Tsunami™ Series

RTP-600xp

OPERATION & INSTALLATION MANUAL

VERSION 3.0

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04/30/2003
HOW TO USE THIS MANUAL

I PURPOSE

This manual has been written for Process Development Engineers, Operators, Service Engineers and Technicians working with the RTP-600xp Rapid Thermal Processing System. It provides an overview of the system and its operation, as well as specific operating instructions. It also includes installation, minor service, and troubleshooting procedures.

II MANUAL ORGANIZATION

Following is a description of each section and its associated chapters:

SECTION 1: Introduction to the RTP-600xp System

Chapter 1: Product Overview and Performance
Introduces the system, listing its features and applications within the VLSI fabrication process. A list of performance specifications is provided, along with an explanation of the different factory options and accessories available.

Chapter 2: System Description
Describes the equipment subsystems and their functions. It also provides an overview of the software, its capabilities and features.

SECTION 2: System Start-up

The chapters in this section discuss start-up procedures for a system being powered-up after servicing or installation. This information is intended for a qualified Service Engineers and Technicians.

Chapter 1: Safety Precautions
Illustrates safety precautions to be observed when operating and servicing the RTP-600xp system.

Chapter 2: System Startup
Provides the procedures for powering up and powering down the system. It includes the procedures for loading the system software.

SECTION 3: Basic Operation

The procedures given in the following chapters are intended for all users of the RTP-600xp system. This section is provided primarily for Process Development Engineers responsible for developing operating procedures (by creating recipes) and for maintaining daily operating conditions, and for Operators responsible for running the system. It also contains a description of the menu screens.
HOW TO USE THIS MANUAL

Chapter 1:  Operator Interface
Describes the RPT-600xp system’s operator interface, including the system front panel and computer monitor.

Chapter 2:  Production Mode
Shows how to use the software for running pre-created recipes and viewing the Time/Temperature profile from the Last Recipe run on the system.

Chapter 3:  Engineering Mode
Shows how to use the software for creating, editing, and saving recipes; running processes; and printing and graphing recipe and process run files

Chapter 4:  SPC Mode
Provides Process Engineers and Service Personnel with the ability to retrieve a historical record of Time/Temperature profiles as well as a historical record of System Alarm/Log In Events.

Chapter 5:  System Mode
Provides the senior technical staff with the ability to access critical maintenance and system setup screens.

Chapter 6:  Help Mode
Provides access to an electronic copy of the Manual for easy trouble shooting.

SECTION 4: Component Descriptions and Servicing

This section contains a chapter on each major assembly and, where applicable, descriptions of calibration, removal, and replacement procedures. This information is intended for a qualified Service Engineers and Technicians.

Chapter 1:  Heating Chamber
Discusses the components in the heating chamber, and oven temperature control circuitry.

Chapter 2:  Temperature Measurement Instruments
Discusses the two temperature measurement subsystems used with the RTP-600xp. This section also explains why and how to select either an optical pyrometer or a thermocouple as the wafer temperature measuring device during processing.

Chapter 3:  Quartzware Service
Provides the procedures for cleaning and replacing the quartz isolation tube, and the wafer tray, which holds the wafer during processing.

Chapter 4:  Cooling Subsystems
Discusses the two cooling subsystems.

Chapter 5:  Gas Handling Subsystem
Discusses the process gas handling system.
SECTION 5: Maintenance and Troubleshooting

This section is intended for Service Engineers and Technicians responsible for maintaining the system and diagnosing any error conditions that may occur. It is suggested that you first read Section 4 of this manual to become familiar with the RTP-600xp subsystems before continuing with the information contained in this section.

Chapter 1: Maintenance and Diagnostics
Provides weekly and quarterly maintenance schedules and procedures. Shows how to use the system's diagnostics checks.

Chapter 2: Troubleshooting
Provides a Troubleshooting Guide, with recommended corrective actions, and system error messages.

SECTION 6: Installation Manual

This section is intended for Service Engineers and Technicians responsible for the initial installation of the RTP-600xp system. It is configured as a stand-alone Installation Manual, and may be used independently from the rest of this manual.

Chapter 1: Preface

Chapter 2: Installation Process Overview

Chapter 3: System Inspection

Chapter 4: Installation Site Requirements

Chapter 5: Connecting the Utilities

Chapter 6: Quartzware Installation

Chapter 7: System Power-Up and Testing

Chapter 8: Troubleshooting Guide
III  CONVENTIONS

This Manual uses specific document and keyboard conventions to aid in identifying and locating information.

Screen Menus & Selections, Software Modes, and Keyboard Conventions

Different type fonts are used in this Manual to distinguish between software screen selections, screen names, and modes of operation. Screen menu names are shown in Bold Italic type. Screen selections are shown in bold type. Software operating modes are shown in normal type, with the first letter capitalized. For example:

"Select Engineering from the Main screen to enter the Engineering mode."

The following keyboard convention is used throughout this Manual:

A [Key] is shown in brackets and bold type; e.g., [Esc] = Escape.

Notes, Cautions and Warnings

WARNING: This is given for personal safety, to prevent bodily harm.

CAUTION: This alerts you to avoid system damage.

NOTE: This provides important information, which requires special attention.

Section and Chapter Names, and Figure and Table Numbers

Section and Chapter names appear in bold type when referenced in the text of this Manual.

Figure and Table numbers in this manual incorporate the Manual section number, followed by a serial number; e.g., Figure 3-2 is the second figure in Section 3.
IV CUSTOMER SERVICE

Modular Process Technology Corporation provides technical support and other customer services - Monday through Friday, 9 AM to 6 PM, Pacific Time.

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DISCLAIMER

Modular Process Technology Corporation (MPTC) makes no warranty or representation regarding this Manual, other than those contained in the MPTC product warranty. Moreover, MPTC reserves the right to make modifications to the specifications of the product described within this Manual at any time, without notice and without obligation of MPTC.

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# RTP 600xp

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1.1.1 FEATURES AND APPLICATIONS

The RTP-600xp is a rapid thermal processing system, which uses high-intensity visible radiation to heat a single wafer for a short time at precisely controlled temperatures.

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

Key features include:

- 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

Figure 1-1. *RTP-600xp*
The RTP-600xp is a versatile tool, useful for many applications:

- Ion implant activation
- Polysilicon annealing
- Oxide reflow
- Silicide formation
- Contact alloying
- Oxidation and nitridation
- Compound semiconductor processing

### 1.1.2 PERFORMANCE SPECIFICATIONS

- Steady-State Temperature Stability: ±2 °C, in the range of 250-1300 °C
- Temperature Monitoring Mechanisms: Extended Range Pyrometer PLUS or a thermocouple.
- Heating Rate: 0-200 °C per second, user-controllable
- Cooling Rate: Temperature and process dependent, max. 150 °C per second
- Maximum Non-Uniformity:
  - Radiant Flux: ±0.25%
  - Sheet Resistivity: Uniformity ≤2% (dose monitoring units)
    (Post-anneal sheet resistivity measured on a 150 mm wafer annealed at 1000°C for 10 seconds)
  - Implant: As, $10^{15}$, 75KeV, with implant uniformity ≤0.3%,
    Silicon wafer, no screen oxide, P-type, <100>, 10-20 ohm-cm
- Steady State Time: 1-9999 sec. (1-600 sec. recommended)
- Wafer Sizes for the RTP-600xp: 2", 3", 4", 5", 6", and smaller pieces
1.1.3 **SYSTEM OPTIONS AND ACCESSORIES**

Following is a partial list of options:

- Guard Ring Tray
- Guard Ring
- TC wafers
- Susceptor Assembly with Lid
- Inconel Susceptor TC's
- Printer Card
- Ethernet Card
- Exhaust Collar

The RTP-600xp system integrates the processing unit and an internal computer into one system unit. Each customer receives the following items:

- RTP-600xp system unit
- Flat Panel Color Monitor
- Keyboard
- Mouse (Windows & DOS Graphic versions only)

The computer has at least the following capacities/Performance Specifications

- Pentium Processor
- Windows NT
- Floppy disk drive (1.4MB or larger)
- Hard Disk Drive (10GB or larger)
1.1.4 WARRANTY

Modular Process Technology Corporation expressly warrants that it will either repair or replace on the terms described below any product or component which within twelve (12) months from the date of shipment proves to be defective in design, material, or workmanship in the course of its normal intended use.

Modular Process Technology Corporation products are normally intended to be used in a semiconductor-processing environment in accordance with the functional, environmental, and operational standards published by Modular Process Technology Corporation or generally accepted in the industry. Modular Process Technology Corporation shall have no warranty obligation with respect to any product, which has been modified or altered, or with respect to data contained in any product returned to Modular Process Technology Corporation by the customer.
SECTION 1: CHAPTER 2
SYSTEM DESCRIPTION

1.2.1 INTRODUCTION

The RTP-600xp system consists of a heating chamber unit with an integrated computer control system and software. The wafer to be processed is placed on a quartz tray, which slides into a quartz tube in the processing chamber. Two rows of lamps, one above the quartz tube and one below it, provide the energy for heating the wafer.

The integrated computer control system uses a set of operating instructions known as recipes to control the RTP-600xp. These recipes are created by the Process Engineer to control and monitor the parameters of the processing cycle. The Operator then uses the RTP-600xp software provided to select process parameters (steady state temperatures, processing times, ramp rates, etc.) and run the process.

1.2.2 FRONT CONTROL PANEL

The front control panel houses the controls and readout, which indicate system status and provide on/off control of the system (see Figure 1-2).

![Diagram of front control panel]

Figure 1-2. Front Control Panel
The features of the front panel are:

- LED Readout - Displays temperature of material in contact with TC or in view of pyrometer, depending on device chosen for display
- Floppy Disk Drive - Used for storing and archiving process data
- Emergency Off (EMO) - Shuts everything off when pressed
- EMO Reset - Resets the EMO circuit and restores power to the system
- Power On – HIGH VOLTAGE ON - Turns on the heating unit power circuitry as well as the clean dry air lamp cooling solenoid
- Power Off - HIGH VOLTAGE OFF - Turns off the heating unit power circuitry as well as the clean dry air lamp cooling solenoid
- Door Unlock – Front Panel Door Unlock Switch (not functional unless purchased separately)

1.2.3 HEATING, COOLING, AND TEMPERATURE MEASUREMENT

The following list contains the key features of the RTP-600xp heating, cooling and temperature measurement functions:

- High-intensity visible/infra-red radiation heats wafers for short periods of 1 to 9999 seconds at precisely controlled temperatures in the 250°C to 1300°C range (Note: Typically a range of 1 to 600 seconds is used).
- Tungsten-halogen lamps and cold 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.
- Wafer cooling process purge gas (usually Nitrogen) flows through the quartz isolation tube across the wafer to decrease wafer cooling times
- Lamp cooling clean dry air flows around the lamps and quartz isolation tube to cool off lamps as well as maintain moderate quartz temperatures.
- Chamber cooling water flows through specially prepared water channels to keep the Chamber (rear, sides, top, bottom, collar, door and triac plate) cool during processing.
1.2.4 SOFTWARE SUBSYSTEM

The RTP-600xp software operates in a Windows NT environment using the supplied software program. The main screen offers the options for processing a wafer according to pre-defined recipe parameters. Section 3 explains how to create and run recipes, as well as covering basic operation of the system.
2.1.1 UTILITIES INSPECTION

Check the system utility connections and sources before switching on the RTP-600xp (see Figure 2-1 for the location of each utility connection at the rear of the unit).

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

- Electrical power
- Gas inlet and chamber exhaust
- Cooling water inlet and outlet
- Compressed air inlet

Figure 2-1. Utility Connections, Rear View of Heating Chamber

WARNING: Make sure the chamber exhaust is not restricted. This could cause the quartz tube to over pressurize and 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 before proceeding.
2.1.2 MAINTENANCE

During maintenance operations, observe the following precautions:

1. Do not use replacement parts that are not provided by Modular Process Technology Corporation.

   **WARNING:** Modular Process Technology Corporation is not liable for any damage or injury that may occur when unauthorized parts are used.

2. Disconnect power to the system before performing any maintenance activity that requires the removal of access covers.

2.1.3 GAS HANDLING

Be aware of the following cautions when working with gases in the RTP-600xp system:

1. Use only gases, which have been specified for use in the RTP-600xp system.

   **CAUTION:** Modular Process Technology Corporation is not liable for the use of gases not recommended by the factory.

2. Make sure the specified gases are connected to the proper inlets on the service panel.

   **WARNING:** Failure to properly connect the gas lines may result in dangerous gas mixtures, which could cause harm to personnel and/or the system.
SECTION 2: CHAPTER 2

SYSTEM STARTUP

2.2.1 SOFTWARE INSTALLATION AND STARTUP

The executable RTP-600xp control software is already installed on the hard disk. All the operator needs to do is power up the system and make sure the monitor is on. At this point, the RTP-600xp Main Menu will appear on the screen.

A copy of the RTP-600xp application software is provided on floppy disk, but as a precautionary measure, it is always advisable to make a backup copy of the RTP-600xp directory. It may be needed in the event that the original diskette is misplaced or damaged.

Exiting the Program:

Exit to Windows by logging off and selecting [EXIT].

To Shut Down/Restart follow Microsoft Windows procedures.

2.2.2 POWER UP PROCEDURE

The power up procedure begins with power being switched on in the following sequence:

Power-on Sequence:

Step 1. Turn on the wall circuit breaker for the RTP-600xp.

Step 2. Turn on the front panel key switch. Log In and enter Password.

Step 3. Ensure all external water, gas, air valves have been enabled

Then the RTP-600xp is powered up using the following procedure:

Power Up Procedure:

Step 1. Turn on the monitor if it is off. The "Power" LED on the monitor should illuminate green once system is turned On.

Step 2. Press the "EMO Reset" button - this turns the entire system on. Once the computer boots up, the system Main Menu should appear on the monitor screen. If it does not, check that the monitor is on.

Step 3. Press the "Power On" button - this enables the heating unit.

Step 4. The RTP-600xp system now is ready for operation.
2.2.3 **POWER DOWN PROCEDURE**

The RTP-600xp system may be left with power on continuously, unless maintenance to the system requires removing power from the system.

**NOTE:** Modular Process Technology Corp. recommends leaving the computer on when the system is not in use. The system should be turned off only for maintenance and service.

**Power Down Procedure:**

**Step 1.** Press the “Power Off” button.

**Step 2.** Log Off and select [EXIT] from Main screen.

**Step 3.** Shut down operational system using appropriate Microsoft Windows procedures.

**Step 4.** Press the EMO switch.

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

**Step 6.** If system will be left unattended for any extended period of time, the external water, gas and air inlets should be disabled.
SECTION 3: CHAPTER 1
OPERATOR INTERFACE

3.1.1 OVERVIEW

Using the computer's keyboard and mouse activate screen menus which operates the RTP-600xp system. The menu-driven display greatly reduces the learning process. The menu screens are designed to allow straightforward operation. After a successful power-up, the controller automatically displays the Log On screen (see Figure 3-1).

3.1.2 RTP-600xp LOG ON SCREEN

The RTP-600xp provides three levels of system access via the Log On screen. This access is controlled by passwords protecting distinct system functions. Clicking

![Log On Screen](image)

Figure 3-1. Log On Screen
the Log On button will cause a User Name Pop-Up screen to appear (see Figure 3.2). The User Name will be blank. Click the arrow at the end of the blank User Name window.

![Figure 3-2. Log On Pop-Up Screen with User Name Blank](image)

A choice of any one of three modes, ENG, MPT, or PROD can be selected (see Figure 3-3). Select the appropriate mode. Notice that the chosen mode now fills the previously blank User Name window. Click on the Password button. Enter the

![Figure 3-3. Log On Expanded Pop-Up Screen](image)
Password for the selected Mode via the *Touch Screen Keyboard* (see Figure 3-4). If your system still has the basic Factory Installed passwords encoded into the software use E for ENG, M for MPT and P for PROD.

![Touch Screen Keyboard]

*Figure 3-4. Touch Screen Keyboard*

The touch screen keyboard is a pop-up dialog that allows the user to enter data into the software (see Figure 3-4. Touch Screen Keyboard). Having a pop-up keyboard allows for a cleaner and larger viewing area for the necessary data and graphics. The keyboard contains the normal alphanumeric keys found on most U.S. keyboards and the keys are also arranged in the same pattern as the U.S. keyboard. The keyboard is activated whenever the software requires alphanumeric data to be entered. This depends upon the data-entry field the user pressed. The pressed characters of the keyboard appear in the display of the keyboard. If the set of characters in the display are the intended data to be entered, the user can then press the Enter key. This will then pass the data to the data field. If the user makes a mistake, pressing the left arrow key (in the upper right corner) deletes the entered characters, one at a time starting from the right most character. If the user decides not to enter anything at this time, pressing the ESC key will discontinue the data input and not pass any data to the data field. The keyboard will disappear whenever either the Enter or Esc key is pressed.
3.1.3  **RTP-600xp MAIN ACCESS LEVEL SCREENS**

Once *Log On* is complete the Main Screen for the Access Level chosen will appear. Notice that the functions, which are NOT active for the Access Level chosen, will be lightened so that the printing appears gray and barely visible.

![Main Screenshots](image)

**Figure 3-5. MAIN Screens for Access Level 1, 2, and 3**
3.1.4 **RTP-600xp LOG OFF SCREENS**

Logging Off the RTP-600xp from any of the three password protected levels of system access is accomplished in a similar manner via the Log OFF screens (see Figure 3-5 Log Off Screens). Clicking the Log Off button at the bottom of the Main Screen for any of the Access Levels will cause a message box to appear. This message box allows the user to either click CANCEL to return to the current Access Level or to click OK to complete the Log Off process.

![Log Off Screens for Access Level 1, 2, and 3](image)

Figure 3-6. *Log OFF Screens for Access Level 1, 2, and 3*
SECTION 3  CHAPTER 2

PRODUCTION MODE

The Production Mode is provided for the user who wishes to either RUN a previously created recipe or view the Time/Temperature Profile of the Last Run processed.

3.2.1  PRODUCTION MODE ACCESS FROM MAIN SCREEN

Click [Production] from the Main Menu (see Figure 3-7).

![Main Menu Screen]

Figure 3-7,  Main Menu Screen
3.2.2 PRODUCTION PROCESSING – TC AND PYRO CONTROL RECIPES

By Clicking [Production] from the Main Menu (see Figure 3-7), the Production Screen will appear (see Figure 3-8). This screen is a directory listing of both TC and Pyro control recipes stored in the system.

To Run a TC or Pyro controlled recipe:

1. Click on your desired Recipe File to highlight the recipe for further access.
2. Click [Start Process] to begin recipe. The process controller will use the selected recipe to process the substrate inside the process chamber.

![Production Screen](Image)

Figure 3-8. Production Screen
3. After initializing, the **Process Execution** screen will appear (see Figure 3-9). The **Process Execution** screen shows the process data in real-time. All process parameters are displayed on the screen, both the recipe values and the actual measured values.

![Process Execution Screen](image)

**Figure 3-9. Process Execution Screen**

**Header:** Identification of the process and wafer being processed is displayed at the top of the screen.

**Temperature:** The blue line on the x-y graph depicts the process curve of the temperature vs. time as called for in the selected recipe. As the process progresses, the actual measured temperature is plotted in real time. The actual temperature is plotted in red, while the set point (model) temperature is plotted in green. The instantaneous values of both of these temperatures are also printed numerically at the left hand side of the screen.

**Gas Flows:** The process gas flows are represented as bar graphs on the left hand side of the screen. The numerical value in the middle of each MFC Data Window is the feedback from the MFC for that gas. The gas flows are also plotted on the x-y graph, as percentages of their full flow rates (i.e., for an MFC that is rated at 30 SLPM and is controlling its gas flow at 10 SLPM, the plot is 1/3 of the full scale of the graph, so if the graph full scale is 1,000 °C, the gas plot will be at 333 °C.) The plot colors for the gases are the same as their bar graph colors.
4. Clicking [Cancel] during the run will abort the process and return to the Production Screen.

5. After the process has completed, the words "Process Over" will appear across the screen.

6. Click [Cancel] to return to the Production Screen.
3.2.3 **VIEW LAST RUN SCREEN**

By Clicking [View Last Run] from the Production Screen (see Figure 3-8), the Process Data Display and Analysis screen for the last run processed by the system will appear (see Figure 3-10).

![Process Data Display and Analysis screen](image)

**Figure 3-10. View Last Run Screen**
SECTION 3: CHAPTER 3

ENGINEERING MODE

The Engineering mode is provided for the user who wishes to either CREATE a new recipe or EDIT a pre-existing recipe.

3.3.1 ENGINEERING MODE ACCESS FROM MAIN SCREEN

1. Click [Engineering] from the Main Menu (see Figure 3-11).

2. The Engineering Screen will appear (see Figure 3-12).

![Main Menu Screen](image)

Figure 3-11. *Main Menu Screen*
3.3.2 ENGINEERING SCREEN

This screen allows the user to operate on recipes by either CREATING a new recipe or selecting a recipe from the directory for EDITING, PRINTING, COPYING, DELETING, or VIEWING LAST RUN.

This screen also allows the user to select pre-validated recipes for START PROCESS or Recipe Level PYROMETER CALIBRATION.

Figure 3-12. Engineering Screen
3.3.3 THE “NEW” RECIPE DATA FILE

1. Click [Create/Edit Recipe] from the Engineering Screen.

2. The Recipe Editor Screen for your highlighted Recipe will appear.

3. Click [New] to obtain a blank Recipe Editor Screen (see Figure 3-13).

![Recipe Editor Screen](image)

**Figure 3-13. “New” Recipe Editor Screen**

The “New” Recipe Editor, Figure 3-13, is used to create and edit recipes to be run on the RTP-600xp 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 comments and other information pertinent to the recipe. The lower section (data entry area) is for the process recipe data entry.

In the header, the Process Engineer enters the process Wafer Type, Feedback, the Engineer’s name or initials, and a Title for (or comment about) the process. The type of temperature sensor described here (pyrometer or thermocouple or Open Loop) is the one to be used as the temperature feedback device during the process. This file name can be any legal Windows filename (i.e., the recipe), excluding the path and extension. This field cannot be left as NONAME, for it is used to later recall the recipe.

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3.3.3.1 RECIPE CREATION

A simple cycle recipe may consist of: a starting idle step, ramp (up) step, hold step, ramp (down) step, idle step and stop step. (see Figure 3-14. Simple Process Cycle).

![Simple Process Cycle](image)

Figure 3-14. Simple Process Cycle

Recipe names are stored as filenames on the hard drive. The RTP-600xp system includes a floppy disk drive to download recipes onto a formatted 3.5-inch floppy disk.

The Recipe Editor of the RPT-600xp allows for a straightforward implementation by having a recipe divided into process steps; each step describes the state of the process for a specified amount of time (i.e., up to 50 steps can be specified).

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:

**Step No.** — denotes the step number, and is non-editable.

**Step Function** — denotes the type of process function this step describes. This step can either be a Ramp, Hold, Idle, or Stop. While in the Function column, to select a function simply click on the desired [cell]. A pop-up window will appear with the choices of Ramp, Hold, Idle, Stop, and Cancel. Click the desired function. Once clicked the function will automatically write itself into the pre-selected cell.

**Ramp** — increases the temperature at a constant rate until the desired temperature has been reached. For best process results the gas flow during Ramp is set to the same specified value as in the Hold step. The process
controller cannot do two consecutive Ramp steps, so in multiple ramp recipes the critical ramp must chosen for optimization.

**Hold** -- increases or decreases the controlled parameter as fast as possible until the desired value has been reached, and then maintains that value until the step time has elapsed.

**Idle** -- sets the lamps at "off" while maintaining the gas flow at the specified flow rate for this step.

**Stop** -- ends the entire recipe. This is the last step in the recipe. Once the process controller sees a Stop, it stops all further processing.

**Time (sec)** -- the amount of time to elapse for this step. The time can be from 1 - 9999 seconds, in increments of 1 second. The software will restrict the maximum allowable time as the temperature increases (see table below):

<table>
<thead>
<tr>
<th>Temperature/Deg. C.</th>
<th>Maximum Time/Seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1250</td>
<td>120</td>
</tr>
<tr>
<td>1200</td>
<td>150</td>
</tr>
<tr>
<td>1150</td>
<td>200</td>
</tr>
<tr>
<td>1100</td>
<td>300</td>
</tr>
<tr>
<td>1050</td>
<td>327</td>
</tr>
<tr>
<td>1000</td>
<td>360</td>
</tr>
<tr>
<td>950</td>
<td>400</td>
</tr>
<tr>
<td>900</td>
<td>450</td>
</tr>
<tr>
<td>850</td>
<td>514</td>
</tr>
<tr>
<td>800</td>
<td>600</td>
</tr>
<tr>
<td>750</td>
<td>720</td>
</tr>
<tr>
<td>700</td>
<td>900</td>
</tr>
<tr>
<td>650</td>
<td>1200</td>
</tr>
<tr>
<td>600</td>
<td>1800</td>
</tr>
<tr>
<td>550</td>
<td>3600</td>
</tr>
<tr>
<td>500</td>
<td>2592</td>
</tr>
<tr>
<td>450</td>
<td>3200</td>
</tr>
<tr>
<td>400</td>
<td>4050</td>
</tr>
<tr>
<td>350</td>
<td>5289</td>
</tr>
<tr>
<td>300</td>
<td>7200</td>
</tr>
<tr>
<td>250</td>
<td>9999 (maximum programmable time)</td>
</tr>
</tbody>
</table>

**Temperature (° C)** -- this is the target temperature for this step.

**Gas Line Settings**
1. **Gas 1** -- the value for the flow rate for the first gas of the system.
2. **Gas 2** -- the value for the flow rate for the second process gas
3. **Gas 3** -- the value for the flow rate for the third process gas
4. **Gas 4** -- the value for the flow rate for the fourth process gas
5. **Gas 5** -- the value for the flow rate for the fifth process gas
6. **Gas 6** -- the value for the flow rate for the sixth process gas

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When entering data values into the spreadsheet, the *Recipe Editor* checks for out-of-range entries. If a value is out-of-range, the editor will alert you and will give you the proper range.

After editing has been completed, click [Validate] to validate the recipe. Make any necessary changes if a validation message appears. Re-validate the recipe.

Click [Save] to save the recipe.

Click [Cancel] to return to the *Engineering Screen*.

From the ENGINEERING Screen the computer model of the recipe can be reviewed. Click to graph to enlarge the computer model of the recipe.

The procedure to run a predefined recipe is given in the *Production Mode* chapter in this manual.

The procedure to Minimize Temperature Overshoot/Undershoot by Optimizing Recipe Factors for a predefined recipe is given in the next section.
3.3.3.2 FACTOR OPTIMIZATION

1. Click [Edit Factors] from the Recipe Editor Screen.

2. The Recipe Edit Factors Screen will appear (see Figure 3-15).

![Recipe Edit Factors Screen](image)

Figure 3-15. Recipe Edit "Factors" Screen

RTP-600xp employs a set of factors for closed-loop temperature control. The factors are recipe specific and reside in each recipe. The user can access and modify the factors in recipe editor.
3.3.3.2.1 RECIPE CONTROL FACTOR OPTIMIZATION STRATEGY

It should be pointed out that RTP processing is very sensitive to process environment. In particular, correlation between the temperature of wafer inside the susceptor and the pyrometer reading from susceptor back surface can vary substantially if recipe is run under different starting conditions. You must keep hardware and environment constant and keep wafer-loading time between runs the same.

Factors 1 through 5 take values between 0.01 and 10. The procedure below can be used to determine temperature control factors for a given recipe. It also explains the temperature control methodologies used in this revision.

SPECIAL NOTE: Factor 5 should be tuned before you work on other factors. An optimal value of Factor 5 is obtained when you have smooth connection for the linear intensity increase to the closed-loop ramp up.

1. You may either create a recipe by renaming an existing one and start with the factors for that particular recipe, or set defaults to 1 for all the factors. Run the recipe of your design.

2. Make sure you start your process runs at a consistent condition. For instance,
   a. Warm up the system with the recipe you selected to work on.
   b. Open the door to cool down the substrate. In the meantime, modify the factors as you wish.
   c. Wait until the substrate reaches your pre-selected temperature or your pre-selected post pull out time elapses. When that specific temperature or time is reached, start the next run with the same recipe, or a similar recipe. (The pre-selected temperature or time is often chosen on the basis of how cool the processed material needs to be before it can be re-introduced into the oxygen-rich ambient of the cleanroom without harmful effects.)

3. For susceptor processing, before the RAMP step starts, an "invisible", susceptor warm up step takes place. The lamp intensity is set at the Factory in the System Setup Screen (Pre-Warm Intensity and Pre-Warm Duration).
   a. For 6" OD susceptor and 10°C/sec ramp rate, the System Setup Screen (Pre-Warm Intensity and Pre-Warm Duration) values should be about 3-5% for 5-10sec.
   b. For 4" OD susceptor and 10°C/sec ramp rate, the System Setup Screen (Pre-Warm Intensity and Pre-Warm Duration) values should be about 1% for 5-10sec.

For wafer processing, this warm up step is typically not used.

4. The RAMP step will then start. The lamp intensity will increase linearly from

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an initial value proportional to the ramp rate. The rate of linear increase is proportional to ramp rate and to Factor 5. The linear increase ends when the temperature is within the pre-defined Ramp Change Starting Temp and Ramp Change Ending Temp window, which has been Factory Set on the System Setup Screen.

**IMPORTANT:** Factor 5 should be tuned before you work on other factors. An optimal value of Factor 5 is obtained when you have smooth connection from the linear intensity increase to the closed-loop ramp up.

5. The closed-loop control will then take place for the rest of RAMP until the recipe approaches the HOLD step. Factor 4 is used to modulate system response during the RAMP control. Higher values of Factor 4 can cause oscillation and high noise level. Lower value of Factor 4 can cause excessive temperature undershoot during the ramp.

6. Toward the end of RAMP control and right before the beginning of HOLD, there is a transition step during which the lamp intensity decreases linearly. The duration of the transition step is proportional to Factor 2 and the intensity at the end of transition is proportional to that at the beginning of transition and to Factor 3. Adjust Factor 2 and 3 to optimize the transition.

7. The control response during HOLD is affected by Factor 1. Higher values can cause oscillation and high noise, while lower values result in slow response. Lower values with minimal over shoot or under shoot are preferred. Pyrometer control recipes require very low values of Factor 1 to keep any signal noise from amplifying into the recipe control algorithm.

The control software has been made so that the interactions among the factors are minimal. However certain interactions should still be expected, and iterations in determining the factors may be necessary.
3.3.3.2.2 DEFINITION OF FACTORS

SPECIAL NOTE: Factor 5 should be tuned before you work on other factors. An optimal value of Factor 5 is obtained when you have smooth connection for the linear intensity increase to the closed-loop ramp up.

Factor 1:
Factor 1 affects steady state, or Hold step, temperature control. Higher values result in faster response. However, oscillation can occur with high values.

Factor 2:
Factor 2 strongly influences the transition from Ramp to Hold. It determines the duration of the transition. Higher values can cause under shoot at the beginning of Hold step, while lower values can result in over shoot.

Factor 3:
Factor 3 also strongly influences the transition from Ramp to Hold. It is a multiplier of lamp intensity going from RAMP to HOLD. Low values can cause under shoot at the beginning of Hold step, while high values can result in over shoot.

Factor 4:
Factor 4 affects response in Ramp steps. Low values can cause under shoot, while high values can result in instability.

Factor 5:
Factor 5 controls the rate of increase in lamp intensity during the initial stage of the temperature ramp up. Higher values result in faster rate. An optimal value will lead to a smooth start of closed-loop control in the ramp up.
3.3.3.2.3 **CONTROL FACTORS FOR SAMPLE RECIPES**

The following factor settings work well for the given process:

- **TC Control:**
  - 6" OD Susceptor with Inconel TC
  - TC Calibration with TC-on-wafer
  - Cantilever TC, touch contact

<table>
<thead>
<tr>
<th>Substrate Process</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
<th>F5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Susceptor 400C, R=10C/S</td>
<td>1.0</td>
<td>0.8</td>
<td>0.40</td>
<td>0.8</td>
<td>0.3</td>
</tr>
<tr>
<td>Susceptor 400C, R=20C/S</td>
<td>1.0</td>
<td>0.8</td>
<td>0.30</td>
<td>1.4</td>
<td>0.3</td>
</tr>
<tr>
<td>Susceptor 600C, R=10C/S</td>
<td>1.0</td>
<td>1.0</td>
<td>0.60</td>
<td>0.8</td>
<td>0.3</td>
</tr>
<tr>
<td>Susceptor 900C, R=10C/S</td>
<td>1.0</td>
<td>1.2</td>
<td>0.70</td>
<td>0.8</td>
<td>0.3</td>
</tr>
<tr>
<td>Wafer 400C, R=30C/S</td>
<td>1.0</td>
<td>0.5</td>
<td>0.75</td>
<td>1.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Wafer 600C, R=30C/S</td>
<td>1.0</td>
<td>0.5</td>
<td>0.75</td>
<td>1.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Wafer 700C, R=30C/S</td>
<td>1.0</td>
<td>1.0</td>
<td>0.65</td>
<td>1.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Wafer 900C, R=30C/S</td>
<td>1.0</td>
<td>0.5</td>
<td>0.85</td>
<td>1.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Wafer 1100C, R=30C/S</td>
<td>1.0</td>
<td>0.5</td>
<td>0.85</td>
<td>1.2</td>
<td>0.4</td>
</tr>
</tbody>
</table>

- **Pyrometer Control:**
  - 6" OD Susceptor
  - Silicon Wafer Processing

<table>
<thead>
<tr>
<th>Substrate Process</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
<th>F5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Susceptor 400C, R=10C/S*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Susceptor 400C, R=20C/S*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Susceptor 600C, R=10C/S*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Susceptor 900C, R=10C/S</td>
<td>1.0</td>
<td>1.2</td>
<td>0.70</td>
<td>0.8</td>
<td>0.5</td>
</tr>
<tr>
<td>Wafer 400C, R=30C/S*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Wafer 600C, R=30C/S*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Wafer 700C, R=30C/S</td>
<td>1.0</td>
<td>1.0</td>
<td>0.65</td>
<td>1.2</td>
<td>0.5</td>
</tr>
<tr>
<td>Wafer 900C, R=30C/S</td>
<td>1.0</td>
<td>0.5</td>
<td>0.85</td>
<td>1.2</td>
<td>0.5</td>
</tr>
<tr>
<td>Wafer 1100C, R=30C/S</td>
<td>1.0</td>
<td>0.5</td>
<td>0.85</td>
<td>1.2</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Note that several hardware items can affect processes and thus the factor settings. Factors shown above serve as reference samples. They may vary from system to system. However, same set of factors can be used for both TC control and pyrometer control for a given process.

For wafer processing, pyrometer response to wafer temperature depends on emissivity of wafer back surface. Emissivity varies with wafer type and wafer backside coating. The control factors are expected to change with wafer type. For un-doped silicon wafer without backside coating, optical emission is below the threshold for pyrometer response for temperature below 600C. In that case, pyrometer control can only be achieved for hold temperature above about 700C.

* Pyrometer control is for processes above 700°C

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3.3.3.3 PYROMETER CALIBRATION OVERVIEW

When a pyrometer is used for closed-loop temperature control, calibration needs to be performed to establish correlation between pyrometer signals and thermocouple readings as the reference temperature. RTP-600xp provides two level calibration, system level and recipe level.

3.3.3.3.1 SYSTEM LEVEL PYROMETER CALIBRATION

There are two critical files, which govern system level pyrometer control: SYS_PYRO.WFR and SYS_PYRO.SPT. These files contain system level pyrometer calibration data for wafer processing and susceptor processing, respectively. System level pyrometer calibration is performed before the system is released for delivery. This calibration should be performed by the user when pyrometer change and/or quartz tube change take place. Make sure a thermocouple is properly installed prior to performing the calibration.

Prior to performing system level pyrometer calibration with one of the two SYS_PYRO files, the user should save the current file. Select the file and then enter a different file name and save. The newly named file can be re-instated as the SYS_PYRO file by click SAVE TO SYSTEM. Since SYS_PYRO files can be easily over written this way, the user is advised to save his calibration file to a different name as back up.

System level calibration captures correlation between pyrometer and thermocouple while lamp intensity is increasing. At HOLD step or RAMP step with different ramp rates, the relationship between pyrometer and thermocouple can be different from that obtained during the calibration. For applications where better correlation is needed, recipe level pyrometer calibration can be performed.

3.3.3.3.2 RECIPE LEVEL PYROMETER CALIBRATION

Recipe level pyrometer calibration can be performed for a given recipe with pyrometer control. The user must ensure that a proper TC is installed as the reference temperature for the pyrometer. There are several basic styles of TC. The most common are: (1) the TC Wafer which has the TC embedded directly into a wafer; (2) the Cantilever TC which is in contact with the wafer when running wafer processing; and (3) the Inconel TC which is used with susceptor processing (NOTE: The Inconel TC can be placed so that it is in contact with the wafer in the susceptor or with the susceptor itself).

With thermocouple properly installed, select [Engineering] from the Main Menu the **Engineering Screen** will appear (See Figure 3-12).
Select the recipe, press [Pyrometer Calibration]. Pyrometer Calibration will perform recipe level pyrometer calibration. When the process is completed, a file is created and saved that contains fine correlation between thermocouple and pyrometer for the particular recipe. The correction is applied when the recipe is run by pressing [Start Process]. Note that recipe level calibration is recipe specific. When steps in the recipe are altered by the user, the calibration must be performed again. For a recipe that no PYROCAL has ever been performed, the user can still run the recipe by clicking PROCESS START. However, no recipe level pyrometer correction is applied.
3.3.4 **EDITING AN “EXISTING” RECIPE DATA FILE**

1. Click [Engineering] from the **Main Menu**.
2. The **Engineering Screen** will appear.
3. Click on your desired **Recipe File** to highlight the recipe for further access.
4. Click [Create/Edit Recipe] from the Engineering Screen.
5. The **Recipe Editor Screen** for your highlighted Recipe will appear.

![Recipe Editor Screen](image)

Figure 3-16. **Recipe Editor Screen**

6. After editing has been completed, click [Validate] to validate the recipe.
7. Click [Save] to save the recipe.
8. Click [Cancel] to return to the **Engineering Screen**.
SECTION 3: CHAPTER 4

SPC MODE

The SPC mode provides Process Engineers and Service Personnel with the ability to retrieve a historical record of Time/ Temperature profiles as well as a historical record of System Alarm/ Log In Events.

3.4.1 SPC MODE ACCESS FROM MAIN SCREEN

1. Click [SPC] from the Main Menu Screen

2. The SPC Mode Directory Pop-Up Screen will appear (see Figure 3-17).

![Modular Process Technology Corp.](image)

Figure 3-17. *SPC Mode Directory Pop-Up Screen*

From the SPC Mode Directory Pop-Up screen, the two types of historical data that can be retrieved are displayed. A selection of either Process Data or System Event Log can be made.

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3.4.2 **SPC MODE PROCESS DATA SCREEN**

1. From the **SPC Mode Directory Pop-Up Screen** click [Process Data]

2. The **Historical Process Data File Directory Screen** will appear (see Figure 3-18).

![Figure 3-18. SPC Mode Process Data Screen](image)

The SPC Mode Process Data Screen provides Process Engineers and Service Personnel with the ability to easily retrieve historical Time/ Temperature profiles. On the Process Data Menu Screen, all the recipes that are stored in the system are listed under “Recipe”. Under “Data File”/ “Created Date Time” is a listing in sequence of the individual run data files from the “selected” recipe. On this screen it is also possible to copy the file to Floppy Drive A.
3. Select a process data file to plot. The historical Time/Temperature plot is automatically shown in the Selected File box on the Process Data Screen. By clicking on the graph the Process Data Display and Analysis Screen is displayed (see Figure 3-19).

![Historical Time/Temperature Profile](image)

Figure 3-19. *Historical Time/Temperature Profile*
3.4.3 SPC MODE EVENT LOG SCREEN

1. From the SPC Mode Directory Listing Pop-Up Screen click [Event Log]

2. A Log listing recorded System Events/Alarms will appear (see Figure 3-20).

![RTP600xp](image)

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>04/28/03 09:43:01</td>
<td>Log On</td>
<td>User: MPT, Success</td>
</tr>
<tr>
<td>04/28/03 16:45:50</td>
<td>Log On</td>
<td>User: MPT, Success</td>
</tr>
<tr>
<td>04/25/03 16:05:14</td>
<td>Log On</td>
<td>User: MPT, Success</td>
</tr>
<tr>
<td>04/25/03 15:47:23</td>
<td>Log On</td>
<td>User: MPT, Success</td>
</tr>
<tr>
<td>04/25/03 15:37:44</td>
<td>Log On</td>
<td>User: MPT, Success</td>
</tr>
<tr>
<td>04/25/03 12:19:10</td>
<td>Alarm</td>
<td>Manual: Gas Reading -25.6, out of range 200000.0, by 30.0% or more for over 5 min.</td>
</tr>
<tr>
<td>04/25/03 11:55:37</td>
<td>Log On</td>
<td>User: MPT, Success</td>
</tr>
<tr>
<td>04/16/03 18:27:49</td>
<td>Alarm</td>
<td>Manual: Temperature over/under shoot for 94.150325°C at HOLD.</td>
</tr>
<tr>
<td>04/16/03 14:42:21</td>
<td>Log On</td>
<td>User: MPT, Success</td>
</tr>
<tr>
<td>04/16/03 14:08:11</td>
<td>Alarm</td>
<td>Manual: Temperature over/under shoot for 1.611328°C at HOLD.</td>
</tr>
</tbody>
</table>

![Figure 3-20. Historical System Event/Alarm Log](image)

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SECTION 3. CHAPTER 5

SYSTEM MODE

The SYSTEM mode provides Process Engineers and Service Personnel with the ability to operate the system in a single step mode.

3.5.1 SYSTEM MODE ACCESS FROM MAIN SCREEN

1. Click [System] from the Main Screen

2. The System Mode Directory Pop-Up Screen will appear (see Figure 3-21).

![System Mode Directory Pop-Up Screen](image)

Figure 3-21. System Mode Directory Pop-Up Screen

From the System Mode Directory Pop-Up Screen, the seven types of System User Interface Functions are displayed. A selection of System Setup, Chamber Calibration, Pyrometer Calibration, Diagnostics, Bank Control, Board Test, or Alarm Setup can be made.
3.5.2 **SYSTEM SETUP**

1. From the *System Mode Directory Pop-Up Screen* click [System Setup]

2. The *System Setup Screen* will appear (see Figure 3-22).

![System Setup Screen](image)

**Figure 3-22. System Setup Screen**

The System Setup Screen provides Process Engineers and Service Personnel with the ability to define parameters for Chamber, Wafer Type, Options, and Password.

**WARNING:** Before setting any system item, please make sure to check each specification. Otherwise it will damage system and operator.
Changing values for each field in the *Chamber - System Setup Screen* requires the operator to click on the field. Below is a list of each field and your available options:

<table>
<thead>
<tr>
<th>Field</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas X Enabled</td>
<td>After clicking on the field, this field can be toggled to a yes or no by pressing the space key.</td>
</tr>
<tr>
<td></td>
<td>Comments: This field should be a yes only if the gas is actually connected and being used in process recipes.</td>
</tr>
<tr>
<td>Gas X Name</td>
<td>Left clicking this field activates a pop-up window, you can step through the available gas designators until the desired type is displayed.</td>
</tr>
<tr>
<td></td>
<td>Comments: The type of gas being displayed should be equivalent to MFC type installed in system because software recognizes hazardous gases and ensures certain safety features are enabled.</td>
</tr>
<tr>
<td>Gas X Unit</td>
<td>Left clicking this field allows user to enter unit of measure for MFC flow, which will be displayed in recipe menu. Up to eight characters can be typed to define Gas Flow Volume.</td>
</tr>
<tr>
<td></td>
<td>Comments: Manufacturing uses industry standard designations of SLPM or SCCM.</td>
</tr>
<tr>
<td>Gas X Color</td>
<td>Left clicking this field activates a pop-up Color Scheme window, you can step through the available colors as desired for display during process runs or data acquisition.</td>
</tr>
<tr>
<td></td>
<td>Comments: User can choose any color desired including the same color for each gas if desired.</td>
</tr>
<tr>
<td>Line Frequency</td>
<td>Left click either 50 or 60.</td>
</tr>
<tr>
<td></td>
<td>Comments: the value of the line frequency should be set to regional power specifications.</td>
</tr>
<tr>
<td>Edge Sensor</td>
<td>Left click this field yes or no.</td>
</tr>
<tr>
<td></td>
<td>Comments: For future use, this field should always be set to no.</td>
</tr>
<tr>
<td>Show Water Valve</td>
<td>Left click this field yes or no.</td>
</tr>
<tr>
<td></td>
<td>Comments: For future use, this field should always be set to no.</td>
</tr>
</tbody>
</table>
Show Air Valve  Left click this field yes or no.

Comments: For future use, this field should always be set to no.

Show UV Lamp  Left click this field yes or no.

Comments: For future use, this field should always be set to no.

Show Door Open-Close Status  Left click this field yes or no.

Comments: For future use, this field should always be set to no.

Show Door Lock-Unlock Status  Left click this field yes or no.

Comments: For future use, this field should always be set to no.
3.5.2.2 WAFER TYPE SETUP SCREEN

1. From the System Setup Screen click [Wafer Type]

2. The Wafer Type Setup Screen will appear (see Figure 3-23).

![Wafer Type Setup Screen](image)

Figure 3-23. Wafer Type Setup Screen

The Wafer Type Setup Screen can also be accessed by clicking [Wafer Type] from either the Chamber, Options or Password Setup screens.

This screen allows you to customize certain parameter used by the system during operation.
Changing values for each field in the *Wafer Type - System Setup Screen* requires the operator to click on the field. Below is a list of each field and your available options:

<table>
<thead>
<tr>
<th>Field</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>This field can be changed to desired text describing conditions for usage.</td>
</tr>
<tr>
<td></td>
<td>Comments: The example wafer type setup screen described under wafer and environment of silicon at low temperature under TC Control.</td>
</tr>
<tr>
<td>Max Temp (wafer)</td>
<td>This field can be changed to desired values from 50°C to 1250°C using the number keys.</td>
</tr>
<tr>
<td></td>
<td>Comments: During pyrometer calibration or lamp calibration, this value should be set to 1250°C, but then reduced to 50–100°C higher than highest process temperature engineer plans on running. By limiting this value, the engineer ensures untrained operators cannot make recipes for wafers higher than specified value chosen and during manual modes will shut down if value is surpassed.</td>
</tr>
<tr>
<td>Max Temp (susceptor)</td>
<td>This field can be changed to desired values from 50°C to 1250°C using the number keys.</td>
</tr>
<tr>
<td></td>
<td>Comments: During pyrometer calibration or lamp calibration, this value should be set to 1050°C, but then reduced to 50–100°C higher than highest process temperature engineer plans on running. By limiting this value, the engineer ensures untrained operators cannot make recipes for susceptors higher than specified value chosen and during manual modes will shut down if value is surpassed.</td>
</tr>
<tr>
<td>Pre-Warm Intensity</td>
<td>This field can be changed to increase or decrease percentage intensity used for preheating oven during process runs.</td>
</tr>
<tr>
<td></td>
<td>Comments: Normally used when substrate is of a high mass to overcome thermal inertia. Typical value for wafer is zero %. Typical value for susceptor is 5%.</td>
</tr>
<tr>
<td>Pre-Warm Duration</td>
<td>This field can be used to increase or decrease duration of PreWarm intensity.</td>
</tr>
<tr>
<td></td>
<td>Comments: Larger values are typical for large mass substrates. Typical value for wafer is zero seconds. Typical value for susceptor is 10 seconds.</td>
</tr>
</tbody>
</table>

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Ramp Change Starting Temp  This field can be increased or decreased based upon initial recipe ramp rate and Model/Real temperature correlation.

Comments: Ramp Change starting temperature and Ramp Change ending temperature is the range that the software will switch from open loop control to closed loop control. Typical value for Wafer is 200C. Typical value for Susceptor is 240C.

Ramp Change Ending Temp  This field can be increased or decreased to allow for larger or smaller margin for open loop to closed loop control change over.

Comments: Ramp Change starting temperature and Ramp Change ending temperature is the range that the software will switch from open loop control to closed loop control. Typical value for Wafer is 250C. Typical value for Susceptor is 280C.

Temp Alarm Tolerance  This field can be increased or decreased to alert user when Temperature deviation is greater than value chosen.

Comments: Typical value for Wafer and Susceptor is 50C.

Gas Alarm Tolerance  This field can be increased or decreased to alert user when gas pressure falls below tolerance desired.

Comments: Typical value 30%. 
3.5.2.3 OPTIONS SETUP SCREEN

1. From the System Setup Screen click [Options]

2. The Options Setup Screen will appear (see Figure 3-24).

![Options Setup Screen](image)

Figure 3-24. Options Setup Screen

The Options Setup Screen can also be accessed by clicking [Options] from either the Chamber, Wafer Type, or Password Setup screens.

This screen allows you to choose your default printer path for print operations in other menus.
3.5.2.4 PASSWORD SETUP SCREEN

1. From the System Setup Screen click [Password]

2. The Password Setup Screen will appear (see Figure 3-25).

![Password Setup Screen]

**Figure 3-25. Password Setup Screen**

The Password Setup Screen can also be accessed by clicking [Password] from either the Chamber, Wafer Type, or Options Setup screens.

This screen allows you to administrate Users/Passwords as well as User Access privileges.
3.5.3 CHAMBER CALIBRATION - DONE AT THE FACTORY

The Chamber Calibration Screen provides TRAINED FACTORY Service Personnel with the ability to calibrate the Chamber automatically.

1. From the System Mode Directory Pop-Up Screen click [Chamber Calibration]
2. The Chamber Calibration Setup Screen will appear (see Figure 3-26).

![Figure 3-26. Chamber Calibration Setup Screen](image)

DO NOT ATTEMPT THIS ON YOUR OWN

The Lamp Calibration SETUP screen allows the FACTORY SERVICE REPRESENTATIVE to automatically calibrate the lamps for the chamber within a settable temperature range.

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3.5.3.1 **THE CHAMBER (LAMP) CALIBRATION SCREEN**

Calibration of the chamber is necessary so that the temperature control software understands the thermal dynamics of the process wafer as the RTP chamber heats it.

When Chamber (Lamp) Calibration is invoked with [Calibration], the Chamber (Lamp) Calibration process will not start until the Initial Temperature (settable in the Chamber Calibration Screen) is met. A suggested temperature is 200°C. If it is below 200°C, the lamp intensity will start to increase till the temperature reaches 200°C. The calibration then starts. If the starting temperature is above 200°C, the system will wait till it reaches 200°C before the calibration starts.

Any existing Chamber (Lamp) calibration file can easily overwrite the system calibration files, SYS_LAMP.SPT and SYS_LAMP.WFR, when Save-To-System is selected in the Edit screen. When conducting chamber (lamp) calibration, you should use a different file name and select [Save]. Later, if you decide to make it SYS_LAMP.SPT or SYS_LAMP.WFR, simply select [Save-To-System]. This way you always have a back-up file.

When doing lamp calibration with a susceptor, use the following settings:
- Maximum Temp = 1000°C or less
- Initial Temp = 200°C
- End Temp = 1000°C or less
- Gas – Nitrogen 3.0

When doing lamp calibration with a wafer, use the following settings:
- Maximum Temp = 1250°C or less
- Initial Temp = 210°C
- End Temp = 1000°C or less
- Gas – Nitrogen 3.0
3.5.3.2 LAMP CALIBRATION PROCEDURE

During the lamp calibration procedure, either the Pyrometer or a TC can be used as the MASTER Indicator of Temperature. The RTP-600xp temperature control hardware will use the temperature information so that the temperature control software understands the thermal dynamics of the process wafer as it is heated by the RTP chamber.

It is important that the chamber configuration be as close as possible to the actual configuration that is in use during customer processing. Use the same temperature control method, the same type of wafer, and the same type of internal chamber items (susceptor with lid for example) that will be used when processing your “real” wafers.

NOTE: Always run nitrogen purge gas during this procedure.

1. Make sure the quartz isolation tube and quartz tray are clean. Any opacity of the tube or tray will affect pyrometer readings.

2. Make sure that all hardware and facility conditions are stable.

3. Make sure that the configuration inside the chamber is as close to that to be used with “real” wafers as possible.

4. Make sure that the temperature control device is properly installed (if a TC is used) or properly calibrated (if the pyrometer is to be used).

5. From the MAIN Screen, click [Chamber Calibration] the Chamber Calibration Screen will appear.

6. Select the file to overwrite or create a new file.

7. From Chamber (Lamp) Calibration Screen, verify settings

8. Click [Calibration] to begin Chamber (Lamp) Calibration.

9. At the completion of the Lamp Calibration the Lamp Calibration Screen will appear. Press [Save] to save file to the directory. If you wish to also overwrite the system file, Press [Save to System].

10. Press [Cancel] to return to the MAIN Screen.
3.5.3.3 **VIEW COEFFICIENTS**

1. From the *Chamber Calibration Screen* click [View Coefficients]
2. The *Chamber Calibration Screen* will appear (see Figure 3-27).

![Chamber Calibration Screen](image)

**Figure 3-27. Chamber Coefficients Screen**

This screen is used to view coefficients that are used by the system's temperature control algorithms.
3.5.3.3 **VIEW CURVE**

1. From the *Chamber Calibration Screen* click [View Curve]

2. The *Lamp Calibration Graphics Display Screen* will appear (see Figure 3-28).

Clicking the [View Curve] button on the CHAMBER CALIBRATION screen will allow you to view the following post chamber lamp calibration screen for each file selected.

![Typical Lamp Temperature vs Intensity Curve](image)

Figure 3-28. **TYPICAL LAMP TEMPERATURE VS INTENSITY Curve**

This screen is a visual depiction of Energy/Temperature transfer at different intensities.
3.5.4 PYROMETER CALIBRATION

The Pyrometer Calibration Setup Screen provides Process Engineers and Service Personnel with the ability to
- SELECT/De-SELECT previously created System Control Pyrometer Calibration files,
- Create NEW Pyrometer Calibration files, and
- VIEW previously created System Control Pyrometer Calibration files.

1. From the System Mode Directory Pop-Up Screen click [Pyrometer Calibration]

2. The Pyrometer Calibration Setup Screen will appear (see Figure 3-29).

![Pyrometer Calibration Setup Screen](image)

Figure 3-29. Pyrometer Calibration Setup Screen

The pyrometer should be calibrated whenever the System Electronic Boards or the pyrometer have been replaced or when process results indicate a lack of correspondence between actual temperature and programmed temperatures.

**NOTE:** Process results can also be affected by dirty quartz or bad process.

**NOTE:** Process results can also be affected by system hardware or facility changes.

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3.5.4.1 PROCESS WAFER PYROMETER CHECK

To verify the accuracy of the pyrometer and associated circuits, a Process Verification Wafer is annealed, and then checked for proper results. During the procedure, care should be taken that contamination does not occur.

Each customer must choose wafer type, system configuration and process conditions consistent with their own system usage. The important point is that the Process Verification Wafer Anneal Results are repeatable and consistent with their own historic internal RTP-600XP Time/Temperature/Ramp Rate/Ambient recipes. In a properly calibrated system Process Results will be the same for either TC controlled or Pyrometer controlled recipes.

The wafer should have the same diameter and backside as the wafers that will be processed after the check. The Process Verification Wafer is annealed, and then checked for the proper resistivity.

NOTE: Anneal results can be affected by dirty quartz or bad process.

NOTE: Anneal results can also be affected by system hardware or facility changes.

- Typical changes in hardware which require pyrometer calibration include, but are not limited to the following: when wafer size is changed, or tray type/size is changed, or when temperature control electronic hardware is changed.

- Typical changes in facility parameters that require pyrometer calibration include, but are not limited to the following: when the temperature of the constant temperature Oven Cooling Water is changed, or when the Lamp Cooling CDA/N2 pressure, flow or temperature is changed.

The Process Wafer Pyrometer check procedure is as follows:

Step 1 Clean the oven quartzware. This ensures there will be no Contamination of the test wafer, and that no contaminated material will affect the transparency of the isolation tube.

Step 2 Install the test wafer on the tray, as you would do for a standard process. This ensures there will be no contamination of the test wafer, and that no contamination material will affect the transparency of the isolation tube.

Step 3 Using pyrometer control, anneal the wafer using Process
Verification Time/Temperature/Ramp Rate/Ambient recipe.

**Step 4** After the wafer has cooled, measure and record anneal result.

If the anneal result is not correct and the uniformity specification for the wafer is acceptable then the pyrometer requires calibration.

**Note:** If results are close, then a recipe calibration needs to be performed instead of a system calibration.
3.5.4.2 PYROMETER CALIBRATION SCREEN

The Pyrometer Calibration Setup Screen allows the user to perform calibration of the pyrometer with either a standard or specific wafer. A standard wafer calibration is usually performed first as a reference using a bare substrate wafer, and then a specific wafer calibration can be performed using a wafer with a specific set of process layers. Before starting any pyrometer calibration, first select a Wafer Type from a list of existing Wafer Types. To select a Wafer Type, select the blank area to the right of Wafer Type and a pull-down list will appear listing all of the Wafer Types.

Enter the maximum temperature that the specific calibration will reach, based on the maximum temperature to which the specific wafer will be exposed during the actual processing. Enter this temperature value, in °C, in the box below Max Temp.

Enter the desired value for Initial Intensity.

Enter the desired value for Intensity Step.

Select either Nitrogen or Argon as the Process Calibration Gas. Next, enter the desired flow rate. The Process Gas Flow Rate Set Point needs to be between 2-3 SLPM (2000-3000 sccm). The Flow Rate should be the same as that used with your standard annealing recipes during the RAMP and HOLD steps.

When pyrometer calibration is invoked with [Calibration], the calibration process will not start if the starting temperature is not at 148°C. If it is at below 148°C, the lamp intensity will start to increase till the temperature reaches 148°C. The calibration then starts. If the starting temperature is above 148°C, the system will wait till it reaches 148°C before the calibration starts.

Any existing calibration file can easily overwrite the system calibration files, SYS_PYRO.SPT and SYS_PYRO.WFR, when Save-To-System is selected in the Edit screen. When conducting pyrometer calibration, you should use a different file name and select [Save]. Later, if you decide to make it SYS_PYRO.SPT or SYS_PYRO.WFR, simply select [Save-To-System]. This way you always have a back-up file.

When doing pyrometer calibration with a susceptor, use the following settings:

Intensity Step = 0.5
Gas – Nitrogen 3.0
Intensity Init = 5
Maximum Temp = 1000°C or less

When doing pyrometer calibration with a wafer, use the following settings:

Intensity Step = 0.1-0.2
Gas – Nitrogen 3.0
Intensity Init = 0
Maximum Temp = 1250°C or less
3.5.4.3 PYROMETER CALIBRATION PROCEDURE

During the pyrometer calibration procedure, a TC will be used as the MASTER Indicator of Temperature. The RTP-600XP temperature control hardware will use the temperature information from the TC to calibrate the Pyrometer.

There are three basic TC configuration for the RTP-600XP:
- A single point K-Type TC wafer
- A single point K-Type inconel sheathed TC used with susceptors
- A single point K-Type Cantilever TC

It is important that the TC be as close as possible to the actual configuration that is in use during customer processing. If it is not, an offset will be introduced between the calibrated pyrometer temperature and the actual process temperature. This offset will then have to be compensated by making adjustments in the Time/Temperature recipe to match previously determined process results.

NOTE: Always run nitrogen purge gas during this procedure.

1. Make sure the quartz isolation tube and quartz tray are clean. Any opacity of the tube or tray will affect pyrometer readings.

2. Make sure that all hardware and facility conditions are stable.

3. Verify that the TC is correctly installed for the configuration chosen and that the TC Quick Connector is plugged into the door (screw heads facing up).

4. From the MAIN Screen, Click [Pyrometer Calibration]. The Pyrometer Calibration Screen will immediately appear.

5. Select the file to over write or create a new file.

6. From Pyrometer Calibration Screen, verify settings


8. At the completion of the Pyrometer Calibration the Pyrometer Calibration Screen will appear. Click [Save] to save file to the directory. If you wish to also over write the system file, Click [Save to System].

NOTE: If many different types of material are being used, then use the recipe editor to specify which pyrometer calibration file should be used.

Click [Cancel] to return to the MAIN Screen.
3.5.4.3 PYROMETER CALIBRATION “VIEW” SCREEN

The Pyrometer Calibration View Screen provides Process Engineers and Service Personnel with the ability to visually review the post calibration data.

1. From the Pyrometer Calibration Screen click [View]

2. The Pyrometer Calibration Graphics Display Screen will appear (see Figure 3-30).

![Pyrometer Calibration Graphics Display Screen](image)

Figure 3-30. Pyrometer Calibration Graphics Display Screen
3.5.5 **DIAGNOSTICS**

1. From the *System Mode Directory Pop-Up Screen* click [Diagnostics]

2. The *Diagnostic Screen* will appear (see Figure 3-31).

The System Diagnostics mode provides Process Engineers and Service Personnel with the ability to operate the system in a single step mode.

![System Diagnostics Screen](image)

**Figure 3-31. System Diagnostics Screen**

It is possible to damage the system if the user does not follow proper safety precautions with the gases and temperature.

**WARNING:** Do not exceed a steady state temperature >1250° C. A melting substrate will destroy the quartz tray and tube. The high temperature can also do other damage to the chamber itself.

**WARNING:** Do not exceed a combined Gas Flow of 30SLPM or 30,000 sccm. Quartz may break due to overpressure.
The System Diagnostics screen (see Figure 3-31. **System Diagnostics Screen**) is used to verify the proper operation of each device in the RTP–600xp independently of the other devices. Each gas flow and the over-all lamp power can be manually set to any desired value within the limits of the device.

To flow gas, select desired gas button. Green color means that the gas flows successfully and Red color means that the gas does not flow. To adjust gas flow rate, you can increase or decrease gas amount with left/right arrow key.

It is possible to select temperature measurement with either pyrometer or thermocouple.

It is possible to select Wafer, Susceptor, or Custom substrate material.

It is possible to alter the lamp intensity value by pressing either the upper or lower sections of the long stick bar. If you want a Zero intensity value, press the INTENSITY ZERO button.
3.5.6 **BANK CONTROL**

The Bank Control Screen provides Process Engineers and Service Personnel with the ability to operate the RTP-600xp system in a single step mode and isolate each bank of lamps.

1. From the **System Mode Directory Pop-Up Screen** click [Bank Control]
2. The **Bank Control Screen** will appear (see Figure 3-32).

![Bank Control Screen](image)

Figure 3-32. **Bank Control Screen**

From the above screen displays we can determine that all four lamps of lamps are operational.

**NOTE:** An indicator of a defective bank is when existing recipes start having large undershoots and poor temperature control.

It is recommended to test each bank after each system POWER ON sequence.

**DO NOT LOWER PULSES BEYOND 7000**

**WARNING:** The **Bank Control Screen** provides Factory or Certified Service Personnel with the ability to visually monitor the LOW LEVEL turning on of the system’s Lamps.
3. The **Bank Control** (functionality check).

   a. Each bank is controlled by increasing or decreasing the number of pulses sent through its corresponding circuit. For example:
      
      i. On the **Bank Control** screen, set bank value by clicking appropriate **[Increase/Decrease]** button and perform test with set value, by clicking appropriate **[Test]** button. At the top of the screen there are **[All Bank ----]** buttons which allow the testing of the lamp banks all at once.
      
      ii. A larger decrease in pulses corresponds to a higher intensity each lamp will output and therefore the temperature will rise inside chamber.
      
      iii. To turn lamps off, press the corresponding bank **[Increase]** button until set value reaches max value (7500) again or click **[Stop/Reset]** button to automatically stop all operations. To continue, click the bank **[Test]** button again.

   b. Each individual bank, as well as the ALL bank function, operates in the same manner as stated above.

   **Note:** Lamps will not turn on if Power On Button hasn't been engaged and Top Cover Interlock Switch hasn't been set as well as ensuring water flow is above 2.0 gal/ min.

**WARNING:** Decreasing the Bank Counter to less than 7,000 pulses can cause damage if left on for any length of time due to no lamp cooling gas flow. This test is an on/off check. If lamps appear to be on without reduction of pulses, then exit screen immediately and consult your service representative.
3.5.7 **BOARD TEST**

The Bank Control Screen provides Process Engineers and Service Personnel with the ability to operate the RTP-600xp system in a single step mode.

1. From the **System Mode Directory Pop-Up Screen** click [Board Test].

2. The **Board Test Screen** will appear (see Figure 3-33).

![Board Test Screen](image)

**Figure 3-33. Board Test Screen**

On the above screen, we can see digital/analog signal values of the A/D-D/A board.

Looking at the A/D, D/A signal display, we can visibly check the A/D –D/A board.

**WARNING:** This level of access is not recommended for normal system operational check. It is only supplied to help troubleshoot non-routine problems that may arise. If the operator does not take special precautions, the machine can be severely damaged, along with severe injury to people and equipment around machine.
3.5.8 ALARM SETUP

The Alarm Setup Screen provides Process Engineers and Service Personnel with the ability to operate the RTP-600xp system in a single step mode.

1. From the System Mode Directory Pop-Up Screen click [Alarm Setup].

2. The Alarm Setup Screen will appear (see Figure 3-34).

![Alarm Setup Screen]

**Figure 3-34. Alarm Setup Screen**

On the Alarm Setup screen, we can review the different types of Alarm Names that are available as well as view Alarm actions when specific Alarm Events occur.

In the example above, if a Gas Flow Error occurs all gases and lamps will be shut off.

To view the system action during an Alarm Event:

Step 1. First select the Alarm Name by using the Pop-up screen.

Step 2. Next click the Alarm Name Display Window.

Step 3. Finally, view the Alarm Actions boxes. The actions activated by the Alarm Event will be indicated by check marks in the appropriate boxes.
SECTION 3: CHAPTER 6

HELP MODE

The HELP mode provides Process Engineers and Service Personnel with the ability to review electronically the RTP-600xp manual directly from the system.

3.6.1 HELP MODE ACCESS FROM MAIN SCREEN

1. Click [Help] from the Main Screen

2. The RTP-600xp Manual Screen will appear (see Figure 3-35).

Figure 3-35. RTP-600xp Manual Screen
4.1.1 HEATING CHAMBER

The heating chamber contains upper and lower banks of high intensity, tungsten-halogen lamps (see Figure 4-1). There are 10 lamps on the top and 11 lamps on the bottom. The lamps emit radiant energy to heat the wafer. At low temperatures the wafer absorbs visible light, and at high temperatures it absorbs infrared radiation.

Figure 4-1. Heating Chamber and Components

Proprietary reflective plating on the oven walls intensifies the effect of the lamps. This plating reduces the lamp intensity needed for processing at high temperatures, thereby increasing the life of the lamp. The plating also enhances heating uniformity and ramp-up speed.
4.1.2 CLOSED-LOOP TEMPERATURE CONTROL

The RTP-600xp temperature control system is a responsive closed-loop temperature monitoring system. The temperature of the wafer is monitored using a pyrometer or a thermocouple (TC).

![Temperature Signal Block Diagram](image)

**Figure 4-2. Temperature Signal Block Diagram**

The TC signal is fed to the TCN Box, where it is linearized and scaled, and then to the Analog Board; the Pyrometer signal goes directly to the Analog board (NOTE: A TC/Pyro Amplifier/Filter Board set conditions the signals prior to passing onto Analog board). The Analog Board performs A-D conversion, and the digitized signals are sent to the Controller, where time-temperature values are stored. The Controller sends command signals to the Lamp Control Circuitry, which controls the lamp intensities.

The system contains the following printed circuit boards: Controller Board, Analog/Filter Board set, TC/Pyro Board, and Lamp Control Circuitry consisting of a Timer Board, OCB Board, and Zero-Crossing Board. All of these boards are in the system cabinet, behind the front panel distributed appropriately on both the Computer side and the Oven section. The Analog Board performs the A-D conversions and transfers signals from the temperature sensors to the Controller. The Timer Board receives lamp intensity data from the Controller for the purpose of controlling the firing of the SCR feeding power to each lamp. The OCB Board is the interface between the lamps and the Timer Board. The Zero-Crossing Board detects the AC-voltage as each alternation crosses through zero volts, when it signals the Timer Board to start counting. When the Timer Board finishes counting it tells the OCB Board to fire the lamp's SCR.
4.2.1 USES OF THE PYROMETER & THERMOCOUPLE

The RTP-600xp system has two types of temperature monitoring devices: a pyrometer and a thermocouple.

The thermocouple is used below 800° C for silicon wafer processing and below 950° C for susceptor processing.

4.2.1.1 The Pyrometer

The pyrometer design is proprietary and is noted for its fast response time and low service requirements.

The pyrometer is attached to the bottom plate of the oven. The pyrometer remains permanently in place, even when not in use. Radiation from the wafer reaches the pyrometer by passing through the bottom of the transparent quartz tube and through a small opening in the oven floor. The pyrometer converts light energy to a voltage.

The Extended Range Pyrometer (ERP\textsubscript{PLUS}) is a dual infrared detector, which provides accurate and consistent temperature measurement during rapid thermal processing of semiconductor wafers. The ERP\textsubscript{PLUS} measures wafer temperature by detecting infrared radiation emitted from the wafer at specified wavelengths. The resulting signal is then adjusted for non-wafer radiation sources.

During extended heating cycles, the temperature of the RTP quartz tube gradually increases and distorts pyrometer temperature measurement. To insure consistently accurate temperature measurements throughout all phases of the heating cycle, the quartz tube is cooled with compressed air, which maintains its temperature within a specified range.

However, wafer temperature measurement is a complex issue, requiring consideration beyond merely cooling the pyrometer and quartz tube. To accurately measure wafer temperature inside an RTP heating chamber, undesired radiation emitted from non-wafer sources must be compensated for or filtered out. Sources of undesired radiation include the tungsten-halogen heating lamps and infrared energy emitted from the quartz tube.
Figure 4-3. *Radiation Distributions*

Figure 4-3 shows one example (900°C Silicon Wafer processing) of the distribution of each primary source of radiation within the heating chamber.

The ERPPLUS incorporates a band pass filter, operating in a proprietary range, to eliminate the measurement of wavelengths shorter than a specified cutoff wavelength. This minimizes the effects of radiation from the tungsten halogen lamps.
PYROMETER PLACEMENT:

The internally cooled extended range pyrometer (ERP+) is attached to the bottom plate of the oven. The pyrometer remains permanently in place, even when not in use. Radiation from the wafer reaches the pyrometer by passing through the bottom of the transparent quartz tube and through a small opening in the oven floor. The pyrometer converts light energy readings to a voltage.

Figure 4-4. *INSTALLED PYROMETER Photograph*
4.2.1.2 The Thermocouple

The TC assembly is used for several functions in the RTP-600xp.

- Calibrating the system pyrometer
- Susceptor processing for temperatures under 950°C
- Wafer processing for temperatures under 800°C
- Calibrating individual pyrometer recipe files

The K-type thermocouple is situated inside the quartz tube. Thermocouple life is shortened by operations at temperatures higher than 950°C or with the use of process gases other than inert gases such as Nitrogen or Argon.

The thermocouple should be removed and the calibrated pyrometer should be used for temperature measurement above 800°C for silicon wafer processing or 950°C for susceptor processing.

The thermocouple assembly can be of the following types:

- Cantilever TC Assembly: This type is a 10-mil type K chromel-alumel bead thermocouple in direct contact with the backside of the wafer. The thermocouple is held against the wafer by two spring wires, which also serve as the thermocouple leads. The Cantilever thermocouple is distinguished by its use of the small thermocouple bead. The Cantilever TC Assembly is used both for the calibration of the pyrometer and the day-to-day temperature controlling of the system running wafer processes below 950°C.

- TC Wafer Assembly: This is a type K chromel-alumel thermocouple that is cemented to a wafer. The cement used is sodium-free ceramic cement. The TC Wafer assembly is used both for the calibration of the pyrometer and the day-to-day temperature controlling of the system running R&D pieces set upon its surface.

- Inconel TC Assembly: This is a type K chromel-alumel thermocouple that is sheathed in Inconel. This assembly is used with the susceptor process.

For thermocouple assemblies, the two thermocouple wires run through a ceramic/or “other insulating material” tube to a specialized type K connector on the inside of the oven door. The wires are run through gas-tight seals in the door to a terminal block on the front of the door, inside the faceplate.

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 per degree centigrade. The signal is digitized (see Section 4.1.2) and sent to the Controller for the temperature control system.
4.2.2 **SELECTION OF TEMPERATURE MONITOR**

To select the type of temperature sensor to be used (pyrometer or thermocouple), use the RTP-600xp Recipe Editor Screen, Lamp Calibration Screen or the System Diagnostics Screen.

4.2.3 **THERMOCOUPLE INSTALLATION AND PERFORMANCE CHECK**

The TC assembly may be used in place of the pyrometer for the measurement of oven temperature.

4.2.3.1 **Installing the Thermocouple**

Wear latex (or other protective) gloves whenever you are handling oven quartzware or TCs (NOTE: gloves are necessary to protect the quartzware and TCs from the contamination that occurs when either the quartzware or TCs come into contact with the organics and mineral salts from our human bodies. These human materials are known to be destructive to most devices and materials that would normally be heated in the RTP unit). When the thermocouple is installed, its operation should be checked before it is used for processing wafers.

4.2.3.2 **Checking Thermocouple Operation**

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

Step 2. From the *Main* screen go to the *System Diagnostics* screen.

Step 3. Insure that the TC Assembly is installed correctly (See Section 4.2.4 for Drawings Showing Installed TC Assemblies).

Step 4. Enable the lamps, and increase the lamp intensity to 15%.

Step 5. Observe the temperature feedback of the thermocouple display

Step 6. Upon successful monitoring of temperature feedback the system is ready for TC controlled processing.

**NOTE:** Ensure door is closed, all interlocks are enabled, water is flowing and Power-On button has been engaged. Failure to do this will prevent lamps from coming ON.
4.2.4 **Drawings of showing Installed TC Assemblies**

Drawing showing Modular Process Technology’s single point K-type instrumented TC wafer installed in a RTP-600xp.

![Diagram of TC wafer installation](image)

**Figure 4-5. Single point K-type instrumented TC wafer installed in RTP-600xp**

*N*OTE: When using the TC Wafer Assembly, it is best to use a process specific customer wafer with the exact process front side and backside conditions. For the customer TC wafer, place the backside of the TC wafer toward the pyrometer.

When a customer wafer TC Assembly is not available, a TC Assembly made using a prime wafer of the same process material as is used by the customer is an excellent alternative. For the Prime Wafer TC wafer, place the polished surface of the TC wafer toward the pyrometer. This allows for consistent results over multiple TCs used over multiple months or years because the results are not influenced by the backside condition of the TC wafer.
Drawing showing Modular Process Technology's single point K-type Inconel TC Instrumented susceptor TC installed in a RTP-600xp.

Figure 4-6. *Single point K-type Susceptor Inconel TC installed in RTP-600xp*

Drawing showing Modular Process Technology's single point K-type Cantilever TC installed in a RTP-600xp.

Figure 4-7. *Single point K-type Cantilever TC installed in RTP-600xp*
SECTION 4: CHAPTER 3
QUARTZWARE SERVICE

4.3.1 INTRODUCTION

The quartz tray and quartz tube may need to be removed for cleaning if they become contaminated. The tube and tray are easily inspected for material build-up from process by-products occurring during heating cycles. The visual inspection of the tray is done when the door is OPENED. Use a flashlight to inspect the tube (Typically the material build-up is on the top inside of the tube directly over the wafer/susceptor). A severely contaminated tube will decrease the amount of energy reaching the wafer. Any opacity will reduce radiated energy reaching the pyrometer and affect temperature measurement.

This section describes the procedure for removing and installing the quartz tray and quartz tube for routine cleaning or replacement.
4.3.2 QUARTZWARE REMOVAL

Tools and Supplies:
- Allen wrench set (US type)
- Phillips screwdriver
- Latex gloves
- 0.050 Allen head wrench
- 7/64 Allen head wrench

WARNING: Make sure the wall circuit breaker for the RTP-600xp is off and be sure the system is cool before handling.

CAUTION: Always use latex gloves when handling quartz ware.

There are two sub-sections in the Quartz Removal Segment of the Manual.

- Quartz Isolation Tray Removal
- Quartz Isolation Tube Removal

Procedures for each are given below.
4.3.2.1 Quartz Isolation Tray Removal

Step 1. Shut off power from the system. If a thermocouple is not being used, go to Step 3.

Step 2. Open the oven door and pull it out half way. Put on latex gloves. Disconnect the thermocouple at the terminals on the inside of the oven door. Remove and store Thermocouple.

Step 3. Pull the oven door fully out. Put on latex gloves. Use 0.050 Allen head wrench to push door flange o-ring forward/out of the way (without damaging the o-ring) and then loosen the two tray set-screws (see Figure 4-8).

Step 4. Lift out the quartz tray, taking care not to strike the tray against the oven door or any other hard object (Note: Store the tray on a clean surface, preferably of quartz).

![Diagram of Quartz Isolation Tray](image)

**Figure 4-8. Leveling Screw Locations**
4.3.2.2 Quartz Isolation Tube Removal

Step 1 Remove the top cover of the system cabinet by first removing the Top Cover screws (see Figure 4-9) and then lifting on the rear of the cover and lifting the complete cover upward.

Step 2 Remove two front panel screws located at bottom left front and bottom right front of unit (see Figure 4-9). Note: Ensure oven door is open at least half way before proceeding to next step.

Step 3 Remove front panel / divider panel screw located at top front off center to left of unit (see Figure 4-9). Now the front panel should be able to swing forward towards the front door.

Figure 4-9. System Cabinet showing Screw Locations
Step 4. After swinging the front panel forward about 30 degrees, you should be able to see two water tubes and an exhaust tube connected to the middle top of the front flange (see Figure 4-10). Using a 7/64-rounded head Allen wrench, remove the two screws that hold the exhaust tube to the front flange. Note: There is a black o-ring that seals the exhaust tube to the flange and it should stay in place during replacement, but care should be taken not to knock it out.

Step 5. Remove the eight flange screws on the door flange plate (see Figure 4-10) in a star pattern. Start from center and continue moving towards the edge. Note: Remove screws ¼ of a turn at a time. Be careful not to drop the O-ring inserted in the groove on the surface of the plate. Flip the flange up between the front panel and oven and let rest on the top of oven. Then push the front panel back into original position and replace screw on divider panel. This will hold flange in place while you replace the tube.

Figure 4-10. Front Flange Screw Location
Step 6. Un-screw gas connector fitting located at rear of oven (see Figure 4-11). (Note: A nipple on the rear of the quartz tube fits into an O-ring in the gas connector which seals the quartz to gas inlet. The actual bracket that screw into the oven is purposely left loose to prevent alignment stress.)

Figure 4-11. Rear Access To Quartz Isolation Tube
Step 7. Gently press the nipple forward to loosen the quartz tube while at the same time place your other hand inside tube until tube glides freely. Once free from gasket seal, slowly/horizontally pull tube out of the front of the unit (see Figure 4-12).

**WARNING:** Do not bump tube against the chassis or heat lamps while removing.

![Diagram of removing the quartz isolation tube]

**Figure 4-12. Removing the Quartz Isolation Tube**
4.3.3 QUARTZWARE INSTALLATION

Tools and Supplies:
- Allen wrench set (US type)
- Phillips screwdriver
- Latex gloves
- 0.050 Allen head wrench
- 7/64 Allen head wrench

WARNING: Make sure the wall circuit breaker for the RTP-600xp is off and be sure the system is cool before handling.

CAUTION: Always use latex gloves when handling quartz ware.

There are two sub-sections in the Quartz Installation Segment of the Manual.

- Quartz Isolation Tube Installation
- Quartz Isolation Tray Installation

Procedures for each are given below.
4.3.3.1 Quartz Isolation Tube Installation

Step 1. Examine the O-ring on the heating chamber flange surface. If it is damaged or burned, replace it.

Step 2. Install the quartz tube by inserting it straight back into the heating chamber. The quartz tube contains a small window. The tube should be inserted with the window on the bottom (see Figure 4-13).

Figure 4-13. Installing the Quartz Isolation Tube

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

Step 3. When the tube is fully inserted, wiggle it slightly to ensure that it is fully positioned on the inner O-ring. The front lip of the tube should then be flush with the outer surface of the oven flange.
Step 4. Inspect the O-ring on the outer flange plate. Check it for damage or wear. Replace it if necessary.

Step 5. Once tube is in place, remove front panel/divider panel screw (see Figure 4-14) and hold front flange that is resting on oven while you pull front panel forward 30 degrees. Now slowly lower front flange into place directly in front of tube opening. Use the 7/64 Allen head wrench and replace the two screws that connect the exhaust tube to the front flange. Note: Ensure o-ring is still present on exhaust tube (see Figure 4-15).

Figure 4-14. System Cabinet showing Screw Locations

Step 6. Once exhaust tube has been connected, position front panel back to original location and replace both the front panel/divider panel screw and the two front panel screws located on the bottom left front/bottom right front respectfully.
Figure 4-15. *Front Flange Screw Location*

Step 7. Press the outer flange plate against the tube lip and re-install the eight screws that hold the assembly together. Be sure to tighten the screws uniformly, by tightening each screw a little at a time, in a star pattern starting at the center.

Step 8. Slip the small O-ring onto the rear nipple and reconnect the Gas Connector fitting, finger tight (see Figure 4-11). Always use a new O-ring.

Step 9. Re-install the top cover of the RTP-600xp system.
4.3.3.2 Quartz Isolation Tray Installation

Tools and Supplies:
- Allen wrench set (US type)
- Phillips screwdriver
- Latex gloves
- 0.050 Allen head wrench

WARNING: Make sure the wall circuit breaker for the RTP-600xp is off and be sure the system is cool before handling.

CAUTION: Always use latex gloves when handling quartz ware.

NOTE: The tray rests on the lip on the inner side of the oven door, and is supported by its own weight (see Figure 4-16). The quartz tray must be leveled with respect to the oven (see Section 4.3.4).

![Diagram of Isolation Tray](image)

Figure 4-16. Isolation Tray with opened Door

Step 1. Put quartz tray onto door support lip, taking care not to strike the tray against the oven door or any other hard object (see Figure 4-16).

Step 2. Use 0.050 Allen head wrench to tighten the two tray set-screws (see Figure 4-16 item #2). NOTE: Do not over tighten screws. Tighten them until tray rises slightly above the bottom of the oven chamber opening and the door can be closed completely without tray contacting chamber flange or quartz tube.
Step 3. Push door flange o-ring back into place (see Figure 4-16 item #1) and then proceed to Section 4.3.4 to level the tray.
4.3.4 QUARTZ ISOLATION TRAY LEVELING

When a quartz tray is installed it must be leveled. This helps maintain consistent heating uniformity. The procedure is as follows:

Tools and Supplies:
- Allen wrench set (US type)
- Bubble level
- Ruler
- Latex glove
- 0.050 Allen head wrench

Step 1. Close the oven door until the edge of the tray is flush with the oven flange. (See Figure 4-17, part (a)). Using a ruler, measure the distance from the bottom of the oven flange to the top edge of the quartz tray. Measure the tray on both sides to verify that it is level from side-to-side.
Step 2. Close the oven door until it is open about 3 inches. Using a ruler, measure the distance from the bottom of the oven flange to the top edge of the quartz tray. This distance should be the same as the distance noted in Steps 1 and 2 above. If it is the same, then the quartz tray is level. If it is not the same, then the tray needs to be leveled from front-to-back using the leveling screws.

Step 3. Repeat Steps 1 through 2 to verify that the quartz tray is level. The distance should be the same between the bottom of the oven flange and the top of the quartz 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 is normal and should not be a reason for concern.

Step 4. Place a wafer on the tray. Slowly close the door of the heating chamber. Listen for any scraping sounds, which 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, never force the heating chamber door.
4.3.5 QUARTZWARE CLEANING

NOTE: The quartz ware quartz tube and the quartz tray must be always handled with latex gloves to avoid contamination.

To ensure uniform wafer heating, the quartz tube and the quartz 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 quartz tube and quartz tray, even if no deposits are visible. The quartzware should also be cleaned prior to performing a temperature calibration.

WARNING: Always use caution when handling chemicals to prevent injury or burns. Follow standard Semiconductor Acid safety procedures.

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

Step 1. Obtain the following cleaning materials:

- Concentrated Nitric Acid
- Semiconductor Grade Soap
- Semiconductor Grade Sponge / Cleaning Pad or Cleaning Brush
- 10% Hydrofluoric Acid
- Deionized Water
- Clean Dry Nitrogen

Step 2. If stains / deposited material are visible on the quartzware, scrub with “hot” (warm to the touch) deionized soapy water until all visible residue is removed.

Step 3. Rinse with deionized water for 10 minutes.

Step 4. If stains are still visible on the quartzware, soak in concentrated nitric acid; otherwise, proceed to Step 6.

Step 5. Rinse with deionized water for 10 minutes.

Step 6. Soak in 10% hydrofluoric acid, for no longer than 1 minute, or excessive etching will occur.

Step 7. Rinse with deionized water for 10 minutes.

Step 8. Blow quartzware dry with clean, dry nitrogen.
4.3.6 QUARTZWARE STORAGE

When storing the quartzware, it is extremely important to do so with the minimum possibility of contamination. Even thin films of contaminants not visible to the naked eye can effect heating uniformity and/or contaminate wafers being processed.
SECTION 4: CHAPTER 4

COOLING SUBSYSTEMS

The heating chamber incorporates two cooling subsystems:

- A water cooling subsystem for the oven walls and door
- An air (or nitrogen) cooling subsystem to reduce residual heating of the quartz tube

The oven's water system remains on continuously for as long as the "Power On" switch is on. The air/nitrogen system provides a continual flow through the system cabinet; this removes residual heat from the chamber and remains on continuously for as long as the Power-On switch is ON.

4.4.1 OVEN COOLING SUBSYSTEM

The water-cooling subsystem protects the heating chamber from overheating, and ensures rapid cool down at the termination of each steady-state temperature period. The subsystem circulates water through cooling tubes in the oven walls and door. It includes several components:

- An on/off solenoid valve that enables water flow whenever the "Power On" switch is on. The RTP-600xp system switches the water flow off and on, respectively, when the "Power On" and "Power Off" switches are pressed.
- A flow sensor is connected directly to the lamp power supply to disable the lamps if water flow falls below 2.0 GPM.

4.4.2 QUARTZ TUBE COOLING SUBSYSTEM

When the system is in continuous use (e.g., long-period processing), excess infrared radiation from the hot wafer raises the quartz tube temperature. The tube cooling subsystem prevents the tube from reaching excessive temperatures.

Compressed clean, dry air (or nitrogen) is blown through holes in the top and bottom of the oven. This air circulates around the outside of the quartz tube and disperses through the lamp sockets. The compressed air (or nitrogen) must be water-free, oil-free, and particulate-free. It must be delivered to the RTP-600xp at a flow rate of 10 to 15 SCFM.
4.5.1 **OVERVIEW**

The RTP-600xp incorporates a multigas process subsystem, which provides a versatile, contamination-free wafer environment. The process gases may include inert argon or nitrogen, and/or gases that take an active part in wafer processing, such as oxygen, ammonia, hydrogen chloride, and forming gas. In this manual, the term "process gas" refers to either or both types, whichever is in use.

Process gases enter the system at the rear utility panel of the RTP-600xp cabinet, and go through the MFC’s inside the cabinet. The process gases are carried within the RTP-600xp by stainless steel tubing.

Gas enters the oven through a sealed extension on the rear of the quartz tube. During thermal processing, the door seals against a stationary metal flange, which in turn is sealed against the front opening of the quartz tube. This creates a hermetically sealed processing environment. The gas leaves the quartz tube through a single hole in the flange. It is then delivered via tubing to the rear utility panel for exhausting.

**WARNING:** It is important to exhaust process gases of all types to a safe exhaust system, outside the processing area.
4.5.2 GAS COMPATIBILITY FEATURES

Gas Groups in RTP-600xp Rev. 2.1:

Group A - Active Agents: H2, N2/H2, Ar/H2, NH3
Group B - Oxidizers: O2, O3, N2O
Group C - None of the above: N2, Ar, He

Group A and B are incompatible. Group C is compatible with either Group A or B.

Recipe Validation Rules on Gas Compatibility:

Group A gas and Group B gas cannot be present in the same step. The software will not validate recipes, which do not follow this rule.

Recommendations regarding Recipe Gas usage:

1. It is recommended that only Group C gases be used in the first step and the last step of a recipe.

2. Listed below are typical Gas Flow recommendations:

   • **Before a step** with gases in either Group A or Group B it is recommended that a MINIMUM PURGE flowing a Group C gas at 600 second*SLPM (Time in seconds multiplied by Flow Rate in SLPM) be used.
     EXAMPLE: @ 20 SLPM you need to flow for 30 seconds
     Since, 20 SLPM * 30 seconds = 600 second*SLPM
     Alternatively, you could flow 20 seconds at 30 SLPM and still achieve the required 600 second*SLPM

   • **After a step** with gases either in Group A or Group B it is recommended that a MINIMUM PURGE flowing a Group C gas at 600 second*SLPM (Time in seconds multiplied by Flow Rate in SLPM) be used.
     EXAMPLE: @ 20 SLPM you need to flow for 30 seconds
     Since, 20 SLPM * 30 seconds = 600 second*SLPM
     Alternatively, you could flow 20 seconds at 30 SLPM and still achieve the required 600 second*SLPM.

   • **After the last step** with gases either in Group A or Group B it is recommended that a MINIMUM PURGE flowing a Group C gas at 600 second*SLPM (Time in seconds multiplied by Flow Rate in SLPM) be used.
     EXAMPLE: @ 20 SLPM you need to flow for 30 seconds
     Since, 20 SLPM * 30 seconds = 600 second*SLPM
     Alternatively, you could flow 20 seconds at 30 SLPM and still achieve the required 600 second*SLPM.

   • **Before the end of the recipe** it is recommended that a MINIMUM PURGE flowing a Group C gas of 1800 second*SLPM (Time in seconds multiplied
by Flow Rate in SLPM) be used.
EXAMPLE: @ 20 SLPM you need to flow for 90 seconds
Since, 20 SLPM * 90 seconds = 1800 second*SLPM
Alternatively, you could flow 60 seconds at 30 SLPM and still achieve
the required 1800 second*SLPM.

Gas Purge Features in Diagnostics Screen:
When a pneumatic valve is attempted to open:
1) If a single gas line is chosen, you may set desired flow rates and should
   see flow feedback; and/or

2) If multiple gas lines are chosen, the software will check compatibility and
   prevent both Group (a) and Group (b) gases flowing at the same time.

Gas Restriction in Pyrometer and Chamber Calibrations:
Gases selectable for pyrometer or chamber calibrations are limited to Group C
only.
4.5.3 EXHAUST PLUMBING

Process gases are carried out through the chamber exhaust on the back of the RTP-600xp cabinet. Depending on the process gases being used and the type of wafers being processed, the exhaust may be toxic and hazardous. In this case, the chamber exhaust must be connected to a facility scrubber.

WARNING: Maximum back pressure not to exceed 2.00” H₂O or tube will break
5.1.1 PREVENTIVE MAINTENANCE

Preventive maintenance checks should be performed on a weekly and quarterly basis to ensure consistent operation of RTP-600xp.

**WARNING:** Switch off the power to the heating chamber at the wall breaker whenever you remove the cover. Even when the panel switch is in the "OFF" position, there is power to the triac plate, on top of the oven.

5.1.1.1 Weekly Maintenance

- Water flow -- Connect an external flow meter in series to the water inlet line. Check the flow, and replace the filter if water flow drops below 3.0 GPM (Oven requires 3.0GPM with a minimum flow of 2.0GPM). Check the chiller water level to ensure that the level hasn't fallen below the low water level marker.

- Cleanliness -- Check the quartz isolation tube and wafer tray for contamination. Also inspect the heating chamber for signs of water and particles. If Quartzware appears visually dirty or ionic contamination is suspected clean according to the procedure in Section 4.3.5.

- Thermocouple (if the thermocouple is connected) -- When the system is cold, check the temperature from the system diagnostics screen. It should display ambient temperature. Increase the lamp intensity and check for temperature rise. Note that to do this water must be flowing, the cover must be on the unit or the interlocks must be overridden.

- Lamps -- Check uniformity: run a test wafer and measure the resistivity uniformity. Compare the values with those obtained on the wafer measured when the unit was first installed. If the uniformity measurements are unacceptable, check the continuity of the lamps using an ohmmeter (refer to Section 5.1.3.1).
5.1.1.2 Quarterly Maintenance

- Oven -- Inspect for frayed or damaged wiring to lamps. Check the front flange O-ring for burning or other damage.

- Interlocks -- Check the water interlock by turning off water supply to the system and trying to run a process cycle via the RTP-600xp software. Check the door interlock by opening door and trying to run a process cycle via the RTP-600xp software. The interlocks should prevent the lamps from turning ON.

- Quartz -- Inspect the quartz isolation tube and wafer tray for signs of cracking, chipping, or other unusual wear. If the quartzware is dirty, clean it according to the instructions in 4.3.5.

- Leakage -- If cross contamination is not an issue, run a Titanium Silicidation Anneal to ensure that the quartz isolation tube is hermetically sealed.

- Lamps -- Visually inspect lamp sockets for cracks or discoloration.

- Water -- Inspect for water leaks and bad hoses. Check the customer supplied Water Flow Gauge against the last quarterly flow reading. If the flow is significantly lower several items can be checked:
  - First: Check the customer supplied filter on the incoming Process Cooling Water. Change the filter if it appears to be full of foreign material.
  - Second: If changing the incoming Process Cooling Water filter does not correct the flow, check the water lines for clogging by checking the customer supplied water pressure gauges installed on both the incoming and out going Process Cooling Water lines. The differential pressure across the oven must be within between 40 and 75psi.
5.1.2 DIAGNOSTIC CHECK

The Diagnostic Check procedure tests the heating chamber control system by verifying that the lamps are turning on properly.

Step 1. Make sure the system is on, the monitor is on, external water flow enabled, top cover switch enabled and door in closed position (note: Locked if door lock feature present), and TC sensor installed in system.

Step 2. From the Main screen, click [System]. The System Pop-Up Window will appear. Click [Diagnostics] to view the SYSTEM SETUP screen.

Step 3. Enable the lamps by turning on the [Power On] switch.

CAUTION: Do not place a wafer in the chamber at this time. A wafer could accidentally be melted and damage the system.

Step 4. Slowly increase the intensity of the lamps, and watch for a rise in the TC temperature feedback.


If you do not see a rise in temperature, call Modular Process Technology Corporation for assistance.
5.1.3 MAINTENANCE PROCEDURES

System maintenance procedures are provided in the following sections.

- 5.1.3.1 Lamp Troubleshooting and Replacement
- 5.1.3.2 O-Ring Check
- 5.1.3.3 Water Filter Check
- 5.1.3.4 600xp MFC FACTOR Check FOR BROOKS 5850 & 5964 MFCs calibrated for Nitrogen
5.1.3.1 Lamp Troubleshooting and Replacement

A sudden change in process results (uniformity) may indicate a lamp failure. (Air-cooling flow and dirty quartz ware may also affect uniformity.) Check lamp continuity to verify that all lamps are properly connected.

Step 1. Turn off the system power by turning off its Power Off switch and also shutting off the wall circuit breaker.

Step 2. Remove the cabinet cover. The cover is held in place with 13 screws.

Step 3. Remove the lamp wiring harness from each lamp socket on the right side of the chamber (as you face the front panel). This insures that each lamp is in an open circuit.

NOTE: Be careful not to damage the lamp sockets when unplugging the wires. The lamp sockets are fragile.

Step 4. Using an ohmmeter, check the continuity of each lamp. Ground one lead to the harness connecting the lamp sockets that are on the left side of the chamber. Use the other lead to measure each individual lamp on the right side. If a lamp indicates an open circuit, that lamp is burned out. This lamp should be replaced. Call Modular Process Technology Corporation for replacement lamps.

To replace a lamp, follow the procedures below:

NOTE: If you have not already done so, be sure to turn off all power to the heating chamber and remove the cover. Also, wear latex gloves while handling the lamps. When installing a new lamp, be sure first to clean it with ethanol.

Step 1. Remove the lamp wiring harness on the right side of the oven (as you face the front panel) from 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 old lamp.

Step 3. Notice the bump located in the center of the new lamp: on the top bank of lamps this bump must point up; on the bottom bank of lamps this bump must point down. Gently slide the new lamp into the socket hole; making sure the lamp is seated in the proper socket for the lamp being replaced.

Step 4. Retighten the socket screw so it fits snugly. Do not over tighten.

Step 5. Using an ohmmeter, check continuity of lamp being replaced to ensure proper seating. Follow step 4 in Section 5.1.3.1.

Step 6. Replace the lamp wiring harness, and the cover.
5.1.3.2 O-Ring Check

Step 1. Open the oven door. Remove the eight screws, which hold the flange to the heating chamber and the two screws that hold the exhaust tube to the flange (see Section 4.3.2). Let the flange rest on the door rails.

Step 2. Check the O-ring on the flange. If it is burned or damaged, replace it.

Step 3. Reinstall the flange and the screws. Retighten the screws a little at a time, in a star pattern on the flange and then install the exhaust tube (see Figure 4-7).

Step 4. Inspect the O-ring on the gas inlet. If it is damaged, replace it.

Step 5. Inspect the O-ring on the inside of the door. If it is damaged, replace it.

5.1.3.3 Water Filter Check

Step 1. Turn off the power and water supply to the system.

Step 2. Remove the water inlet hose on the rear utility panel.

Step 3. Inspect the filter at the mouth of the water inlet for blockage. Replace the filter if necessary.

Step 4. Replace the water inlet hose, and turn on the power and water supply. Note: This filter is not part of the RTP-600xp system and would have been supplied by the customer.
### 5.1.3.4 600xp FACTOR Check FOR BROOKS 5850 & 5964 MFCs calibrated for N₂

<table>
<thead>
<tr>
<th>Gas Type</th>
<th>Gas Symbol</th>
<th>600xp Factor For Brooks 5850 &amp; 5964 MFC's Calibrated For Nitrogen</th>
<th>Change MAX Gas Flow In SETUP To Value Below</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>N₂</td>
<td>1.0</td>
<td>NEW Flow = MFC Max SLPM * Factor</td>
</tr>
<tr>
<td>Oxygen</td>
<td>O₂</td>
<td>1.0</td>
<td>NEW Flow = MFC Max SLPM * Factor</td>
</tr>
<tr>
<td>Argon</td>
<td>Ar₂</td>
<td>1.4</td>
<td>NEW Flow = MFC Max SLPM * Factor</td>
</tr>
<tr>
<td>Forming Gas in Nitrogen</td>
<td>10% H₂/ 90% N₂</td>
<td>1.0</td>
<td>NEW Flow = MFC Max SLPM * Factor</td>
</tr>
<tr>
<td>Ammonia</td>
<td>NH₃</td>
<td>0.8</td>
<td>NEW Flow = MFC Max SLPM * Factor</td>
</tr>
<tr>
<td>Nitrous Oxide</td>
<td>N₂O</td>
<td>0.8</td>
<td>NEW Flow = MFC Max SLPM * Factor</td>
</tr>
</tbody>
</table>

**NOTE:** It is always better to use a MFC calibrated for the Process Gas that is being used. Thus, the factor for the MFC would be 1.
5.2 **TROUBLESHOOTING GUIDE**

If your RTP-600xp unit is malfunctioning, consult the troubleshooting guide below. If you need additional assistance, please contact Modular Process Technology Corp.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Recommended Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Computer:</strong></td>
<td></td>
</tr>
<tr>
<td>No display</td>
<td>Check all power switches. Make sure the power cable is plugged in, and connected to the monitor.</td>
</tr>
<tr>
<td>No response to menu selections or commands</td>
<td>Make sure the computer circuit boards are configured correctly, and securely plugged into the computer. Make sure the computer has a properly installed VGA-graphics card and monitor. Make sure the keyboard is properly plugged in.</td>
</tr>
<tr>
<td>No LED display on readout</td>
<td>Check power to the display board which should be +5VDC. Check the cable connections between the display board and controller board.</td>
</tr>
<tr>
<td><strong>Heating Chamber:</strong></td>
<td></td>
</tr>
<tr>
<td>No power to chamber</td>
<td>Make sure there is power at the circuit breaker, and the system is switched on. Check the 2 fuses on the back panel of the system cabinet. Take off the system cover, and check the 3 large fuses on top of the heating chamber. Note: Some RTP-600xp models have two additional fuses located below MFC's inside chamber section that should be checked if present.</td>
</tr>
<tr>
<td>Air leak</td>
<td>Make sure the O-ring in the door flange securely fits in its groove. Check all other O-rings. Make sure the gas inlet and outlet fittings are tight. Make sure the door is closed and locked. Visually inspect the quartz isolation tube for cracks or roughness. Check that the screws holding the oven front flange to the quartz isolation tube are secure.</td>
</tr>
<tr>
<td>Problem</td>
<td>Recommended Action</td>
</tr>
<tr>
<td>---------</td>
<td>--------------------</td>
</tr>
<tr>
<td><strong>Heating Chamber (cont):</strong></td>
<td></td>
</tr>
<tr>
<td>Lamps will not turn on</td>
<td>The oven cooling water may be turned off, or the flow may be too low. Water flow must be greater than 2.0 GPM to satisfy the interlock. Check all cable connections inside the oven cabinet, and between the computer and the oven. Verify the computer cards are configured properly, and are securely plugged into their slots.</td>
</tr>
<tr>
<td><strong>Thermocouple Circuits:</strong></td>
<td></td>
</tr>
<tr>
<td>Front panel readout does not respond to temperature variations</td>
<td>Check thermocouple connections on the inside of the oven door.</td>
</tr>
<tr>
<td>Erratic, negative, or low readings</td>
<td>Check thermocouple connections; make sure leads are not shorted to ground or reversed.</td>
</tr>
<tr>
<td>Negative temperature reading on front panel readout</td>
<td>Check thermocouple leads. Make sure leads are not reversed at door connection.</td>
</tr>
<tr>
<td><strong>Pyrometer Circuits:</strong></td>
<td></td>
</tr>
<tr>
<td>Front panel readout does not respond to temperature variations</td>
<td>Check the power to the heating chamber. Make sure all connections to the circuit cards are secure. Install a thermocouple, and verify whether temperature rises under thermocouple control. Check that quartz tube isn't dirty.</td>
</tr>
</tbody>
</table>
SECTION 6: CHAPTER 1

PREFACE

6.1.1 INTENDED AUDIENCE

This Installation Manual is designed to assist Fab Maintenance Engineers and Technicians to install the RTP-600xp Rapid Thermal Processing System. Building Planners may also use this document to plan facilities in which the RTP-600xp system will be used.

6.1.2 MANUAL USE

Suggested manual use is as follows:

- Facilities personnel -- read Section 6 Chapter 2.
- Service Engineers and Technicians -- read entire manual.

6.1.3 CONTENT DESCRIPTION

Chapter 1; Preface.
This chapter - a description of the Installation Manual.

Chapter 2. Installation Process Overview.
Provides an overview of the installation process for the RTP-600xp system. It describes what must be done to prepare for and initiate the installation process, and what tools are required to perform the installation.

Chapter 3. System Inspection.
Describes the procedure for inspecting the system, and reporting damage, or missing parts.

Chapter 4. Installation Site Requirements.
Describes the principal installation site requirements, including the dimensions of the system and electrical connections, as well as gas, quartz isolation tube cooling, and water specifications and connections.
Chapter 5. Connecting the Utilities.
Offers step-by-step instructions for connecting the utilities to the RTP-600xp system.

Chapter 6. Quartz ware Installation.
Describes the quartz ware installation process for the quartz isolation tube and wafer tray.

Chapter 7. System Power Up and Testing.
Describes the procedures required to power up the system, and the tests, which must be performed to ensure safe RTP operation. These tests include the manual mode test, diagnostic check, and temperature control test.

Chapter 8. Troubleshooting Guide.
A troubleshooting guide is provided, which suggests practical recommendations for common errors, which may occur during installation procedures. Three types of errors are described: leaks, controller errors, and heating chamber errors.
SECTION 6: CHAPTER 2

INSTALLATION PROCESS OVERVIEW

6.2.1 INSTALLATION PROCEDURES

This manual describes how to install the RTP-600xp system and perform an operations check. These activities are outlined in the following sequence of steps:

1. Prepare the site utility connections.
2. Unpack the heating chamber and monitor.
3. Inspect the system for damage or missing parts.
4. Channel the utilities.
5. Install the quartz ware.
6. Check the quartz isolation tube for air-leaks.
7. Power up the system.
8. Confirm proper operation.
9. Check for resistivity accuracy.

6.2.2 REQUIRED TOOLS

You will need the following tools to install the RTP-600xp system:

- Allen wrench set (US style)
- Screwdriver set (regular and Philips)
- Open-end wrenches (US style)
- Teflon tape
- Latex gloves
- Test wafers
6.3 SYSTEM INSPECTION

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

Compare the contents of the accessories box with the Modular Process Technology Corporation packing list to make sure all items have been received. Handle the quartz ware with care and always while wearing latex gloves. If any parts are missing or broken, notify Modular Process Technology Corporation immediately.
SECTION 6: CHAPTER 4

INSTALLATION SITE REQUIREMENTS

6.4.1 SYSTEM DIMENSIONS AND WEIGHT

The Dimensions & Weight of the oven and monitor are listed below.

Oven: 24" (61 cm) W x 14" (35 cm) H x 23" (58 cm) D 150 lbs
Flat Panel Screen: 17 1/2" (44 cm) W x 18" (46 cm) H x 7 1/2" (19 cm) D 20 lbs

6.4.2 ELECTRICAL CONNECTIONS

Power requirements differ between the United States, England, Japan, and Europe. Specifications for each is shown in the following list:

- United States/ Korea/ Taiwan... 4 wires
  208 V (240 V on request)
  Three Phase + Gnd
  60 Hz
  90 Amps/phase
  \[3\phi\text{ Watts/phase} = V \times I \times \sqrt{3}\]

- United States/ Korea/ Taiwan... 5 wires
  240 V (240 V on request)
  Three Phase + Neutral + Gnd
  60 Hz
  130 Amps/phase
  \[3\phi\text{ Watts/phase} = V \times I \times \sqrt{3}\]

- England... 5 wires
  415 V
  Three Phase + Neutral + Gnd
  50 Hz
  60 Amps/Phase
  \[3\phi\text{ Watts/phase} = V \times I \times \sqrt{3}\]

- Europe/ China/ Hong Kong... 5 wires
  380 V
  Three Phase + Neutral + Gnd
  50 Hz
  130 Amps/phase
  \[3\phi\text{ Watts/phase} = V \times I \times \sqrt{3}\]

- Europe/ China/ Hong Kong... 4 wires
  200 V
  Three Phase + Gnd
  50 Hz Eastern Japan including Tokyo
  60 Hz Western Japan including Nagoya,
  Kyoto, and Osaka
  90 Amps/phase
  \[3\phi\text{ Watts/phase} = V \times I \times \sqrt{3}\]

- Japan... 4 wires
  200 V
  Three Phase + Gnd
  50 Hz Eastern Japan including Tokyo
  60 Hz Western Japan including Nagoya,
  Kyoto, and Osaka
  90 Amps/phase
  \[3\phi\text{ Watts/phase} = V \times I \times \sqrt{3}\]
6.4.3 GAS AND COOLING REQUIREMENTS

Gas, quartz isolation tube cooling, and water requirements are described below:

Gas(es): Any non-corrosive gas(es) may be used.
Each 10slpm gas is to be regulated to 35 PSI, and be pre-filtered
to <1 micron.
Each 30 slpm gas is to be regulated to 50 PSI, and be pre-filtered
to <1 micron
Inlet connections are VCR-4, Male.
Outlet connection is VCR-8, Male.

Quartz Tube: Tube cooling must use oil- and water-free compressed air or nitrogen.
Tube: Air/nitrogen is to filtered to <3 microns.
Cooling: Tube cooling is to be 125 psi of pressure, with a minimum of 10 CFM flow.
Inlet connection is 3/8” Swagelok fitting. MUST USE MINIMUM 3/8” TUBING.

Water: 10,000 watts at 20°C (34,100 BTU/hr) for full temperature range
operation in production environment
Water is to be filtered to <100 microns, with a measured 3.0GPM (2.0 GPM
minimum flow).
Water Resistivity is to be maintained at 1- 3 meg ohm.
Maximum inlet pressure is 75 PSI; the differential pressure is 40 PSI.
Maximum inlet temperature should be <35°C.
Inlet and outlet connections are ¼” Male garden hose fittings from H2O
source and ½” NPT Female to oven.
DO NOT USE COPPER: The Oven Cooling water line must be hooked up with
reinforced plastic hoses and non-copper Fittings.

6.4.4 CABINET EXHAUST REQUIREMENTS
- 4” diameter duct... the attachment collar to system can be ordered from factory.
- See local Safety Codes... this exhaust handles Lamp Cooling and accidental
escape of Process Gases.
- USE Aluminum (DO NOT USE PLASTIC OR COPPER).

6.4.5 PROCESS EXHAUST REQUIREMENTS
- Maximum Backpressure or Draw < 2” water
  NOTE: [1” H2O = 0.036psi] [1PSI = 27.6” H2O] [ 1PSI = 51.7 torr].
  Install Pressure Gauge Capacitive Manometer or 1000 torr Bartriton
  Electronic Manometer at outlet of Process Exhaust using T connection.
- See local Safety Codes... this exhaust handles Process Gases flowing into the
  chamber.
- Outlet connection is VCR-8 Male. (WARNING: It is the responsibility of the installer
to ensure back pressure NEVER exceeds 2” H2O or TUBE WILL BREAK.
  TYPICALLY 3/8” stainless tubing if tubing has under a 10ft Run. Use ½” stainless
  tubing if tubing has 10ft or greater Run).
SECTION 6: CHAPTER 5
CONNECTING THE UTILITIES

All utilities are connected at the rear utility panel of the RTP-600xp (see Figure 6.1).

![Rear Utility Panel](image)

Figure 6-1. Rear Utility Panel

The following steps describe the sequence for connecting each utility. Refer to Figure 6.1 for the location of each connector.

1. Connect the following electrical components:
   - Main power cable, to wall circuit breaker
   - Monitor power cable, to monitor and rear utility panel of RTP-600xp
   - Monitor signal cable
   - Keyboard
   - Printer (if used)
2. Connect the gas connections:

   Inlet (Gas #): VCR-4, MALE
   Outlet (Exhaust): VCR-8, MALE

3. Connect the tube cooling Compressed Air Inlet: 3/8" Swagelok

4. Connect the water connections:

   Water Inlet: Garden hose fitting
   Water Outlet: Garden hose fitting

5. Review all connectors to insure that you have attached the utilities to their proper connectors. Double-check the gas; tube cooling, and water pressures against the specifications listed in Section 6.4.3.

6. Connect the Cabinet Exhaust. Review all connectors to insure that you have attached the utilities to their proper connectors. Double-check against the specifications listed in Section 6.4.4.

7. Connect the Process Exhaust. Review all connectors to insure that you have attached the utilities to their proper connectors. Double-check against the specifications listed in Section 6.4.5.
6.6.1 INTRODUCTION

The quartz tray and quartz tube may need to be removed for cleaning if they become contaminated. The tube and tray are easily inspected for material build-up from process by-products occurring during heating cycles. The visual inspection of the tray is done when the door is OPENED. Use a flashlight to inspect the tube (Typically the material build-up is on the top inside of the tube directly over the wafer/susceptor). A severely contaminated tube will decrease the amount of energy reaching the wafer. Any opacity will reduce radiated energy reaching the pyrometer and affect temperature measurement.

This section describes the procedure for removing and installing the quartz tray and quartz tube for routine cleaning or replacement.
6.6.2 QUARTZWARE REMOVAL

Tools and Supplies:
- Allen wrench set (US type)
- Phillips screwdriver
- Latex gloves
- 0.050 Allen head wrench
- 7/64 Allen head wrench

**WARNING:** Make sure the wall circuit breaker for the RTP-600xp is off and be sure the system is cool before handling.

**CAUTION:** Always use latex gloves when handling quartz ware.

There are two sub-sections in the Quartz Removal Segment of the Manual.

- Quartz Isolation Tray Removal
- Quartz Isolation Tube Removal

Procedures for each are given below.
6.6.2.1 Quartz Isolation Tray Removal

Step 1. Shut off power from the system. If a thermocouple is not being used, go to Step 3.

Step 2. Open the oven door and pull it out half way. Put on latex gloves. Disconnect the thermocouple at the terminals on the inside of the oven door. Remove and store Thermocouple.

Step 3. Pull the oven door fully out. Put on latex gloves. Use 0.050 Allen head wrench to push door flange o-ring forward/out of the way (without damaging the o-ring) and then loosen the two tray set-screws (see Figure 6-2).

Step 4. Lift out the quartz tray, taking care not to strike the tray against the oven door or any other hard object (Note: Store the tray on a clean surface, preferably of quartz).

Figure 6-2. Leveling Screw Locations
6.6.2.2 Quartz Isolation Tube Removal

Step 1  Remove the top cover of the system cabinet by first removing the Top Cover screws (see Figure 6-3) and then lifting on the rear of the cover and lifting the complete cover upward.

Step 2.  Remove two front panel screws located at bottom left front and bottom right front of unit (see Figure 6-3). Note: Ensure oven door is open at least half way before proceeding to next step.

Step 3.  Remove front panel / divider panel screw located at top front off center to left of unit (see Figure 6-3). Now the front panel should be able to swing forward towards the front door.

Figure 6-3. System Cabinet showing Screw Locations
Step 4. After swinging the front panel forward about 30 degrees, you should be able to see two water tubes and an exhaust tube connected to the middle top of the front flange (see Figure 6-4). Using a 7/64-rounded head Allen wrench, remove the two screws that hold the exhaust tube to the front flange. Note: There is a black o-ring that seals the exhaust tube to the flange and it should stay in place during replacement, but care should be taken not to knock it out.

Step 5. Remove the eight flange screws on the door flange plate (see Figure 6-4) in a star pattern. Start from center and continue moving towards the edge. Note: Remove screws ¼ of a turn at a time. Be careful not to drop the O-ring inserted in the groove on the surface of the plate. Flip the flange up between the front panel and oven and let rest on the top of oven. Then push the front panel back into original position and replace screw on divider panel. This will hold flange in place while you replace the tube.

Figure 6-4. *Front Flange Screw Location*
Step 6. Un-screw gas connector fitting located at rear of oven (see Figure 6-5). (Note: A nipple on the rear of the quartz tube fits into an O-ring in the gas connector which seals the quartz to gas inlet. The actual bracket that screw into the oven is purposely left loose to prevent alignment stress.)

Figure 6-5. *Rear Access To Quartz Isolation Tube*
Step 7. Gently press the nipple forward to loosen the quartz tube while at the same time place your other hand inside tube until tube glides freely. Once free from gasket seal, slowly/horizontally pull tube out of the front of the unit (see Figure 6-6).

**WARNING:** Do not bump tube against the chassis or heat lamps while removing.

Figure 6-6. *Removing the Quartz Isolation Tube*
6.6.3 **QUARTZWARE INSTALLATION**

Tools and Supplies:
- Allen wrench set (US type)
- Phillips screwdriver
- Latex gloves
- 0.050 Allen head wrench
- 7/64 Allen head wrench

**WARNING:** Make sure the wall circuit breaker for the RTP-600xp is off and be sure the system is cool before handling.

**CAUTION:** Always use latex gloves when handling quartz ware.

There are two sub-sections in the Quartz Installation Segment of the Manual.

- Quartz Isolation Tube Installation
- Quartz Isolation Tray Installation

Procedures for each are given below.
6.6.3.1 Quartz Isolation Tube Installation

Step 1. Examine the O-ring on the heating chamber flange surface. If it is damaged or burned, replace it.

Step 2. Install the quartz tube by inserting it straight back into the heating chamber. The quartz tube contains a small window. The tube should be inserted with the window on the bottom (see Figure 6-7).

Figure 6-7. Installing the Quartz Isolation Tube

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

Step 3. When the tube is fully inserted, wiggle it slightly to ensure that it is fully positioned on the inner O-ring. The front lip of the tube should then be flush with the outer surface of the oven flange.
Step 4. Inspect the O-ring on the outer flange plate. Check it for damage or wear. Replace it if necessary.

Step 5. Once tube is in place, remove front panel/divider panel screw (see Figure 6-8) and hold front flange that is resting on oven while you pull front panel forward 30 degrees. Now slowly lower front flange into place directly in front of tube opening. Use the 7/64 Allen head wrench and replace the two screws that connect the exhaust tube to the front flange. Note: Ensure o-ring is still present on exhaust tube (see Figure 6-9).

Figure 6-8. System Cabinet showing Screw Locations

Step 6. Once exhaust tube has been connected, position front panel back to original location and replace both the front panel/divider panel screw and the two front panel screws located on the bottom left front/bottom right front respectfully.
Figure 6-9. Front Flange Screw Location

Step 7. Press the outer flange plate against the tube lip and re-install the eight screws that hold the assembly together. Be sure to tighten the screws uniformly, by tightening each screw a little at a time, in a star pattern starting at the center.

Step 8. Slip the small O-ring onto the rear nipple and reconnect the Gas Connector fitting, finger tight (see Figure 6-5). Always use a new O-ring.

Step 9. Re-install the top cover of the RTP-600xp system.
6.6.3.2 Quartz Isolation Tray Installation

Tools and Supplies:
- Allen wrench set (US type)
- Phillips screwdriver
- Latex gloves
- 0.050 Allen head wrench

**WARNING:** Make sure the wall circuit breaker for the RTP-600xp is off and be sure the system is cool before handling.

**CAUTION:** Always use latex gloves when handling quartz ware.

**NOTE:** The tray rests on the lip on the inner side of the oven door, and is supported by its own weight (see Figure 6-10). The quartz tray must be leveled with respect to the oven (see Section 6.6.4).

![Figure 6-10. Isolation Tray with opened Door](image)

Step 1. Put quartz tray onto door support lip, taking care not to strike the tray against the oven door or any other hard object (see Figure 6-10).

Step 2. Use 0.050 Allen head wrench to tighten the two tray set-screws (see Figure 6-10 item #2). NOTE: Do not over tighten screws. Tighten them until tray rises slightly above the bottom of the oven chamber opening and the door can be closed completely without tray contacting chamber flange or quartz.

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Step 3. Push door flange o-ring back into place (see Figure 6-10 item #1) and then proceed to Section 6.6.4 to level the tray.
6.6.4 QUARTZ ISOLATION TRAY LEVELING

When a quartz tray is installed it must be leveled. This helps maintain consistent heating uniformity. The procedure is as follows:

Tools and Supplies:
- Allen wrench set (US type)
- Bubble level
- Ruler
- Latex glove
- 0.050 Allen head wrench

Step 1. Close the oven door until the edge of the tray is flush with the oven flange. (See Figure 6-11, part (a)). Using a ruler, measure the distance from the bottom of the oven flange to the top edge of the quartz tray. Measure the tray on both sides to verify that it is level from side-to-side.
Step 2. Close the oven door until it is open about 3 inches. Using a ruler, measure the distance from the bottom of the oven flange to the top edge of the quartz tray. This distance should be the same as the distance noted in Steps 1 and 2 above. If it is the same, then the quartz tray is level. If it is not the same, then the tray needs to be leveled from front-to-back using the leveling screws.

Step 3. Repeat Steps 1 through 2 to verify that the quartz tray is level. The distance should be the same between the bottom of the oven flange and the top of the quartz 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 is normal and should not be a reason for concern.

Step 4. Place a wafer on the tray. Slowly close the door of the heating chamber. Listen for any scraping sounds, which 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, *never* force the heating chamber door.
6.6.5 QUARTZWARE CLEANING

NOTE: The quartz ware quartz tube and the quartz tray must be always handled with latex gloves to avoid contamination.

To ensure uniform wafer heating, the quartz tube and the quartz 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 quartz tube and quartz tray, even if no deposits are visible. The quartzware should also be cleaned prior to performing a temperature calibration.

WARNING: Always use caution when handling chemicals to prevent injury or burns. Follow standard Semiconductor Acid safety procedures.

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

Step 1. Obtain the following cleaning materials:

- Concentrated Nitric Acid
- Semiconductor Grade Soap
- Semiconductor Grade Sponge / Cleaning Pad or Cleaning Brush
- 10% Hydrofluoric Acid
- Deionized Water
- Clean Dry Nitrogen

Step 2. If stains / deposited material are visible on the quartzware, scrub with “hot” (warm to the touch) deionized soapy water until all visible residue is removed.

Step 3. Rinse with deionized water for 10 minutes.

Step 4. If stains are still visible on the quartzware, soak in concentrated nitric acid; otherwise, proceed to Step 6.

Step 5. Rinse with deionized water for 10 minutes.

Step 6. Soak in 10% hydrofluoric acid, for no longer than 1 minute, or excessive etching will occur.

Step 7. Rinse with deionized water for 10 minutes.

Step 8. Blow quartzware dry with clean, dry nitrogen.
6.6.6 QUARTZWARE STORAGE

When storing the quartzware, it is extremely important to do so with the minimum possibility of contamination. Even thin films of contaminants not visible to the naked eye can affect heating uniformity and/or contaminate wafers being processed.
SECTION 6: CHAPTER 7
SYSTEM POWER UP AND TESTING

This section describes the procedures for powering up the system, and the test procedures (manual mode test), which must be performed directly after power up to ensure safe system operation.

6.7.1 Utilities Inspection

Check the system utility connections and sources before switching on the RTP-600xp (see Figure 6-8) for the location of each utility connection at the rear of the unit. Visually inspect the following utilities to make sure connections are secure and utilities are on:

- Electrical power
- Gas inlet and chamber exhaust
- Cooling water inlet and outlet
- Compressed air inlet

Figure 6-12. *Utility Connections (rear view of system cabinet)*
**WARNING:** Make sure the chamber exhaust is not restricted. This will cause the quartz tube to over pressurize and 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.

### 6.7.1.1 Maintenance

During all maintenance operations, observe the following precautions:

1. Do not use replacement parts that are not provided by Modular Process Technology Corporation.

**WARNING:** Modular Process Technology Corporation is not liable for any damage or injury that may occur when unauthorized parts are used.

2. Disconnect power to the system before performing any maintenance activity that requires the removal of access covers.

3. Whenever the quartz isolation tube is changed, perform a test that verifies the leak tightness of the quartz chamber (Often this test is simply running a TiSi recipe & wafer, but confirm appropriate technique with the Tool Owner). Replace the O-ring on the isolation tube nipple each time the tube is removed.

### 6.7.1.2 Gas Handling

Be aware of the following cautions when working with gases in the RTP-600xp system:

1. ONLY use gases, which have been specified for use with the RTP-600xp system.

**WARNING:** Modular Process Technology Corporation is not liable for the use of gases not recommended.

2. Make sure the specified gases are connected to the proper inlets on the service panel.

**WARNING:** Failure to properly connect the gas lines may result in dangerous gas mixtures, which could cause harm to personnel or the system
6.7.1.3 Gas Flow Calibration

The gas flow controllers are calibrated for use with nitrogen and/or could be calibrated for use with specific gases ordered at time of purchase. These gas calibration factors are implemented at the factory at shipping. If gases are changed later, new software calibration factors must also be implemented. Contact Modular Process Technology Corporation for assistance.
6.7.2 System Power Up

At this point in the installation procedures you are now ready to power up the RTP-600xp system. The following steps describe the power up sequence (see Figure 6-13):

1. Switch on the facilities circuit breaker(s), external gas valves, air inlet valves and water valves.
2. Turn the key switch so the key is horizontal.
3. Turn on the RTP-600xp using the EMO Reset switch.
4. Turn on the Power On switch.

Figure 6-13. Front Panel Controls
6.7.3 Diagnostic Check

The Diagnostic Check procedure tests the heating chamber control system by verifying that the lamps are turning on properly.

Step 1. Make sure the system is on, the monitor is on, external water flow enabled, top cover switch enabled and door in closed position (note: Locked if door lock feature present), and TC sensor installed in system.

Step 2. From the Main screen, click [System]. The System Pop-Up Window will appear. Click [Diagnostics] to view the SYSTEM SETUP screen.

Step 3. Enable the lamps by turning on the [Power On] switch.

CAUTION: Do not place a wafer in the chamber at this time. A wafer could accidentally be melted and damage the system.

Step 4. Slowly increase the intensity of the lamps, and watch for a rise in temperature in the TC temperature feedback.


If you do not see a rise in temperature, call Modular Process Technology Corporation for assistance.
SECTION 6: CHAPTER 8

TROUBLESHOOTING GUIDE

This guide is intended to help you fix some of the common errors, which may occur during installation. If you need further help, contact Modular Process Technology Corporation.

6.8.1 Gas Leak Check Failure

If the system is not leak tight, perform the following:

1. Check all the O-rings for proper placement and seating.
2. Tighten the gas inlet and outlet connectors.
3. Ensure that the door is closed and locked.
4. Check the quartz isolation tube flange for polished smoothness and cleanliness.
5. Check to ensure that all screws are tight on the flange.

6.8.2 Controller Errors

If the controller has no display, use the following troubleshooting steps:

1. Ensure that the power is turned on at the source, at the RTP-600xp, and at the monitor.
2. Make sure the RTP-600xp is connected to the proper power.
6.8.3 **Heating Chamber Errors**

Troubleshooting steps for heating chamber errors are described below.

**Contactor not dropping when “Power On” button is pressed:**

1. Check to make sure the power is on at the wall circuit breaker.

2. Check that the key switch is in the horizontal position.

3. Check the fuses (2) on the cabinet rear panel and two fuses under MFC’s. (Note: Only present on some models.) Also check the three 80-Amp fuses and the three 1-Amp fuses located on Triac Plate (Top of Oven).

**No Display On Digital Readout:**

1. Check the power to the display board as well as cable connections.

**Pyrometer Does Not Show A Temperature Rise:**

1. Check the power to the heating chamber or cleanliness of quartz tube. Check pyrometer cable connections and Controller/Filter Board connections. Ensure intensity is high enough to increase temperature above 400-500°C (5-10%).
1. RTP-600xp Facility Check List
System Dimensions and Weight
The Dimensions & Weight of the oven and monitor are listed below.

Oven: 24" (61 cm) W x 14" (35 cm) H x 23" (58 cm) D 150 lbs
Monitor: 14" (36 cm) W x 15.5" (40 cm) H x 15.5" (40 cm) D 15 lbs

Electrical Connection Requirements
(Wall Circuit Breaker required within 6 ft of system. 9 ft of conduit provided with unit)
- Three Phase + Gnd ... 4 wires
  220 V, 60 Hz (DELTA)
  208 V, 60 Hz (DELTA)
  200 V, 60 Hz (DELTA)
  200 V, 50 Hz (DELTA)
- Three Phase + Neutral + Gnd ... 5 wires
  240 V, 50 Hz (WYE)
  230 V, 50 Hz (WYE)
  220 V, 60 Hz (WYE)
  220 V, 50 Hz (WYE)
90 Amps/phase [3Φ Watts = V x I x 3] 60 Amps/phase [3Φ Watts = V x I x 3]

Process Gases Requirements
- Any non-corrosive gas(es) may be used.
- Each 10slpm MFC is to be regulated at 35 PSI, and be pre-filtered to < 1 micron.
- Each 30slpm MFC is to be regulated at 50 PSI, and be pre-filtered to < 1 micron.
- Inlet connections are VCR-4 Male

Lamp Cooling Clean Dry Air/or Nitrogen Requirements
- Tube cooling must use oil- and water- free (install coalescent filter) compressed air or nitrogen
- Air/nitrogen is to be filter for particulates to < 3 microns
- Tube cooling is to be regulated to 125 PSI of pressure, with a measured minimum of 10 SCFM flow.
- Inlet connection is 3/8" Swagelock fitting. MUST USE MINIMUM 3/8" TUBING.

Oven Process Cooling Water Requirements:
10,000 watts at 20°C (34,100 BTU/hr) for full temperature range operation in production environment
- Water is to be filtered for particulates to <100 microns, with a measured 3.0GPM (2.0 GPM minimum flow.)
- Water Resistivity is recommended to be maintained at 1 - 3 meg ohm.
- Be sure Oven Cooling Water is Copper free... <20ppb REQUIRED
- Maximum inlet pressure in 75 PSI; the differential pressure is 40 PSI
- Maximum inlet temperature is < 35°C. Recommended inlet temperature is 15°C
- Inlet and outlet connections are ½” Male garden hose fittings (outer surface)/ ½” NPT Female(inner surface).

DO NOT USE COPPER: The Oven Cooling water line must be hooked up with plastic hoses and Stainless Steel fittings

Cabinet Exhaust Requirements
- 4” diameter duct... the attachment collar to system can be ordered from factory.
- See local Safety Codes... this exhaust handles Lamp Cooling and accidental escape of Process Gases.
- USE Aluminum (DO NOT USE PLASTIC OR COPPER).

Process Exhaust Requirements
- Maximum Backpressure or Draw < 2” water
  NOTE: [1" H2O = 0.036psi] [1PSI = 27.6" H2O] [1PSI = 51.7 torr]
  Install Pressure Gauge Capacitive Manometer or 1000 torr Baratron electronic Manometer at outlet of Process Exhaust using T connection. [Also, Dwyer Instruments – Series 2000 Magnehelic gage]
- See local Safety Codes... this exhaust handles Process Gases flowing into the chamber.
- Outlet connection is VCR-8 Male. (WARNING: It is the responsibility of the installer to ensure back pressure NEVER exceeds 2” H2O or the QUARTZ TUBE WILL BREAK. Use ½” stainless tubing.
- USE welded 316L Stainless Steel Pipe and Fittings.
SCHEMATIC APPENDIX

1. RTP-600xp System Block & Chassis Wiring
2. RTP-600xp Card Cage Board Plus Connect Location
3. RTP-600xp Triac Plate
4. RTP-600xp DC Power Supply
5. RTP-600xp Power Supply Adapter PCB
6. RTP-600xp Front Panel PCB – with Door Interlock Option
7. RTP-600xp 3 Phase Zero Crossing Detector
8. RTP-600xp Oven Control PCB
9. RTP-600xp Six Gas MFC Interface PCB
10. RTP-600xp Display Board
11. RTP-600xp TC/Pyrometer Adapter PCB
12. RTP-600xp AD Input Filter PCB
13. RTP-600xp A/D, D/A and MFC Cable
14. RTP-600xp Timer/Counter to OCB Cable
15. RTP-600xp Display Cable
16. RTP-600xp TC Cable
17. RTP-600xp Keyboard Cable
18. RTP-600xp Hard Disk Cable
19. RTP-600xp Floppy Disk Cable
20. RTP-600xp Speaker Cable
21. RTP-600xp Computer Power Cable
22. Pneumatic Interface Board
600S CARD CAGE BOARD PLUS CONNECT LOCATION

- 6 PIN (TRIAC HARNESS)
- 4 PIN (POWER)
- 34 PIN (TIMER/COUNTERTO OCB CABLE)

- 20 PIN (PYROMETER CABLE)
- 3 PIN (POWER)
- 6 PIN (A/D, DA, MFC CABLE)
- 4 PIN (TC CABLE)

- TC/Pyro Adapter Board

- 3 PHASE ZERO CROSSING DETECTOR BOARD

- Oven Control Board

- 3 PIN (POWER)
- 5 PIN (TIMER/COUNTER TO OCB CABLE)
- 18 PIN (TRIAC HARNESS)
DC POWER SUPPLY

NOTES:
1) DC POWER SUPPLY = INTERNATIONAL POWER SOURCES MODEL PU206-41C.
2) INPUT (AUTORANGING) = 100-120 V AC OR 200-240 V AC, 5.2 A MAX., 50-60 Hz.
3) OUTPUTS: V01 = +5.0 V DC, TO 30.0 A; V02 = +15.0 V DC, TO 6.0 A;
   V03 = -15.0 V DC, TO 4.0 A; V04 = 24.0 V DC, TO 4.0 A.
   "COM" IS COMMON TO V01, V02, & V03; V04 IS FLOATING.
4) "PS LUG" ABOVE REFERS TO TERMINAL LUG FROM EXTERNAL POWER SUPPLY BOARD.
5) BLK WIRES ON INPUT ARE FOR FAN1 & FAN2.
FROM TO/PYROMETER ADAPTER PCB

CHANNEL 0 IN - THERMOCOUPLE

PL1

A/D INPUT 0

ANALOG GROUND

CHANNEL 2 RETURN

A/D IN 0 RETURN

ANALOG GROUND

CHANNEL 1 IN - PYROMETER

A/D INPUT 1

ANALOG GROUND

CHANNEL 1 RETURN

A/D IN 1 RETURN

ANALOG GROUND

CHANNEL 2 IN - GAS #1

A/D INPUT 2

ANALOG GROUND

CHANNEL 2 RETURN

A/D IN 2 RETURN

ANALOG GROUND

CHANNEL 3 IN - GAS #2

A/D INPUT 3

ANALOG GROUND

CHANNEL 3 RETURN

A/D IN 3 RETURN

ANALOG SIGNALS

(A/D SIGNALS)

TO A/D INPUT MODULE
PCB-200414M (P2)

TITLE: RTP-900S A/D INPUT FILTER PCB

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Date: 17 JUL 92
DRAWN BY:

SHEET 1 OF 1
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17 INCH, 40-CONDUCTOR RIBBON CABLE

TO IDE BOARD (J2) J1 TO HARD DISK DRIVE

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19 INCH, 34-CONDUCTOR RIBBON CABLE

TO IDE BOARD (J3)

TO FLOPPY DISK DRIVE

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NOTES:
1.) WIRES ALL #18 AWG. PVC-INSULATED.
2.) J1 & J2 = BURNDY GTC8P1 SHELL,
   EACH WITH 6 (F) PINS, TYPE 182TR9L.

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