

Step 8.   If the computer asks you to overwrite a file, type "**a**" for "All" and press *ENTER* to replace the old files.

Step 9.   You have just updated your control software. Now reboot the computer to have it take effect.

E: BACKING UP AND RESTORING THE SOFTWARE

E.1   OVERVIEW

It is always advisable to make a backup copy of the AW-900 software. It may be needed in the event that the system is damaged, and problems develop on the computer which necessitates reloading the software.

Refer to this section for information on how to make a backup copy of the system. Make as many copies of the AW-900 system software as you deem necessary. Store the backups in separate places in case the software must be reloaded in the future.

The procedures listed below will backup all information from the hard drive to a USB drive that is 2 GB in size.

E.2   BACK UP PROCESS DATA, RECIPES, CONTROL SOFTWARE

This procedure will backup the process data, recipes and control software to a USB drive. These files can be archived on a server. They can also be viewed on your office computer that is running the AllWin21 control software in demo mode.

Step 1.   Connect the USB drive to the USB port on the machine's computer.

Step 2.   Reboot the computer.

Step 3.   When the computer has booted and is idle at the Main Menu, exit the control software. (Refer to the appendix section "Exiting the Program".)

Step 4.   Change drive to the USB drive. For example, if it is drive "e:", then type the following DOS command:

   e:

Step 5.   Create a directory for the backup data (if it has not been created). For example, if the directory name is "backup", then type the following DOS command:

   mkdir backup

Step 6.   Change to that directory. For example, if the directory name is "backup", then type the following DOS command:

cd backup

Step 7.   Type the following DOS command:

xcopy c:*.* . /s

E.3   <u>BACK UP THE ENTIRE DRIVE C:</u>

Drive C: contains the operating system, drivers and the control software and generated files (i.e. recipes, calibration data and process data on drive C:) that the machine is depended on.

This procedure will backup all files that reside on drive C:.

Step 1.   Connect the USB drive to the USB port on the machine's computer.

Step 2.   Reboot the computer.

Step 3.   When the computer has booted and is idle at the Main Menu, exit the control software. (Refer to the appendix section "Exiting the Software".)

Step 4.   Change the drive to drive "C:" by typing the following DOS command:

c:

Step 5.   Change to the root directory of drive "C:" by typing the following DOS command:

**cd **

Step 6.   Change the drive to the USB drive. For example, if it is drive "E:", then type the following DOS command:

e:

Step 7.   Create a directory for the backup data (if it has not been created). For example, if the directory name is "backupAW", then type the following DOS command:

mkdir backupAW

Step 8.   Change to that directory with the following DOS command:

cd backupAW

Step 9.   Type the following DOS command:

xcopy c:*.* . /s

This will backup all files to your USB drive. These files can be archived on a server.

E.4   <u>BACK UP DRIVE D:</u>

Drive D: usually contains only process data. The amount of process data is usually dependent on the amount of wafers being processed.

To back up this drive, follow the procedure "Back Up The Entire Drive C:", but substitute "d" for "c".

E.5 <u>CREATING A BOOTABLE 3.5" FLOPPY DISK</u>

Creating a bootable floppy disk allows booting the computer and restoring all files if the hard disk has to be replaced because it failed.

Step 1.   When the computer is idle at the Main Menu, exit the control software. (Refer to the appendix section "Exiting the Software".)

Step 2.   Change to the root directory of drive "C:" by typing:

         **cd **

Step 3.   Insert a 3.5" floppy disk into the floppy disk drive.

Step 4.   Type the following DOS command to make the floppy disk bootable:

         sys a:

Step 5.   Type the following DOS command to transfer all DOS utilities necessary to help restore the hard drive:

         xcopy bootdisk*.* a:*.* /s

The following list of utility files should be in the DOS subdirectory.
     xcopy.exe
     deltree.exe
     di1000dd.sys
     fdisk.exe
     format.com
     himem.sys
     sys.com
     usbaspi.sys

E.6   <u>RESTORING THE HARD DRIVE</u>

Allwin21 uses DOS 7.10 as the operating system for the control software. It has a size limit of 100 GB per drive. However, some of our functions were made before this time using DOS 6.22 which has a size limit of 2 GB per drive. Therefore, drive C: is partitioned to 2000 MB, while drive D: uses the rest of the drive space.

The following procedure will restore the hard drive and will destroy all information and data on the hard drive.

Step 1.   Partition the hard drive using the DOS utility **fdisk**. Partition it so the Primary DOS Partition is 2000 MB in size and the Extended DOS Partition uses the rest of the disk space. Partition the Extended DOS Partition with one Logical DOS Drive, which will use the entire Extended DOS Partition.

Step 2.   Exit **fdisk** and reboot the computer. This will make the partitions permanent.

Step 3.   Format and copy the system files to the first partition as drive C: by typing the DOS command:

         format c: /s

Step 4.   Format the second partition as drive D: by typing the DOS command:

         format d:

Step 5.   Using the USB drive that has the files that you backed up when you backed up the **Entire Drive C:**, attach it to the computer. Reboot the computer.

Step 6.   Copy the files that you backed up when you backed up the entire drive C:. If the USB drive is drive E: and the directory name is "backupAW", then type the following DOS command:

         xcopy e:\backupAW*.* c:*.* /s

F: SOFTWARE STARTUP

F.1   OVERVIEW

The control software is already installed on the hard disk of the control computer. All you need to do is power-up the system and make sure the monitor is on. At this point, the *Main Menu* will appear on the screen. See Figure 6-2.

It is always advisable to make a backup copy of the control software. It may be needed in the event that the system is damaged, and problems develop on the computer which necessitates reloading the software.

Refer to the section "Backing Up and Restoring the Software" of this software manual for information on how to make a backup copy of the system. Make as many copies of the AW-900 system software as you deem necessary. Store the backups in separate places in case the software must be reloaded in the future.

F.2   STARTING THE PROGRAM

To start the program, at the DOS prompt (C:\>), type:

CD \RTAPRO <CR>
RTAPRO <CR>

This will load the control software. When the program has loaded and ready to use, the *Main Menu* screen (shown in Figure 6-2) is the first screen displayed.

To use the control program with the RTAPRO, refer to the Power Up Procedure.

F.3   EXITING THE PROGRAM

Press 'Q' (or 'q') on the keyboard from the *Main Menu* to exit the control software and go to DOS.

To abort and reset the software program at any time, simultaneously press and hold down the [**CTRL**, **ALT** and **DEL**] keys on the PC keyboard. This will reboot the computer and reload DOS -- This procedure could not be used if there is no response from the keyboard.

Alternately, the system can be powered down and then powered up.

G: HOW TO ORDER / RETURN EQUIPMENT

The information contained in this appendix includes the following:

- ➢ How to order equipment and parts

- ➢ How to return parts

- ➢ How to exchange parts

- ➢ What to do when the system is down

- ➢ Service Agreements

G.1   HOW TO ORDER EQUIPMENT AND PARTS

To order parts from Allwin21 Corporation, call:

Allwin21 Corporation
Customer Service
Phone: 1-408-988-5188

To obtain a quote and information concerning part availability, please have the following information ready:

- ➢ System model number (example: AccuThermo AW610)

- ➢ Serial number of the system

- ➢ Part number of the required part

- ➢ Purpose of order (spares, failed part, etc.)

- ➢ "Ship To:" address

- ➢ "Bill To:" address

- ➢ Purchase order number

G.2   <u>HOW TO RETURN PARTS</u>

☞ NOTE

An RMA (Return Material Authorization) number must be obtained from AllWin21 prior to shipping any parts back to AllWin21.

A Return Material Authorization (RMA) Number is required in order to return or exchange system parts. To obtain an RMA number, call:

Allwin21 Corporation
Customer Service
Phone: 1-408-988-5188

Return any failed parts to the following address:

Allwin21 Corporation
1550 Norman Ave.
Santa Clara, CA 95054
Attn: RMA # _____

Ensure that the RMA (Return Material Authorization) number is included with any returned part(s). Include the following information with the part:

➢ System model number (example: AG4100)

➢ Part number of failed part

➢ Detailed failure information

➢ Serial number of system and of the failed parts (if applicable)

➢ "Ship To:" address

➢ "Bill To:" address

➢ Purchase order number

➢ RMA (Return Material Authorization) number

As the customer, it is your responsibility to return the part(s) in a proper packing container. Failure to return the part properly could result in further damage to the part.

☜ **NOTE**

The RMA (Return Material Authorization) number must be visible on the <u>outside</u> of the package when returning a failed part. Allwin21 Corporation will not accept returned parts without an RMA number. This could result in the sender being billed for the full purchase price.

G.3 <u>HOW TO EXCHANGE PARTS</u>

After troubleshooting to isolate a failed part, replace the part with a site spare if one is available. If the system is down due to an isolated failed part and no site spare is available, call:

Allwin21 Corporation
Customer Service
Phone: 1-408-988-5188

Contact Allwin21 Field Service to properly identify the failed part. Allwin21 will issue an RMA (Return Material Authorization) number to you which must be included when the failed part is returned. The failed part MUST be returned to Allwin21 within ten (10) days in the proper packing container or the full purchase price will be billed. Replacement parts under warranty are shipped out in the timeliest manner possible.

All returned parts must be shipped in the same packing material as the replacement part. Failure to return the part in the proper packing container could result in further damage to the part.

G.4   <u>WHAT TO DO WHEN SYSTEM IS DOWN</u>

If the system is down and you cannot isolate or fix the problem within a reasonable period of time, call Allwin21 Corporation Customer Service for telephone assistance or a service visit. Telephone numbers are staffed by trained Allwin21 Corporation technicians, who can provide on-the-spot help with difficult problems and advice on repairs.

Allwin21 Corporation
Customer Service
Phone: 1-408-988-5188

H: MAINTENANCE PLANS

H.1 <u>EXTENDED MAINTENANCE PLANS</u>

AllWin21 commitment to customer support carries on past the warranty period. By offering a choice of extended maintenance plans, we can satisfy most of your service requirements. Contact AllWin21 Field Service or Sales Administration for more details.

H.2 <u>SERVICE TRAINING</u>

AccuThermo system uptime may be increased dramatically by having trained in-house personnel and spare parts kits. Operator and Service training (a three day course) are available at AllWin21 for a fee. These courses cover the following types of information:

➢ System overview

➢ Operation

➢ Software use

➢ Recipe construction

➢ Temperature control and optimization

➢ Preventive maintenance

➢ Electronics operation and troubleshooting

➢ Temperature monitoring using the thermocouple and pyrometer

Students are usually Applications Specialists, Equipment Engineers, System Operators and Maintenance Technicians. Emphasis is on hands-on work, as the classes are small and allow personalized instruction.

I: MANUAL REVISION HISTORY

Date	Rev.	Description
08/11/08	A	Initial Release
04/17/09	B	1) Added section on Safety Features. 2) Extra warning on Gas Handling when maintaining system. 3) Updated facilities specifications. 4) Updated front control picture. 5) Updated rear utility picture. 6) Updated picture of computer. 7) Clarified steps 1 & 2 in "Process a Wafer". 8) Added intro to "Recipe Programming. 9) Removed AW-900-002 and AW-900-008. Inserted AW-900-018 and AW-900-058. 10) Clarified "User Access Levels". 11) Clarified the alloys of a K-type thermocouple and how to distinguish between them. 12) Added more safety warnings in the maintenance sections. 13) Added the proper order of calibrating the temperature circuits. 14) Added the LED Temperature Display Calibration. 15) Clarified the Pyrometer Calibration. 16) Added "Pyrometer Calibration Adjustment" section. 17) Added section on "Adjusting the Pyrometer Offset". 18) Updated the "Gas Calibration" section. 19) Added the "Alarm List". 20) Expanded interlock troubleshooting section. 21) Expanded fuse troubleshooting. 22) Added Uniformity and Contamination troubleshooting sections. 23) Expanded Leak Checking section. 24) Expanded sections on water flow troubleshooting. 25) Expanded section on troubleshooting the thermocouple. 26) Updated the "Parts Guide" section. 27) Added section on selecting gas purity. 28) Added section on explaining some DOS commands. 29) Updated Quartz Tray list 30) Added Susceptor list
05/22/09	C	Included AW410 with the AW610 manual
06/18/09	D	Fine tuned Power-Up & Power-Down procedures
06/15/10	E	Removed wrong information in the Safety Features section.