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Thermal Vacuum System
User Manual

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INTRODUCTION

Abbess Instruments' Thermal Vacuum Chamber Systems are designed and produced for use in production and testing applications requiring an exposure to or process within a controlled vacuum environment at specific temperature. The chambers are often custom designed for specific end-user requirements in recreating extreme atmosphere and temperature situations. Our customers use our full range of vacuum systems for testing or degassing packaged products, liquids and solids, EMI and altitude testing of electronics, computers and complete systems, shock impact targets, plasma science, space simulation and degassing large parts or components for research, and development.

Abbess designs rugged equipment for continuous manufacturing and production use, with safety and a long life in mind. The Vacuum chambers are constructed of heavy aluminum, steel or stainless steel. They have customer replaceable O-ring seals which are designed to withstand repeated closings. Two latches are used to close the standard front-hinged door. All cube chambers are He leak tested to 10-7 torr or better as required and should maintain this for its life dependent on seal condition and customer use.

Most Vacuum Chamber systems are made up of these basic functional components:

Chamber: a vacuum container or chamber.
Pump: a vacuum pump or other means of creating a vacuum.
Hose: a hose, plumbing or tubing needed to connect the chamber to the pump.
Valves: to control vacuum and release/break the vacuum.
Vacuum Pressure Gauge: to measure actual pressure inside the chamber.

Monitoring and control of the systems are attuned to specified process needs and configured to both optimize the end use operation time and assure the proper cycling of vacuum equipment. Visual monitoring of the Chamber interior is made possible through a view window in the chamber door or clear acrylic door construction. Vacuum and thermal systems are integrated into the overall system control allowing for continuous operator involvement in operations within the chamber.

SAFETY CONSIDERATIONS – READ THIS SECTION BEFORE OPERATION

This equipment is designed for use in manufacturing or laboratory environments by trained technicians. Use of this equipment beyond its stated intended purpose and operating parameters is not recommended and will be the sole responsibility of the user. This equipment should not be modified or altered. Abbess Instruments assumes no liability for any misuse of or modification to this product and such misuse or modification will immediately void all warranties.

This equipment should be used in accordance with the operating instructions contained in this manual. For alternative uses not covered in this manual, please contact Abbess Instrument's technical department for product suitability, safety, and alternative operating instructions.

The following are general safety guidelines recommended when using this product. Please consult your laboratory safety officer for any additional safety steps that may be necessary for your specific application or material.

1. **Make sure your operator reads and understands this manual before operating the equipment**.
2. This equipment is to be operated indoors only.
3. This equipment is to be operated in a well-lit area.
4. This equipment is to be operated with an ambient temperature of between 10 degrees C and20 degrees C.
5. This equipment is to be operated with an ambient humidity of between 20 and 50 percent.
6. Thoroughly review your MSDS (Material Safety Data Sheets) for all chemicals to be used with this equipment.
7. If the equipment is fitted with an optional internal thermal source (i.e. Thermal Plate) the user must ensure that temperatures do not exceed the auto ignition point(s) of materials placed in chamber.
8. Hand and eye protection are required when using this product. Additional protection may be required with respect to the materials being used. Please consult your laboratory safety officer.
9. This product should only be used with adequate ventilation.
10. A trained electrical technician should conduct repairs of electrical components. Incorrect replacement parts or assembly may damage the product and create a serious safety hazard for the user. Factory repair is highly recommended.
11. The use of samples containing ether based, fuel, munitions, or other extremely flammable or explosive materials, compounds, or residues should not be used in this equipment.
12. Use of acidic or base material may damage this product and are not recommended unless the product was ordered with the optional protective coating in Teflon or made of Stainless steel.

Installation

Chamber Location and Set-Up

Equipment must be SET-UP and installed in a LOCATION meeting the following criteria and with attention paid to the following areas of concern:

- This equipment is to be operated indoors only.
- This equipment is to be operated in a well-lit area.
- This equipment is to be operated with an ambient temperature of between 10 degrees C and 20 degrees C.
- This equipment is to be operated with an ambient humidity of between 20 and 50 percent.

  This equipment is to be operated on a stable floor, deck, or platform capable of safely supporting it and the intended operation.
- This equipment maybe secured to the floor, deck or platform as required.
- Electrical power connections should be provided as required by licensed professional trades people and in compliance with all applicable codes and ordinances.
- Adequate ventilation for people, process, and equipment must be provided.
- All system components must be assembled, calibrated, tested, and secured as needed for the safe and specified operations.

Custom Abbess Thermal Vacuum System Description

The Abbess Thermal Vacuum System allows articles under test placed inside to be exposed to high vacuum pressure as well as various temperatures via a heated and cooled Main Thermal Plate Assembly. Mass flow controllers are configured to mix six types of gases and capable of regulating the gas mixture flown into the chamber. A Thermal Vacuum Cycle Controller (TVCC) is used to control functions. The TVCC enables system control via panel-mounted switches and indicators and by a Touchscreen PC with a user-specific Graphical User Interface (GUI).

The Thermal Vacuum System consists of the following major components:

- **Vacuum Chamber** - A front loading Stainless Steel Cube Chamber $(24" \times 24" \times 24")$, equipped with a custom stainless steel sliding door with custom latch/closure. All attendant equipment and chamber is mounted upon a Heavy-duty cart/stand. All chamber vacuum environment surfaces are electropolished to obtain working pressure less than 10×10^{-6} Torr.

- **Main Thermal Plate** – Copper Thermal Plate Assembly mounted in the bottom of chamber with heating capability and cooling loop via Chiller/Bath Circulator. Feed-thru for electrical power, thermocouple and cooling lines extend through the rear of the chamber and render the Gold plated Thermal Plate thermally active. The main plate assembly facilitates controlled heating/cooling profiles of article(s) under test in the chamber under vacuum. The heating in the main plate is controlled by a Watlow EZ-Zone Temperature Controller mounted in control panel and integrated into the system GUI provided by the PC Touchscreen.

- **Top Thermal Plate** – Gold plated, copper plate assembly mounted at the top of the chamber with heating capability. Feedthru for electrical power and thermocouple extend through the rear of the chamber. The top plate assembly facilitates controlled heating profiles of article(s) under test in the chamber under vacuum. The heating in the top plate is controlled by a Watlow EZ-Zone Temperature Controller mounted in the control panel and integrated into the system GUI provide by the PC Touchscreen.

- **Control Panel** – Contains components necessary for controlling the system as well as logic and interfaces for the Thermal Vacuum Cycle Controller.

    - 2×Watlow EZ-ZONE Temperature Controllers(Main plate and Top plate)
      (See manufacturer specific documentation).

    - Status Indicators – Provide visual indication of system status.

    - PC Touchscreen Computer – Abbess customized DAQFactory program interface.

    - System GUI control the vacuum components and thermal profiles and gas flow.

    - Program is capable of data logging and monitoring the thermal vacuum system, sensor data and article(s) under test.

- **Vacuum Pumping System** –

    - Roughing Pump – Agilent SH-110 Signal Phase Scroll Pump Dry Roughing Pump removes the bulk of the gas from the chamber from atmosphere down to a crossover vacuum range and serves as an attendant backing pump to the turbo pump.

    - Vibration Isolation Dampener – 300 pound cement block with vacuum hose to dampen the vibration from the roughing pump

    - Turbo Pump – Agilent TwisTorr 304 turbo pump used to achieve high and ultra-high vacuum pressure in the chamber. Maximum rotational speed is 60000 RPM (1010Hz driving frequency) Turbo is also equipped with a Turbo Vent Valve that is activate to decelerate the turbo.

    - Ion Pump – Agilent Vacion Plus 40 Starcell Ion Pump with a 4UHV controller. The pump is rated for 80 hour use at the 1×10^{-6} Torr range.

- **Pressure Gauges**

    - Pfeiffer HPT 200 - Pirani/Bayard-Alpert Combination Digital Gauge. It is connected directly to the vacuum space and capable of reading a pressure range of 5×10^{-10} to 1000 hPa.

    - Pfeiffer RPT 200 – Digital Piezo/Pirani Gauge. It is connected directly to the vacuum space and capable of reading pressure range of 1×10^{-4} to 1200 hPa.

    - Pfeiffer CPT 200 – Digital Piezo/Pirani Gauge. It is connected directly to the vacuum space. It is capable to sense a pressure range of 1 to 1200 hPa.

      Note: 1 hPa≈ 0.75 Torr

- **Control Valves**
    - Chamber Gate Valve – VAT UHV (Ultra High Vacuum) Pneumatically Actuated Gate Valve (CF600 Flange) This valve isolates the chamber from all vacuum pumps.
    - Turbo Gate Valve – VAT UHV Vacuum Pneumatically Actuated Gate Valve (CF600 Flange) This valve isolates the turbo pump from the rest of the system.
    - Ion Valve – UHV Pneumatically Actuated Gate Valve (CF100 Flange) This valve isolates the Ion pump from the rest of the system.
    - High Pressure Angle Valve – VAT UHV Pneumatically Actuated right angle valve (DN40 Flange) This valve isolates the chamber from the larger Alicat gas flow valves.
    - Low Pressure Angle Valves – VAT UHV Pneumatically Actuated right angle valve (DN40 Flange) This valve isolates the chamber from the smaller Alicat gas flow valves.
    - Six Gas Mixing controllers – 6✕Alicat mass flow controllers that is capable of outputting gas 0 - 100SLPM (Standard Liters Per minute). The 6 mass flow controllers are capable of mixing gas into a manifold that they are connected to.
    - Large Pressure controller – Alicat mass flow controller that is capable of outputting high gas flow of 0 - 720 SLPM. The larger control valve is connected to gas mixing manifold and capable of outputting high gas flow into the chamber.
    - Small Pressure controllers – 1✕Alicat mass flow controller that is capable of outputting finite gas flow of 0 - 9 SLPM.1✕Alicat mass that is capable of outputting finite gas flow of 0 - 0.1 SLPM. The two mass flow controllers are connected to the gas mixing manifold and capable of outputting finite gas flow into the chamber.
- **Heating/Cooling Bath Circulator** – Thermo Scientific GlacierSeries G50 Ultra-Low refrigerated circulator with the AC200 controller that is connected to the Main Plate. The bath temperature is capable of a temperature range of -50ºC to 200ºC.
- **Process Ports (Customer Specified)**
    - CF275 flange, Qty 3, Electrical feed-thru with a 9-pin D-sub connector
    - CF450 flange, Electrical feed-thru with a 15-pin D-sub connector
    - CF600 flange, Electrical feed-thru with a 37-pin D-sub connector
    - CF275 flange, Qty 2, Fiber Optic, single mode fiber SM1310 (9/125um)

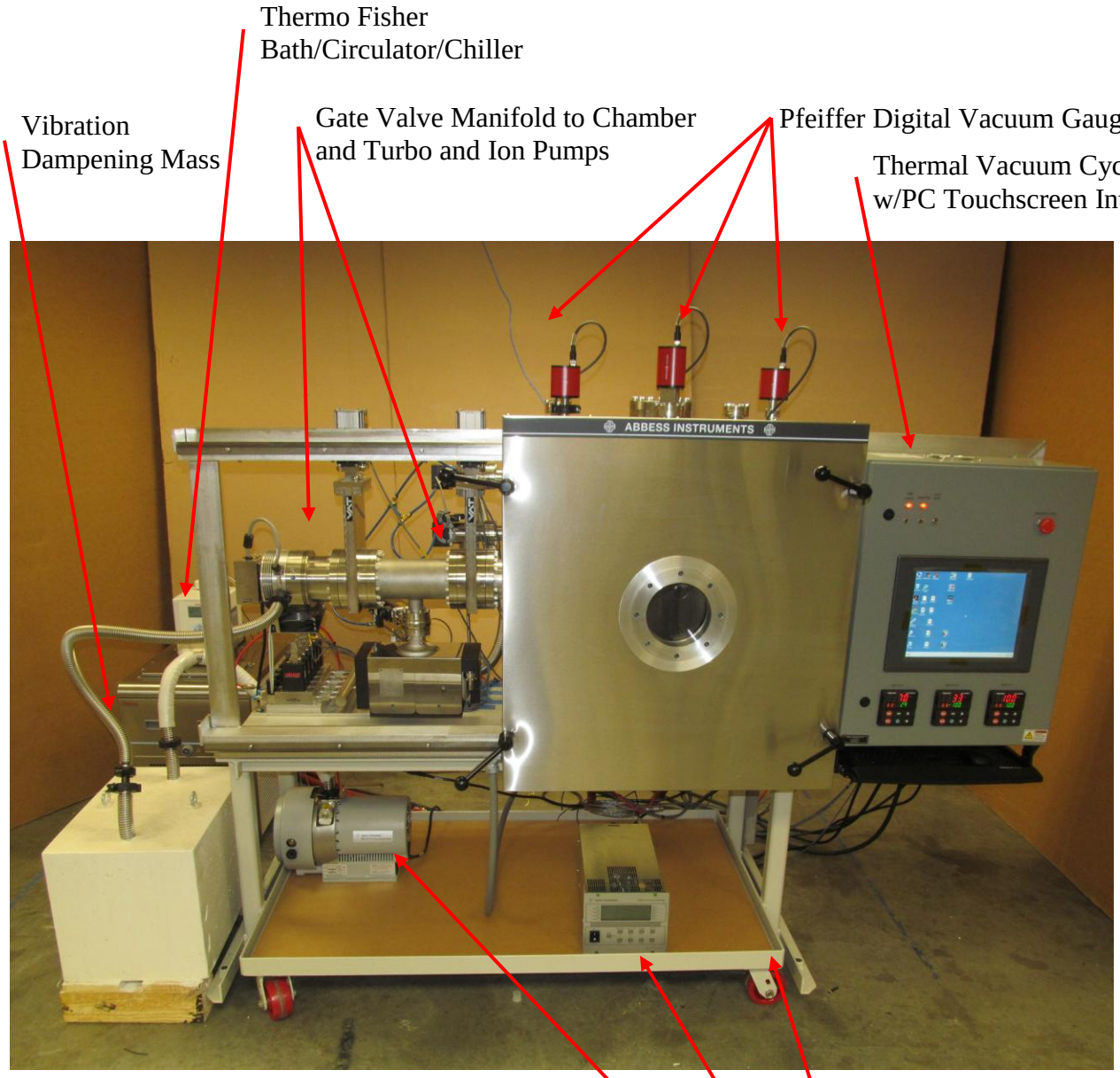


Figure 1 – Front View of Thermal Vacuum System

Figure 2 – Front View of Thermal Vacuum System

Figure 3 – View of Thermal Vacuum Chamber (Door Open)

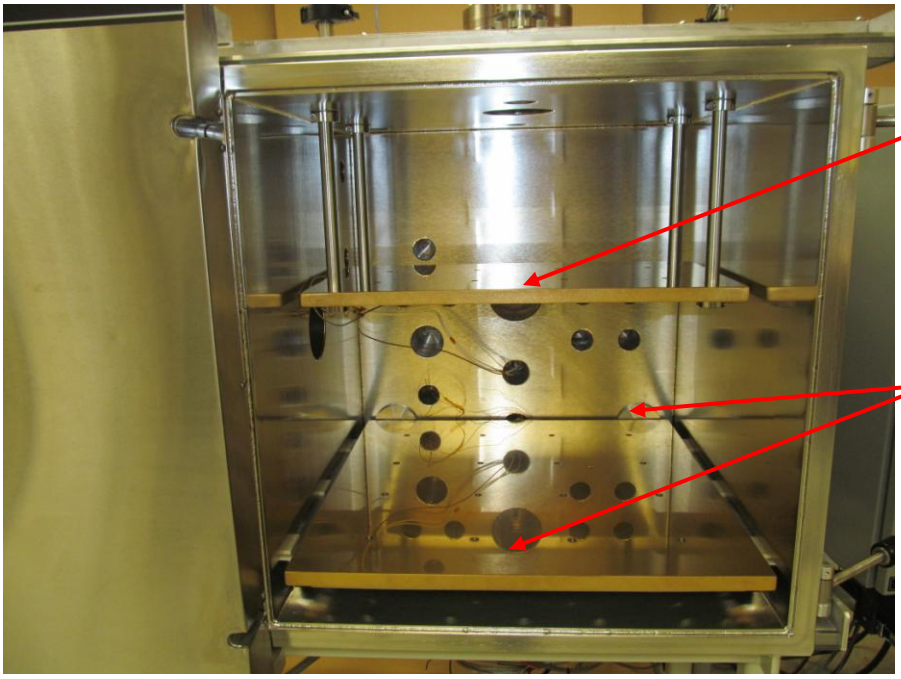


Figure 4 – View of Thermal Vacuum Chamber (Door Open)

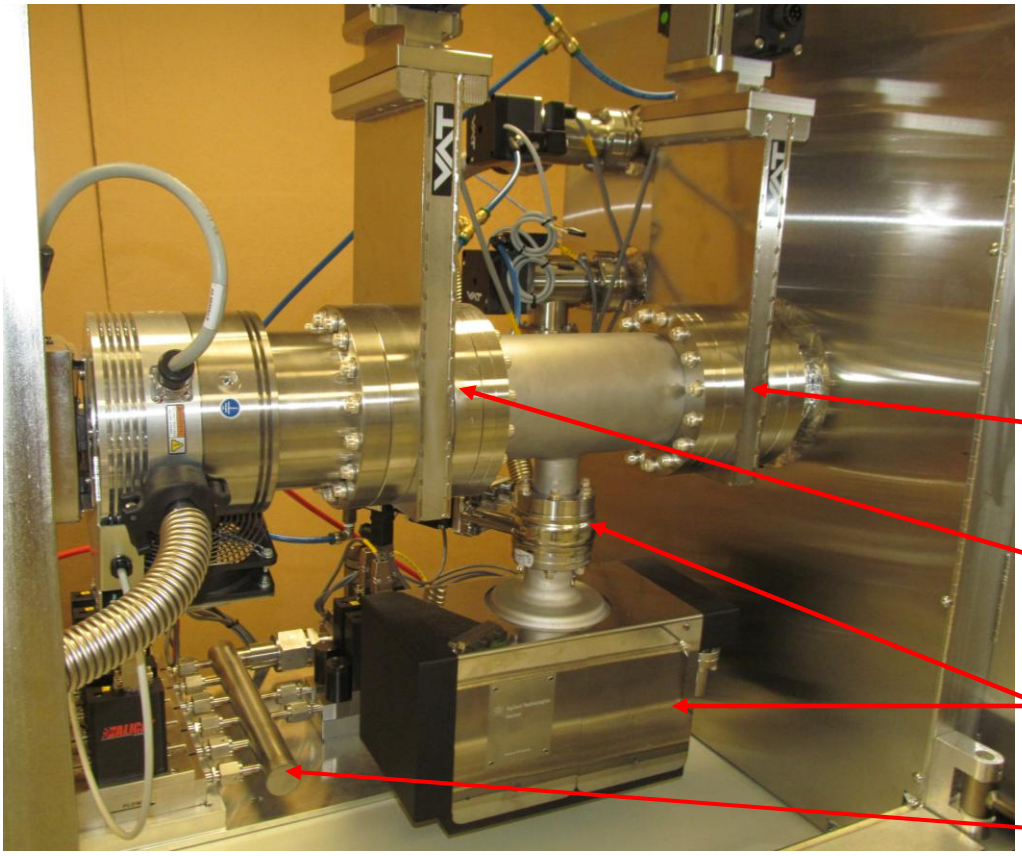


Figure 5 – Detail Side View of Thermal Vacuum System

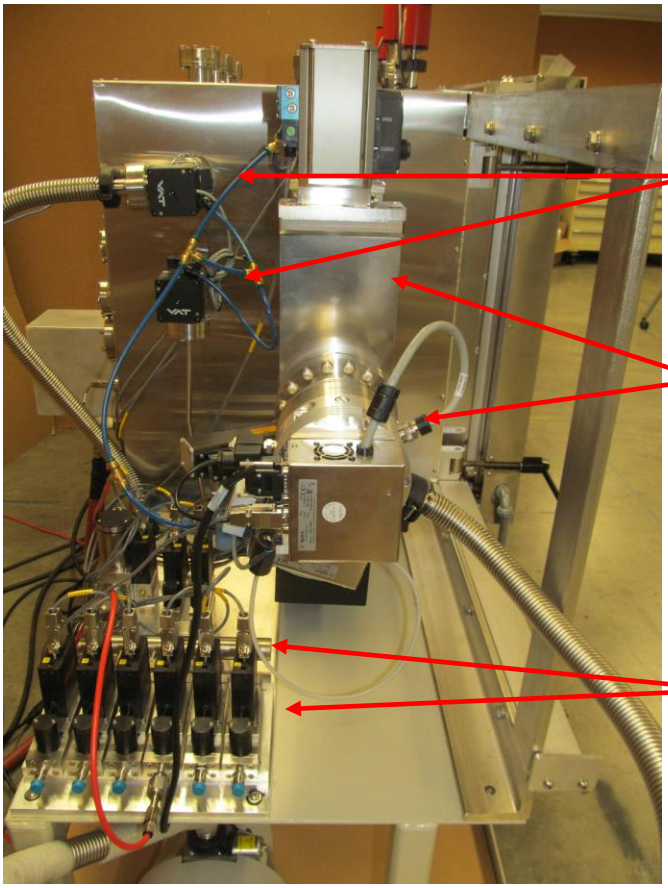


Figure 6 – Detail Side View of Thermal Vacuum System

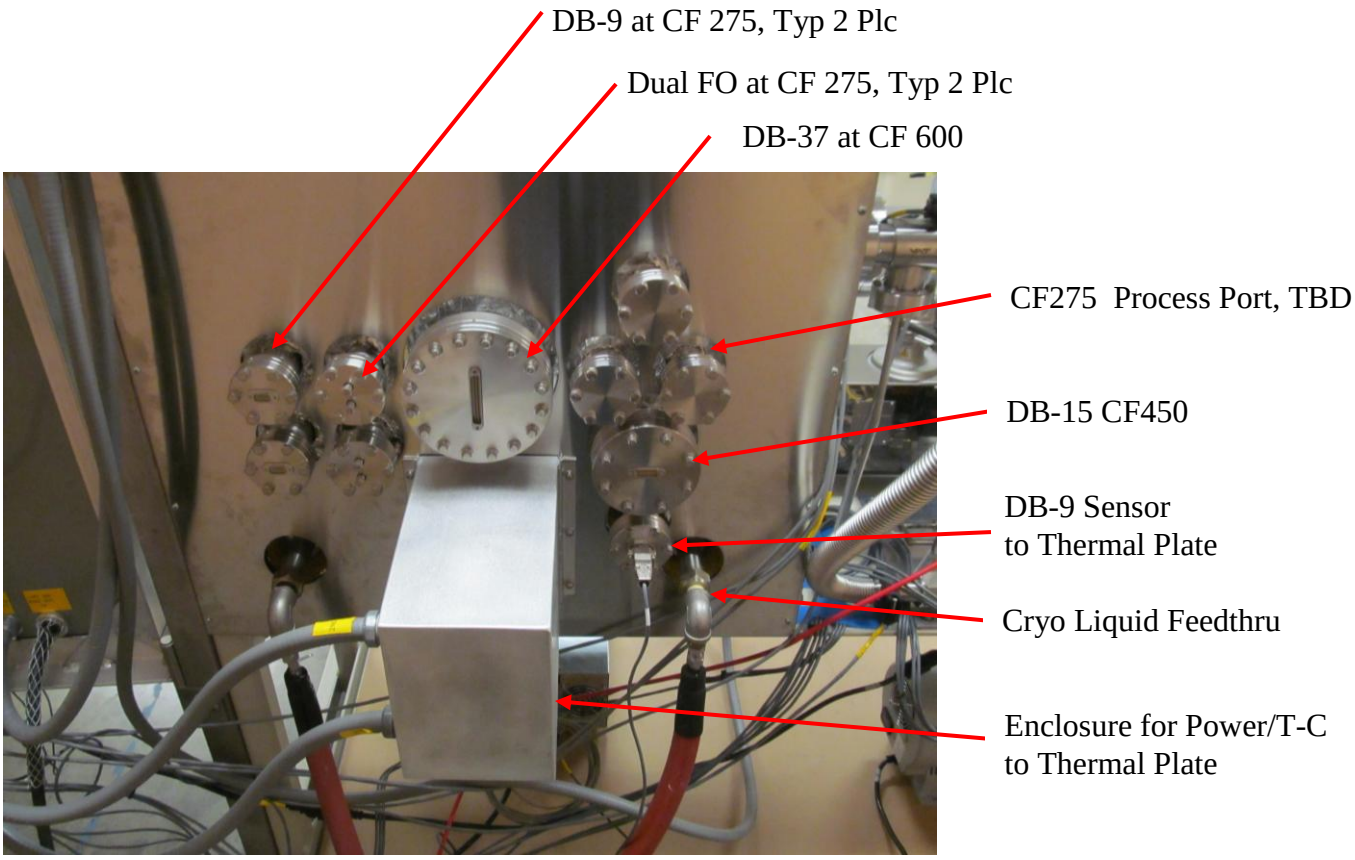


Figure 6 – Detail View of Process Feedthru's at Chamber Rear

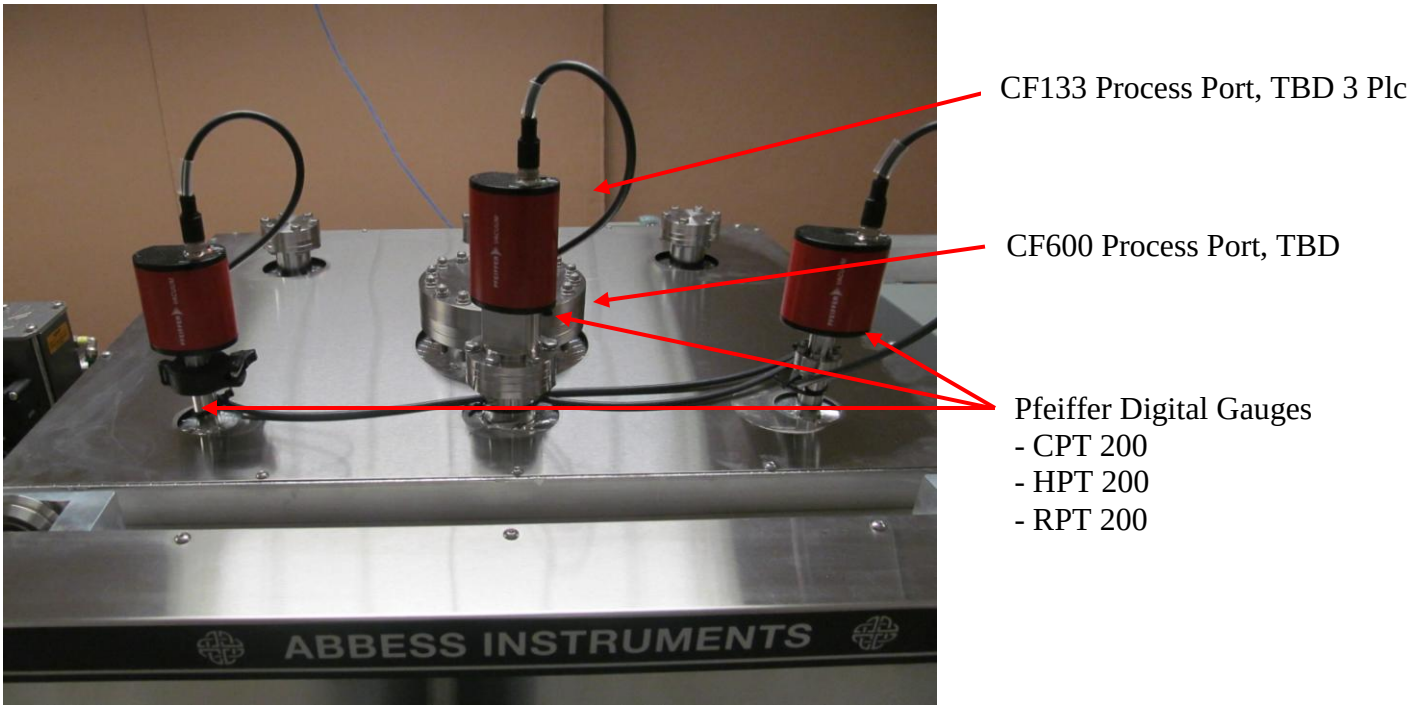


Figure 7 – Detail View of Process Feedthru's at Top of Chamber

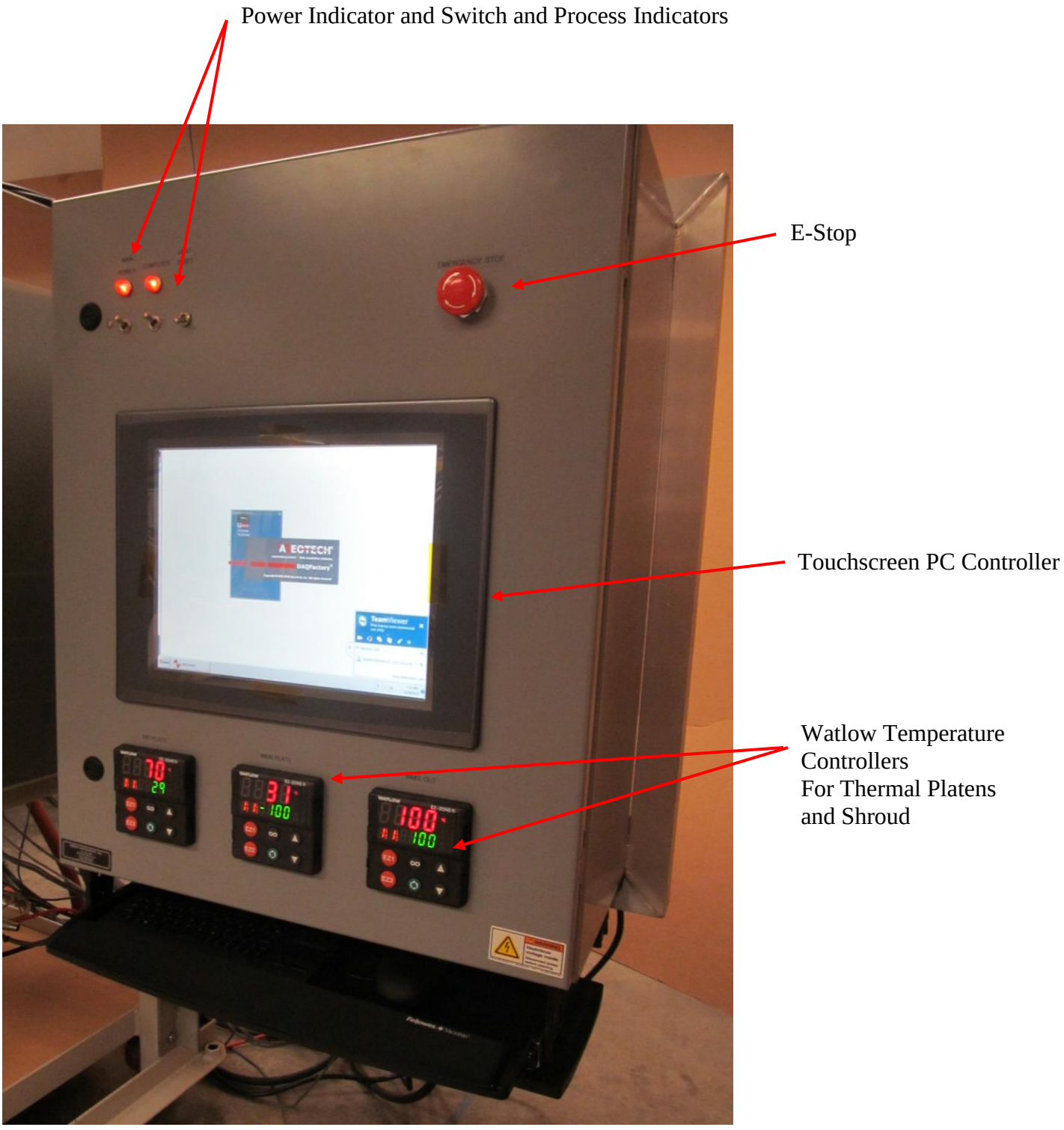


Figure 7 – Thermal Vacuum Cycle Control Detail

Thermal Vacuum Control - Sequence of Operation

System Check

Verify the chamber system has been installed, and connected to facilities, in accordance with sections elsewhere in this manual.

System Start Up

- Operator loads the chamber and secures the properly prepared article(s) under test.
- Operator secures all chamber doors and verifies that all valve and feedthrough ports are secured and ready for vacuum process.
- Operator switches ON the Control Panel power toggle switch.
  The power light indicator will turn on. (Orange)
- Operator switches ON the Computer power toggle switch.
  The power light indicator will turn on. (Orange)
- Wait for the computer to start up Windows 7 OS and load DAQFactory custom control program.
  For more information of the Control Interface GUI refer to page 17.

Pump Down

- To begin pump down process operators should follow the recommended sequence below. It is recommended that the user uses the Pressure page to operate the system.
  - Setup Turbo controller for Soft Start and Active Braking parameters. Check for errors.
  - To start the roughing pump:
    - Be sure that the Turbo Vent Valve is CLOSED.
  - To start Turbo pump:
    - Roughing pump must be pumping.
    - Turbo Pump Gate Valve must be OPEN.
    - Chamber Gate Valve must be OPEN.
    - High Pressure and Low Pressure Angle valves should be OPEN.
    - Pressure must be at the crossover point of LESS than 10 Torr.
  - Start Ion pump:
    - Turbo pump must be pumping.
    - Turbo Pump Gate Valve must be OPEN.
    - Chamber Gate Valve must be OPEN.
    - Ion Pump Gate Valve must be OPEN.
    - High Pressure and Low Pressure Angle valves should be OPEN.
    - Pressure must be at the crossover point LESS than 5×10^{-7} Torr.

      Note: Exposing the Turbo pump to pressuresgreater than 10 Torr must NOT be permitted when the Turbo pump is on.

      Note: Exposing the Ion pump to pressures greater than 5×10^{-7} Torr must NOT be permitted when the Ion pump is on.

Thermal

- The Draper system is capable of cooling and heating the main plate. The top plate is only capable of being heated. The user may setup cooling/heating profiles in the Setup page of the GUI. To run the profiles the user must navigate to therelevant temperature page.

  Note: The chamber must be under vacuum when cooling to avoid condensation and frosting of the thermal plate which will contaminate and possibly damage the system.

System Shutdown/Turn off

- Total System Shut Down
  - Turn off pumps:
    - Turn off Ion pump
    - Turn off Turbo pump
    - Turn off Roughing pump
  - Vent the chamber (optional)
  - Turn off other devices:
    - Stop flow of Alicat Mass flow Controllers
    - Close Alicat Valves
    - Close Angle Valves
    - Be sure no temperature profiles are running
    - Set Watlow set points to room temperature
    - Turn off Glacier on Main Plate Temperature page
    - Close All Gate Valves

- Vent the chamber
  - Either open the Turbo Vent Valve while all the gate valves are open
  - Or use the Alicats to flow sufficient gas into chamber to reach atmospheric pressure

- Exiting GUI program

  - The operator may exit the GUI program by clicking "QUIT" on the Central page.
  - The operator can then shut down the computer through the OS
  - To cut power to the computer, the operator may switch off the power to the computer on the control panel.

  Note: Closing the GUI program will not stop the system devices.
  Warning: If the chamber is at a pressure above atmospheric pressure then opening the door can constitute a hazard. Before opening the chamber, be sure that the chamber is not under pressure. To open the chamber door, the pressure inside the chamber must be at atmospheric pressure, not above or below.
  Warning: The thermal plates and the bake out system are capable of reaching high temperatures which can pose a hazard. Be sure that the thermal plates and bake out are at room temperature before venting the chamber or opening the chamber door.

- Emergency Stop
  Pressing the manual Emergency Stop button on the control panel cuts all power immediately.

  Note: Components may suffer damage as a consequence, so this method must NOT be used for system shutdown.

Custom Abbess: System Monitor and Control Interface GUI (Graphical User Interface)

Central Screen

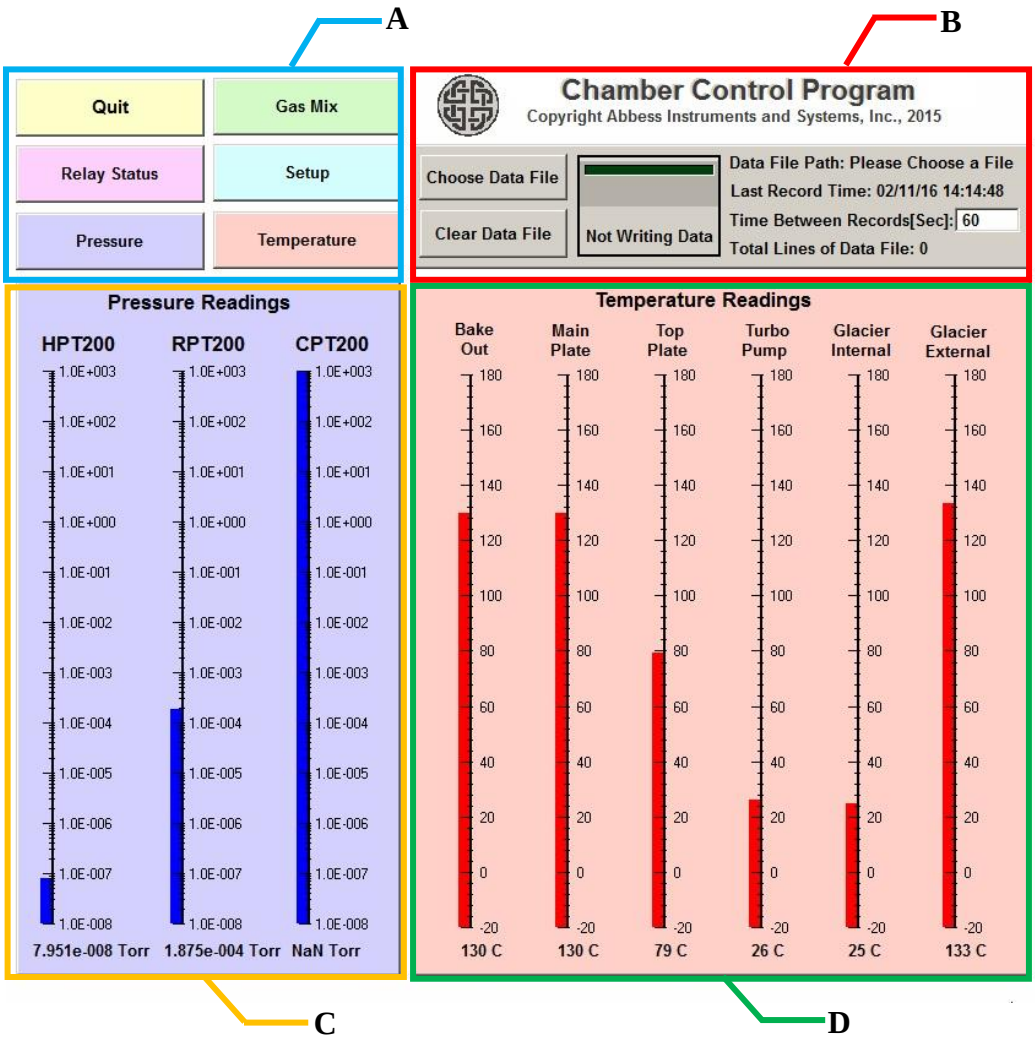


Figure 1 - Central Screen of the Draper GUI

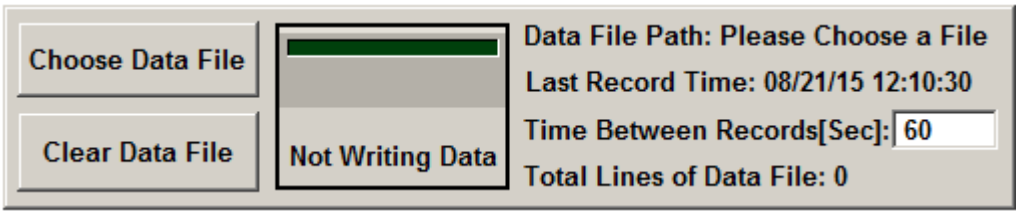
Upon booting the system computer the GUI will initialize beginning with the central screen as shown in Figure 1.

Central Screen

A- Menu

This allows users to navigate to the **Gas Mix**, **Relay Status**, **Setup**, **Pressure**, and **Temperature** pages, as well as **Quit** the program.

B- Data file Settings Panel



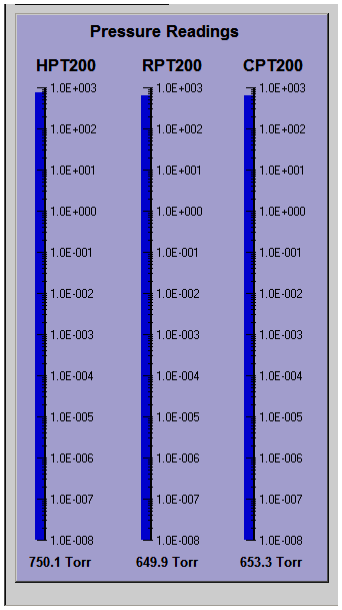
User may create or select a data file. To file data to a new or existing file the user can press **Choose Data File** and then type a new file name that has not been used. This will generate a new file, but users can also select an existing file if desired. Press **Clear Data File** to clear the chosen file. Otherwise the file will be appended with the incoming stream of data.

The data file is a text file and is comma delimited. It can be opened by Notepad or Excel in addition to the control program. The time between the writing of one of data and the next can be entered by the user in the text box labeled **Time BetweenRecords [Sec]**. This is a variable under the control of the user, but cannot be made too small. We recommend a value no smaller than 2 seconds.

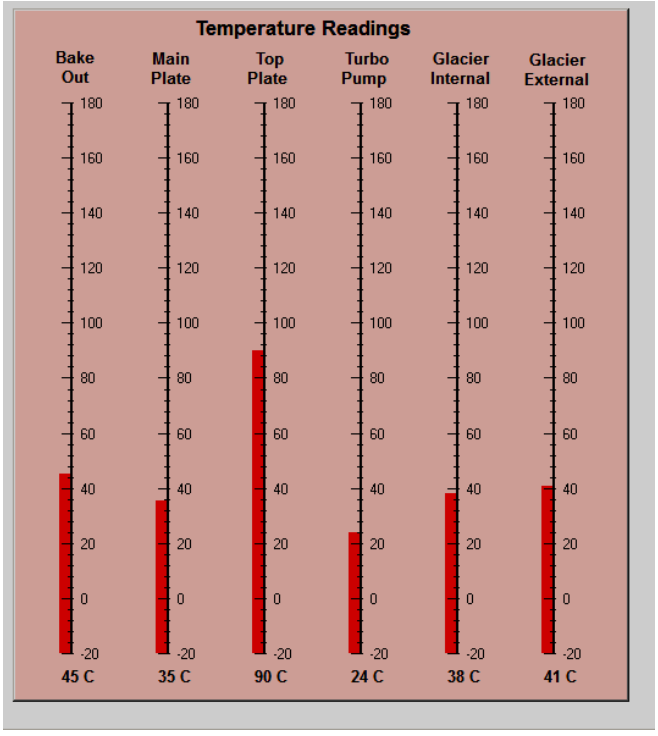
The data consists of records including a time in seconds since 01/01/1970 00:00:00 together with the readings of:

- Adam States (which relays are on/off)
- RPT200 (Pressure)
- HPT200 (Pressure)
- HPT200 (Pressure)
- Ion Pump (Measured Pressure)
- Bakeout Temperature
- Main Plate Temperature
- Top Plate Temperature
- Turbo Temperature
- Glacier Internal Temperature
- Glacier External Temperature
- Ion HV1 Temperature
- Ion Fan Temperature
- Turbo Spinning (Status)
- Turbo Vent Valve State
- Turbo Wattage
- Turbo Status
- Ion State
- Ion Voltage
- Ion Current
- Ion Error Code
- All Alicat Setpoints

C- Displays Pressure readings according to **HPT200**, **RPT200** and **CPT200**.



D- Displays Temperature readings according to **Bake Out**, **Main plate**, **Top plate**, **Turbo Pump**, **Glacier50** internal and external.



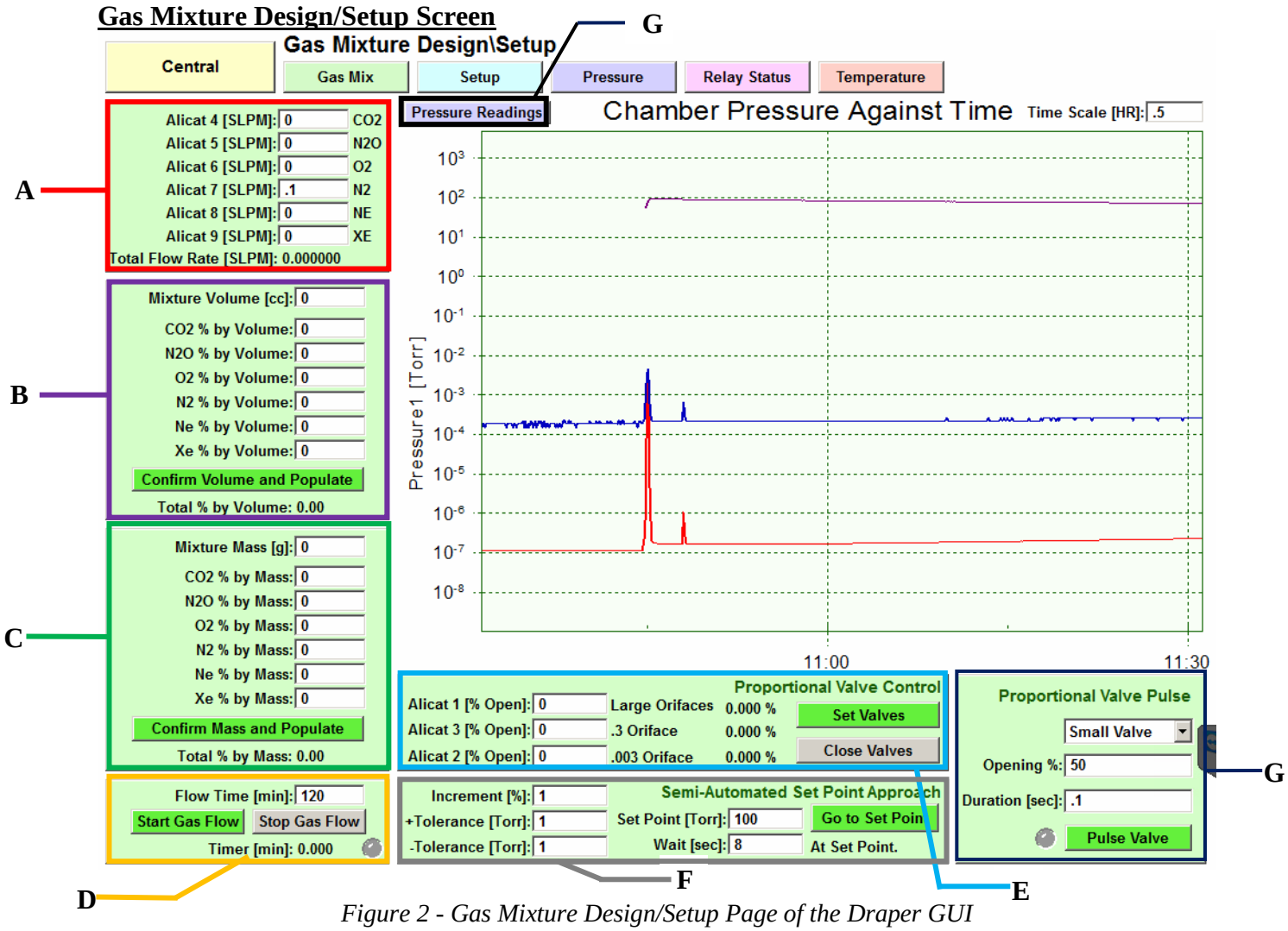


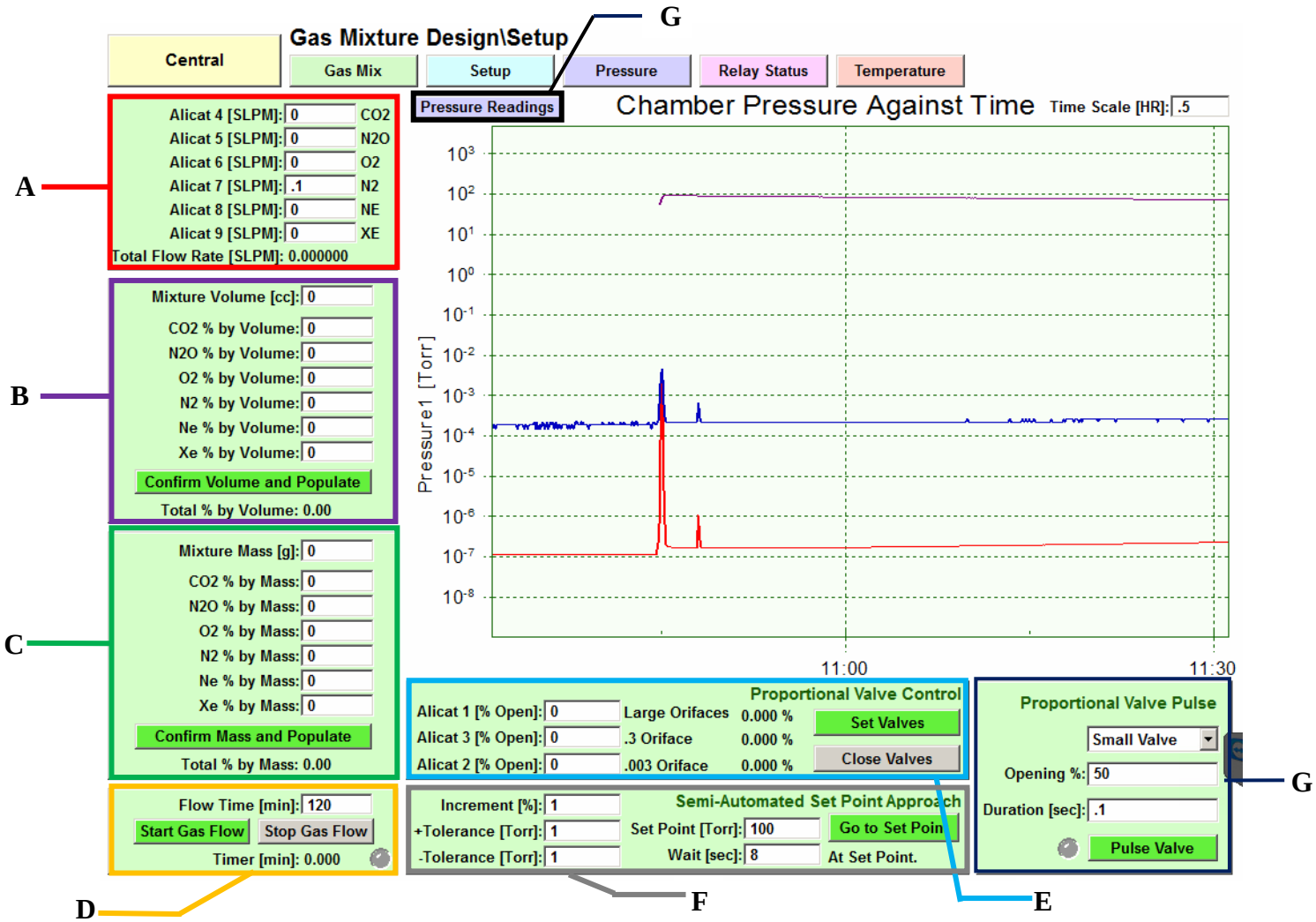
Figure 2 - Gas Mixture Design/Setup Page of the Draper GUI

A – Alicat Gas Mixture
This panel sets the Alicat mass flow controllers to setpoint ranging from 0 to 100 SLPM (Standard liter per minute. The user has the option to set these values manually or they can be calculated by the program based on mass or volume.

B – Gas Mixture by Volume
The user can choose a total volume for the mixture, and can set the percent amount of each gas to create the mixture by volume. The Confirm Volume and Populate button will calculate the SLPM values for each Alicat and populate their text boxes with the respective value.

C – Gas Mixture by Mass
The user can choose a total mass for the mixture, and can set the percent amount of each gas to create the mixture by mass. The Confirm Mass and Populate button will calculate the SLPM values for each Alicat and populate their text boxes with the respective value.

D – Flow Time
The user must enter a **Flow time [min]** when creating a gas mixture. This value is used to calculate the SLPM values for each Alicat. This value is also used to automatically stop the gas flow once the timer reaches the value in the flow time text box. Once the user has defined a gas mixture the mass flow controllers can be activated by pressing the Start Gas Flow button and stopping by pressing the Stop Gas Flow button. User will be able to see the elapsed time of the gas flown and green led stating gas is flowing.

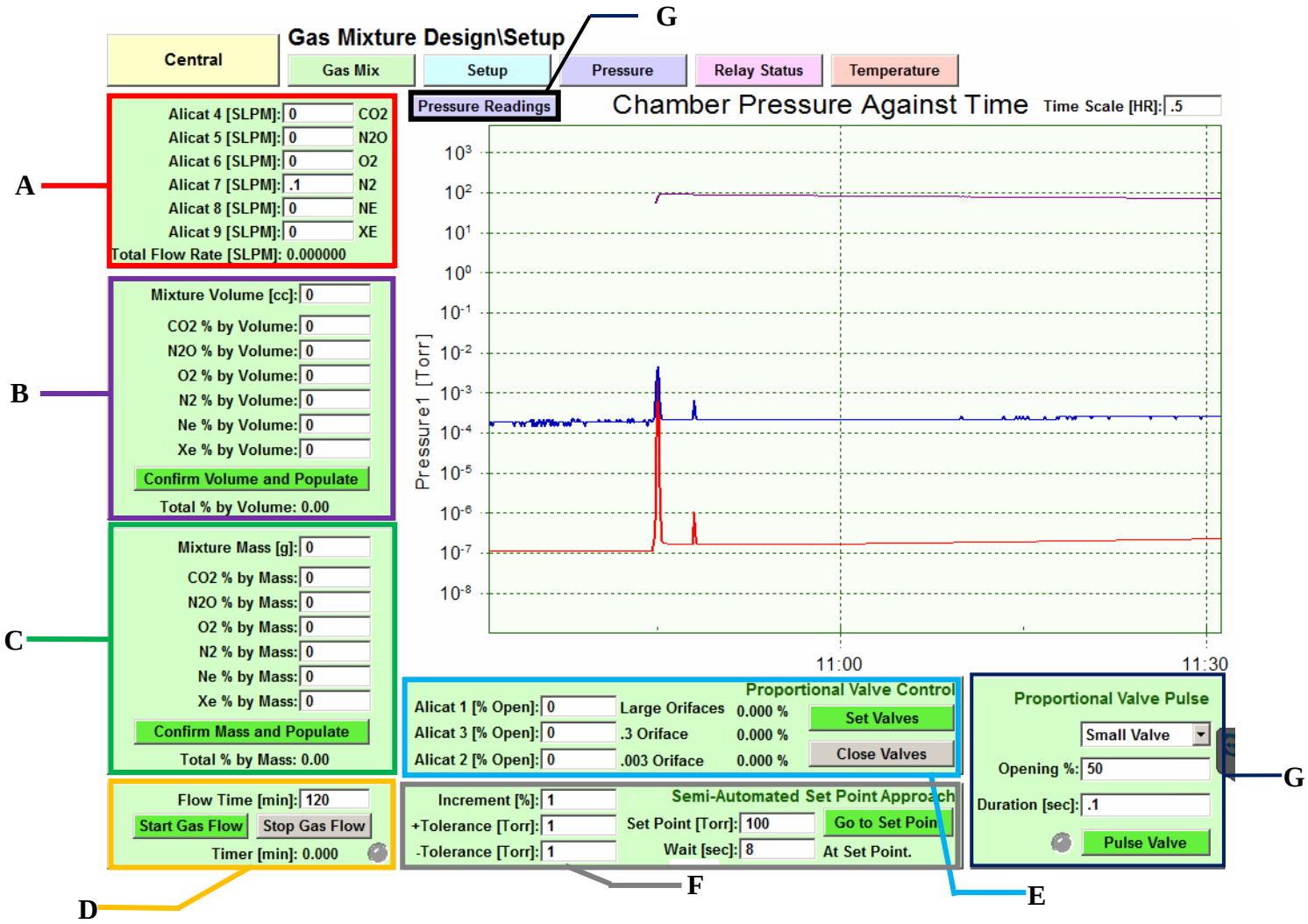


E – Proportional Valve Control

To open the proportional valves manually the user can input a percent open for each of the three proportional valves and when the set valves button is pressed, the value in the fields will be sent to the appropriate proportional valves. The close valves button will set all three proportional valves to zero (closed). The value in the fields are expected to be a number between 0 and 100.

F – Semi-Automated Set Point Approach

To obtain a pressure set point in a semi-automated method, the user can use the following method. The user provides information in the fields and presses the go button, the system will attempt to attain the set point provided. The increment % field allows the user to enter the starting increment of the entire 3 valve system per cycle that the algorithm will initially use to approach the set point. The user can also enter the tolerances: + for above, and – for below the set point. The pressure will be reported to be at set point when the pressure is in the interval [Set Point - (-Tolerance), Set Point + (+Tolerance)]. Wait is the amount of time to delay before the next output is calculated and sent to the valves. The values in all these fields are expected to be positive numbers. This function was designed to be used to approach pressure set points when the pumps are actively evacuating the chamber and there is sufficient pressure in the Alicat manifold, but can be used to obtain a pressure set point above 10^{-2} Torr with the pumps off.

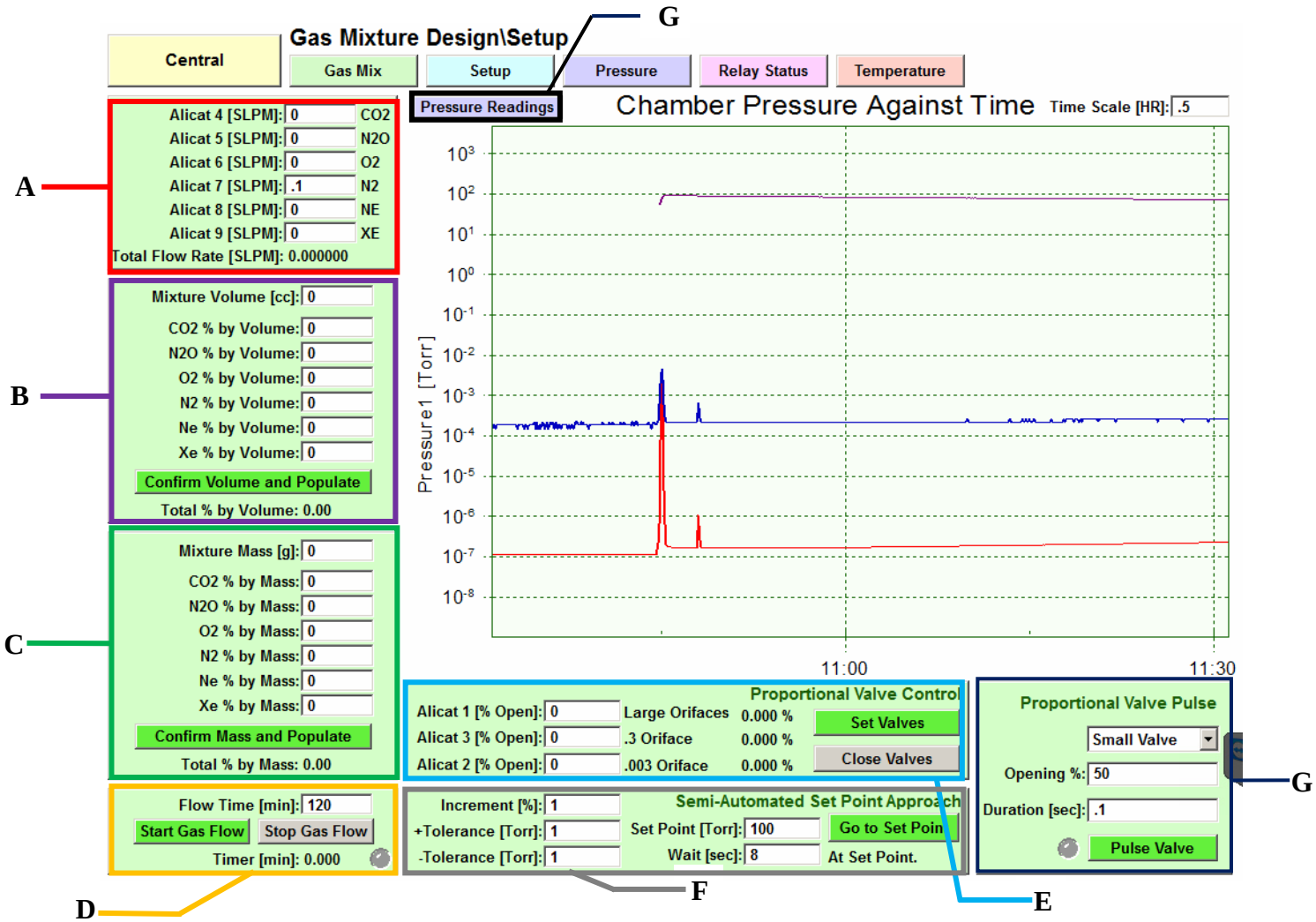


When the user presses the Go to Set Point button an independent thread begins by which the 3 available valves from the Gas flow system are controlled through repeated cycles to close in on a valve setting which, together with the pumps, allows the chamber pressure to stay within tolerance of the desired set point. Once the “Go to Set Point button is press it will turn to “Stop”. Pressing the “Stop” button will stop the thread and the Alicat valves will stop opening, but remain in the current position.

When this thread starts the full increment is added to the valve setting to bring the pressure up to set point. If the pressure then passes the set point and goes out of tolerance above it, this increment is halved and then subtracted from the valve setting until the pressure comes again within tolerance of the set point. If it then slips out of tolerance on the low side the valve setting is again increased to raise the pressure but with and increment halve of what it was. Which each new approach to the set point the increment used to adjust the valve setting is half of what it was before. This way in each cycle the set point approach is slower and more gradual.

In this way oscillations of the pressure are damped down with the result that given no anomalous interference from the hardware, the system will converge stably to the set point. This process is dependent upon the user's supplying the manifold with sufficient pressure through a gas flow and starting the appropriate pumps to accompany this.

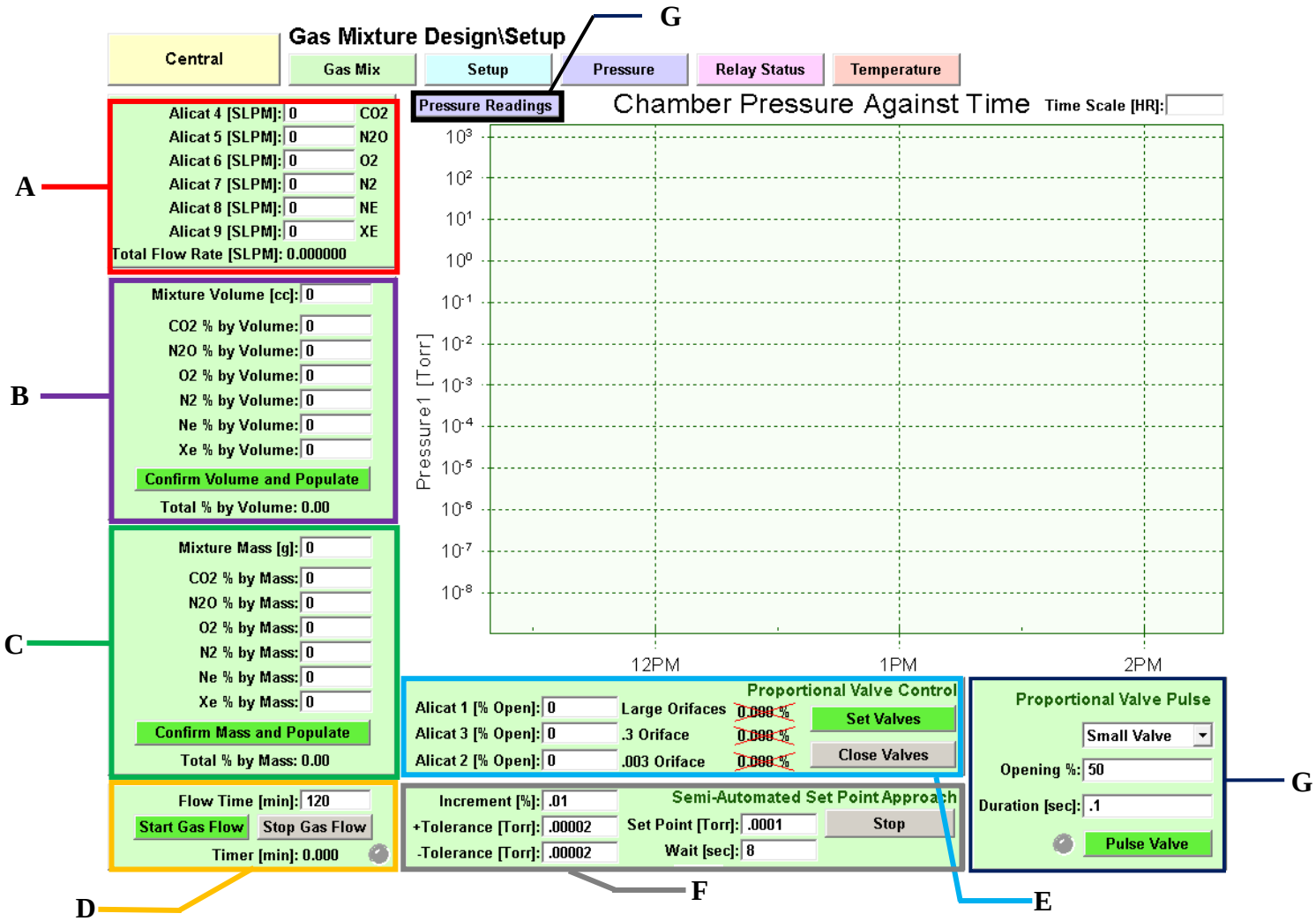
The set point and tolerances for the process are entered in Torr. +Tolerance is the distance above the set point that the pressure can go and still be considered to be "at set point". Similarly, -Tolerance is the distance below the set point that the pressure can go and still be considered to be "at set point".



The user has control in real time over the wait time which is the number of seconds the process takes to make a cycle. Since pressure is measured by the system approximately every 7 seconds, a wait time of more than this amount is recommended.

Semi-Automated Set Point without pumps:

This method can also be used to obtain pressure ranges above 10^{-2} with roughing and turbo pumps off. Chamber will need to be initially pumpdown pass the desired chamber pressure setpoint. User will then need to make sure that the chamber gate valve is closed and isolated from the pumps. Pumps should also be turned off manually. Naturally the chamber pressure will increase because outgassing will occur once the pumps are isolated from the chamber. User should allow the chamber to outgas until it reaches a steady state. This sequence will also assume that the gas mixture has been set and gas is flowing as the sequence runs. To obtain accurate setpoints user will need to define a smaller increment and adjust the tolerance. Once chamber pressure setpoint is within the tolerance, the program will automatically close all the proportional Alicat valves and gas flow into the manifold will stop. If increment are too large and tolerance is too tight the chamber pressure setpoint will overshoot. User will need to stop the pressure setpoint sequence and pump down the chamber below the desired setpoint and start again.



G – Proportional Valve Pulse

To obtain pressure set point in the chamber manually users can slow input a gas mixture into the chamber in a pulsing method. This method is to be used after the chamber has been pumped down in vacuum, chamber should be isolated from the pumps and then pumps should be off allowing the chamber to outgas to a steady state pressure. User selects which proportional valve to pulse, the amount in percent to open that valve, and the duration to keep it open for, then presses the pulse button to perform the pulse specified. The light indicator next to the button will be green during the time of the pulse. This function was designed to be used to approach pressure set points when the pumps are not actively evacuating. The Opening % field is expected to carry a value between 0 and 100, and the Duration field is expected to be any positive number, including fractions of a second.

H – Pressure Readings

This button creates a pop up window with the pressure readings of the Alicat manifold, HPT200, CPT200 and RPT200. These are the same values shown in the pressure page.

Relay Status Screen

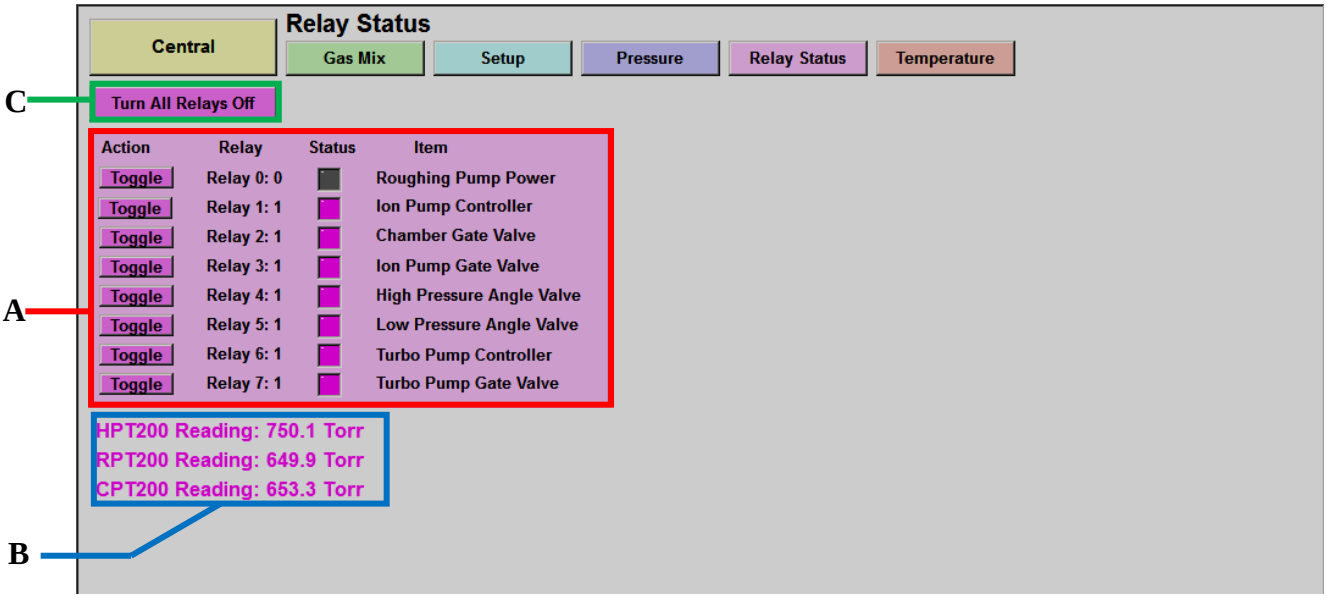


Figure 3 - Relay Status Screen

A–Relay Status Panel
In the Relay Status Screen users may manually control all relays connected to the ADAM 4068 relay controller. Users can click the **Toggle** button on the Action column to toggle the relay accordingly to the item it is lined up to as shown in Figure 2. Upon relay activation the corresponding LED Status will light up.

B–Pressure Readings of the HPT200, RPT200 and CPT200 are displayed as a numerical value.
Note: It is highly recommended to use the **Pressure** page for control of these devices instead of directly altering the relay states through this page, since safety precautions can be bypassed using this page.

C – The Turn All Relays Off button allows the user to close all relays.

Setup Screen

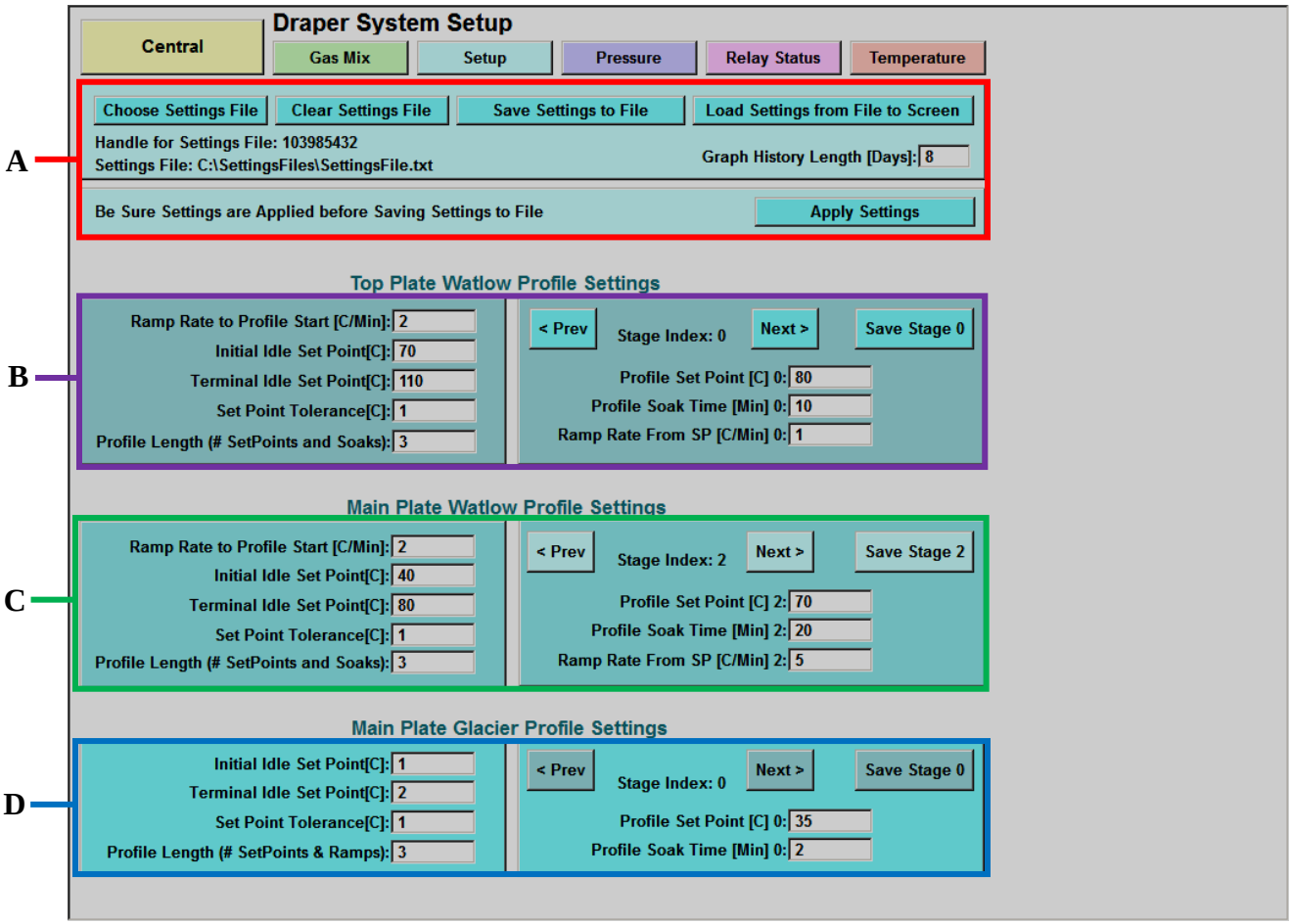


Figure 4 - Setup Screen

System Setup

In the Setup Screen, the user may enter the profile parameters required for the Upper Plate Watlow, Main Plate Watlow and the Main Plate Glacier. Setting and profile parameter can be saved and loaded.

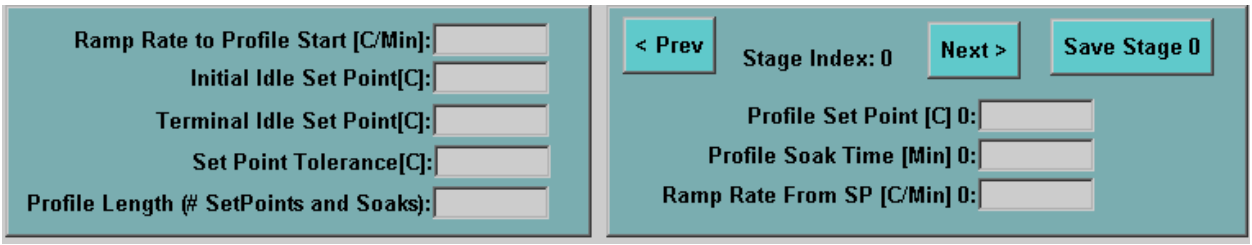
A- The top two panels allows the user to create or choose a file desired to save the settings. This can be done by clicking the **Choose Settings File** button. This button accesses the system where the user can browse to select a settings file or by typing in the desired name. Clicking open will select or create the desired file and show its path.

The "**ClearSettings File**" button can be used to clear any contents of the file. The clearing action is confirmed by a change in the value of the File Handle, the number needed by DAQFactory to reference the file.

Once the settings have been configured the "**Save Settings to Settings File**" button can be used to save the settings to the chosen file. The operator may also load settings from a file using the "Load Settings to Screen" button.

Note: The settings file also includes the settings entered in the Gas Mix page.

Profile Setup (B, C)



This panel sets the temperature profile for the Upper Plate and the Main Plate. For each temperature profile user must enter the Ramp Rate, Initial Idle Set Point, Terminal Idle Set Point, Set Point Tolerance and Profile Length.

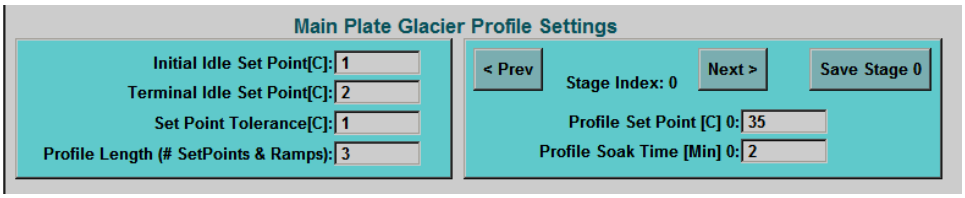
Watlow Profile Start Settings (Left Side)

- **Ramp Rate of Profile Start [ºC/Min] –** User can specify the rate of temperature changeper minute to go from the Initial Idle Set Point to the first profile set point.
- **Initial Idle Set Point** [ºC] – Temperature where the profile will initially start.
- **Terminal Idle Set Point [ºC]** – Temperature where the profile will end.
- **Set Point Tolerance [ºC]** – The range around a given point that the plate temperature must be within to be considered "at set point"
- **Profile Length (# SetPoints and Soaks)** – User can specify a number of repetitions (number of stages) for a described profile instead of defining each repetition as a distinct stage.

Watlow Profile Set Point Settings (Right Side)

The Watlow profile itself consists of a sequence of stages numbered from 0. Each stage consists of (SetPoint, Soak Time, and Ramp Rate) where the Soak time is in minutes and the Set Point in degrees C and the Ramp Rate in C/min.

- **Profile Set Point [ºC]** – User can specify the temperature [ºC] to reach for the profile.
- **Profile Soak Time [Min]** – User can specify the amount of time for the profile to stay at the set profile set point temperature.
- **Ramp Rate from SP [ºC/Min]** – User can specify the rate in temperature [ºC] per minute to leave Profile Set Point.



D - Main Plate Glacier50 Temperature Profile Settings
The Glacier50 temperature settings are the same as the Watlow profile settings except it does not have the option for the temperature change rate.

Example of Profile Setup:
Note: The following example is of a typical Watlow temperature controller profile with cooling and heating. The present system does not have a Watlow temperature controller with active cooling capability. Because of this, the Watlows might not be able to cleanly complete a profile which involves cooling ramps since they will rely on ambient cooling alone. The Glacier50 does have cooling capacity and therefore can run profiles similar to the one below except that the ramp rates are not supported.

In a typical profile of 4 stages is the following:
Stage #: (Profile Set Point[C] #, Profile Soak Time [Min] #, Ramp Rate From SP [C/Min] #)

Stage 0: (40, 30, 1)
Stage 1: (125, 60, 3)
Stage 2: (-45, 45, 4)
Stage 3: (50, 20, 2)

1. Let's say the **Initial Idle Set Point** and **Terminal Idle Set Point** are both 20C and the Ramp Rate to Profile Start is 2[C/M]. The Watlow EZ-Zone temperature controller will ramp from wherever the temperature is currently to 20ºC at a **Ramp Rate** of 1C/min.
2. On arrival at 20ºC it will ramp the temperature at a rate of 2[C/Min] from 20ºC to 40º C to reach Stage 0 of the profile. Once within tolerance of the temperature set point of 40ºC the system will stay at this temperature for 30 minutes.
3. After the 30 minute "soak time" is over the controller will move from 40ºC to Stage 1 temperature of 125ºC at the specified rate of 1ºC/min.
4. On arrival within the temperature set point tolerance of 125ºC, the system controls the temperature to stay close or "soak" at 125ºC for 60 minutes.
5. After the 60 minute "soak time" is over the controller moves the temperature ramp from 125ºC down to -45ºC at the specified rate of3ºC/min.
6. On arrival within the temperature set point tolerance of -45ºC the system controls the temperature to soak at -45C for 45 minutes
7. After the 45 minute "soak time" is over the controller increases the temperature to 50ºC at the rate of 4ºC/min.
8. On arrival at 50ºC the system soaks at 50ºC for 20 minutes and finally heads for 20ºC at 2ºC/min finally arriving at the **Terminal Idle Set Point**.
9. The controller then maintains the system temperature at 20ºC until it receives other instructions.

Note: For further details of thermal control refer to the Glacier 50 and Watlow manuals.

Pressure Control and Pump Down Screen

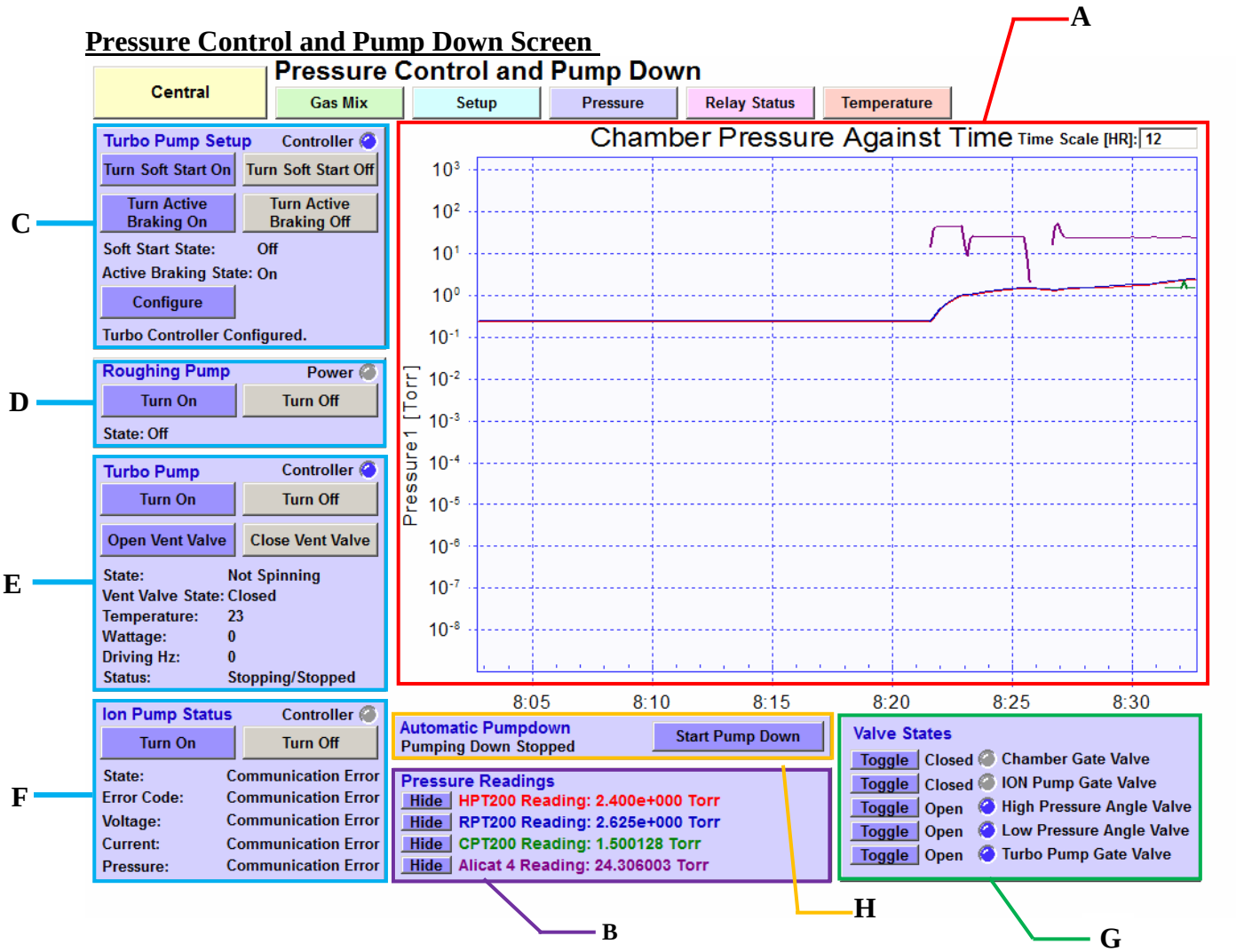


Figure 5 - Pressure Control and Pump Down Screen of Draper GUI

A - Pressure Control and Pump Down screen displays Chamber Pressure on a graph. User may choose the desired time scale of the graph to be shown.

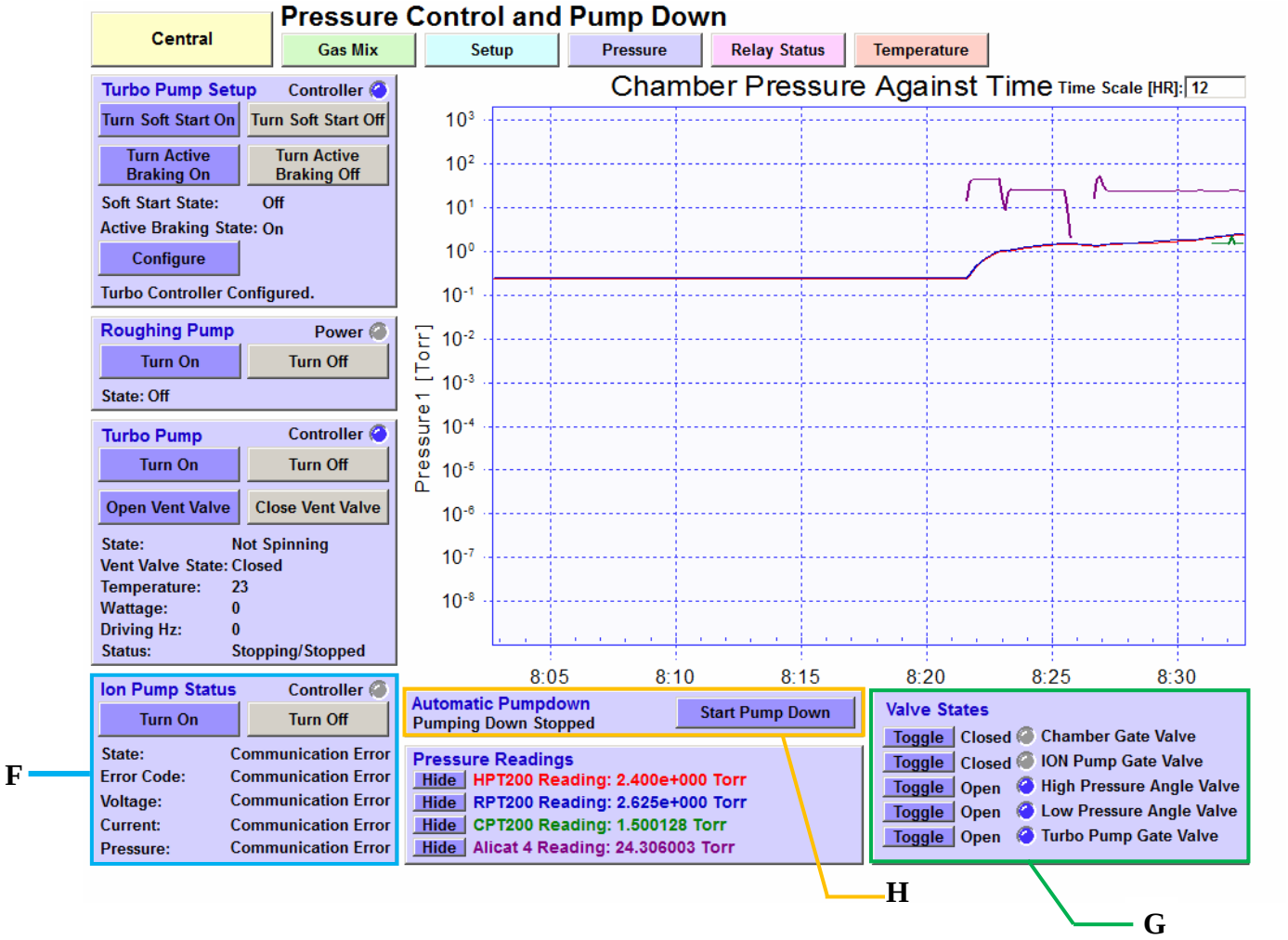
B - Pressure Readings of the **HPT200**, **RPT200** and **CPT200** are displayed as a numerical value and the user has the option to **Show** or **Hide** the readings as traces on the graph.

C - Turbo Pump Setup
The user is allowed choose the settings for **Soft Start** and **Active Braking**. Users must configure **Soft Start** and **Active Braking** and click **Apply.** Not configuring the turbo pump will prevent user to turn the turbo pump on.

D - Roughing Pump can be turned on/off directly by clicking **Turn On** and **Turn Off**. Upon startup of the roughing pump the turbo vent valve will close if not already close.

Note: the Turbo Controller must be configured first in order to close the turbo vent valve.

E - Turbo Pump allows the user to turn on/off the **Turbo Pump** and **Vent Valve**. To turn on/off the **Turbo Pump** the user must have configured the turbo and the chamber pressure must be less than 10 Torr. The **Vent Valve** can be turned on/off by clicking **Turn On/Turn Off** respectively. Turbo pump panel displays the **Turbo** and **Vent Valve** states. It also displays the Turbo's **temperature**, **Wattage** and **Driving Hz** (Frequency).

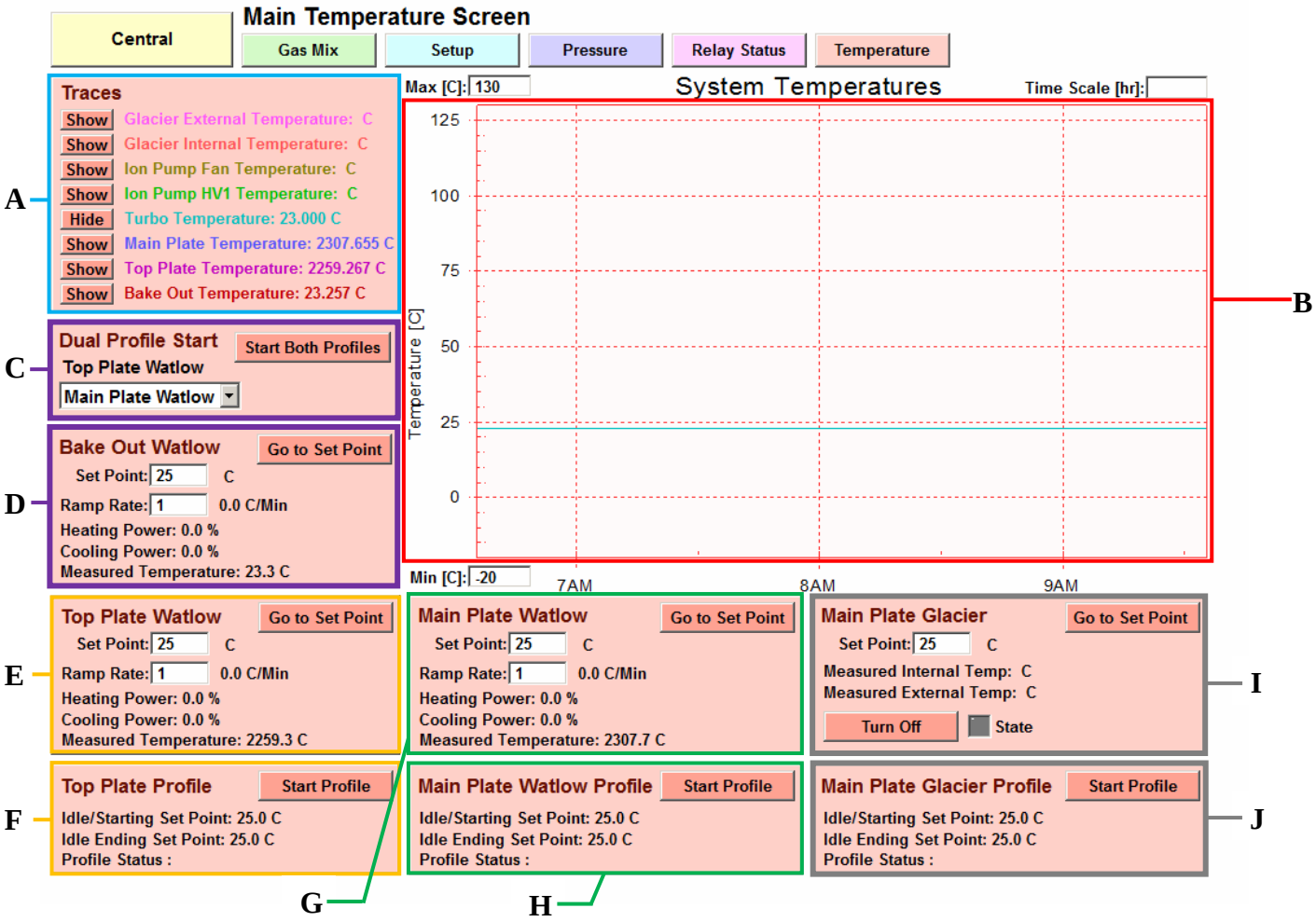


F - Ion Pump Status panel allows the user to turn the Ion Pump on or off by clicking **Turn On/Turn Off** respectively. The panel also displays the **Ion Pump state, Error Code, Voltage, Current** and **Pressure**.

G – Valve Status allows the user to open each valve connected to the chamber and displays the status of each valve. Each valve has it corresponding toggle button.

H – Automatic Pumpdown panel allows the user to start the automatic pumping sequence. The automatic pumping sequence will power the turbo controller, configure it,close the turbo vent valve, open the chamber gate valve, turbo gate valve, and start the roughing pump. All other valves will be closed upon automatic pumpdown. The automatic pump down sequence will pump with the roughing pump until the chmaber is under 10 Torr and automatically turning on the Turbo pump. Once the "Start Pump Down" button is pressed the button caption will change to "Stop Pump Down", pressing this button will stop all the pumps and closed all valves.

Main Temperature Screen

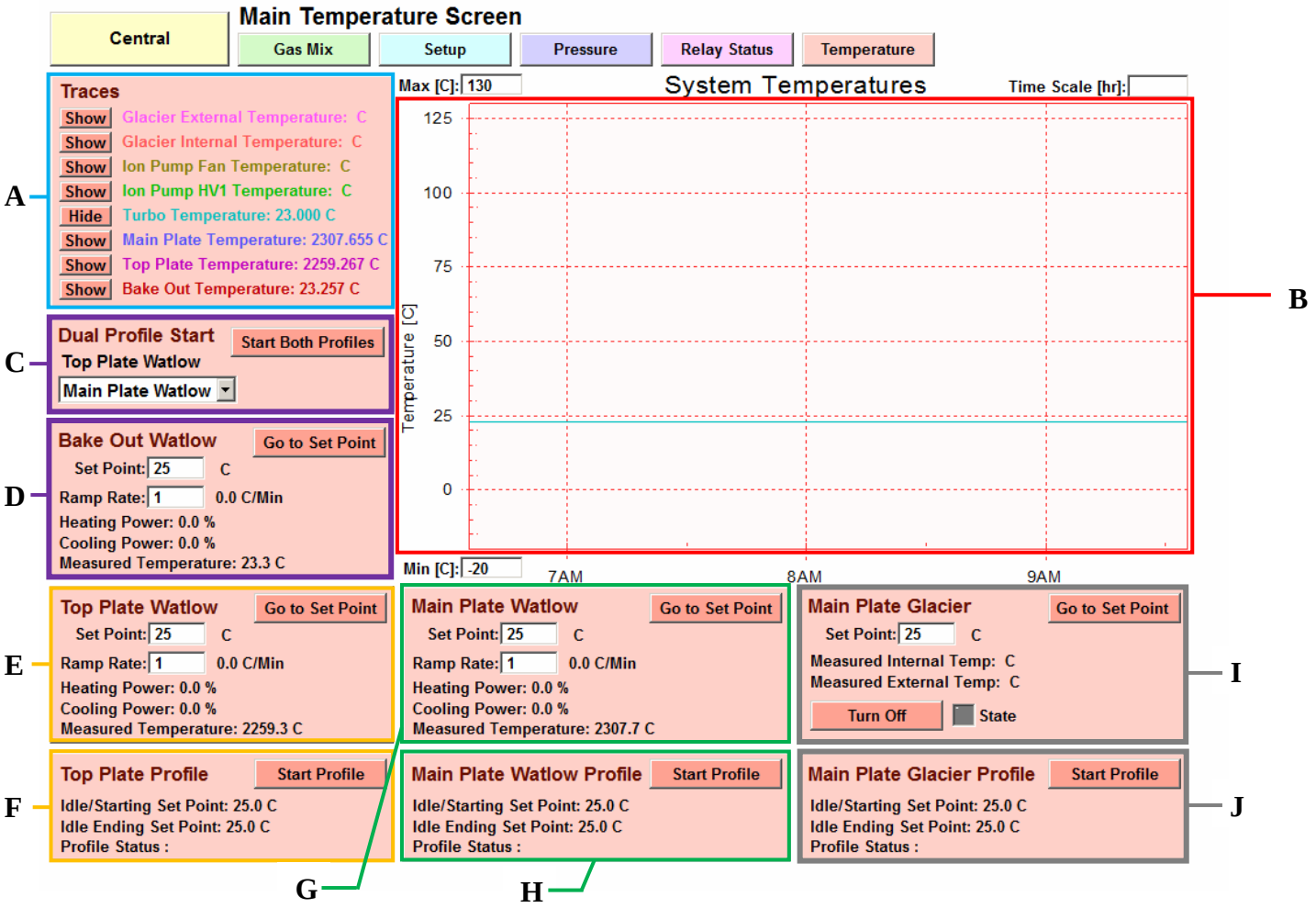


A - Main Temperature Screen displays all the temperatures of the following instruments:

- Glacier External Temperature
- Glacier Internal Temperature
- Ion Pump Fan Temperature
- Ion Pump HV1 Temperature
- Turbo Temperature
- Main Plate Temperature(Watlow)
- Top Plate Temperature (Watlow)
- Bake Out Temperature(Watlow)

The trace key distinguishes the different trace colors and allows the users to hide any of the traces by clicking the corresponding **Hide** button, which will toggle into a **Show** button, which will show the trace again.

B – **System Temperature Graph** displays the temperatures for different instruments. The user may set the Max and Min ranges of the graph. Time Scale allows the user to choose the desired time frame of the graph to be shown.

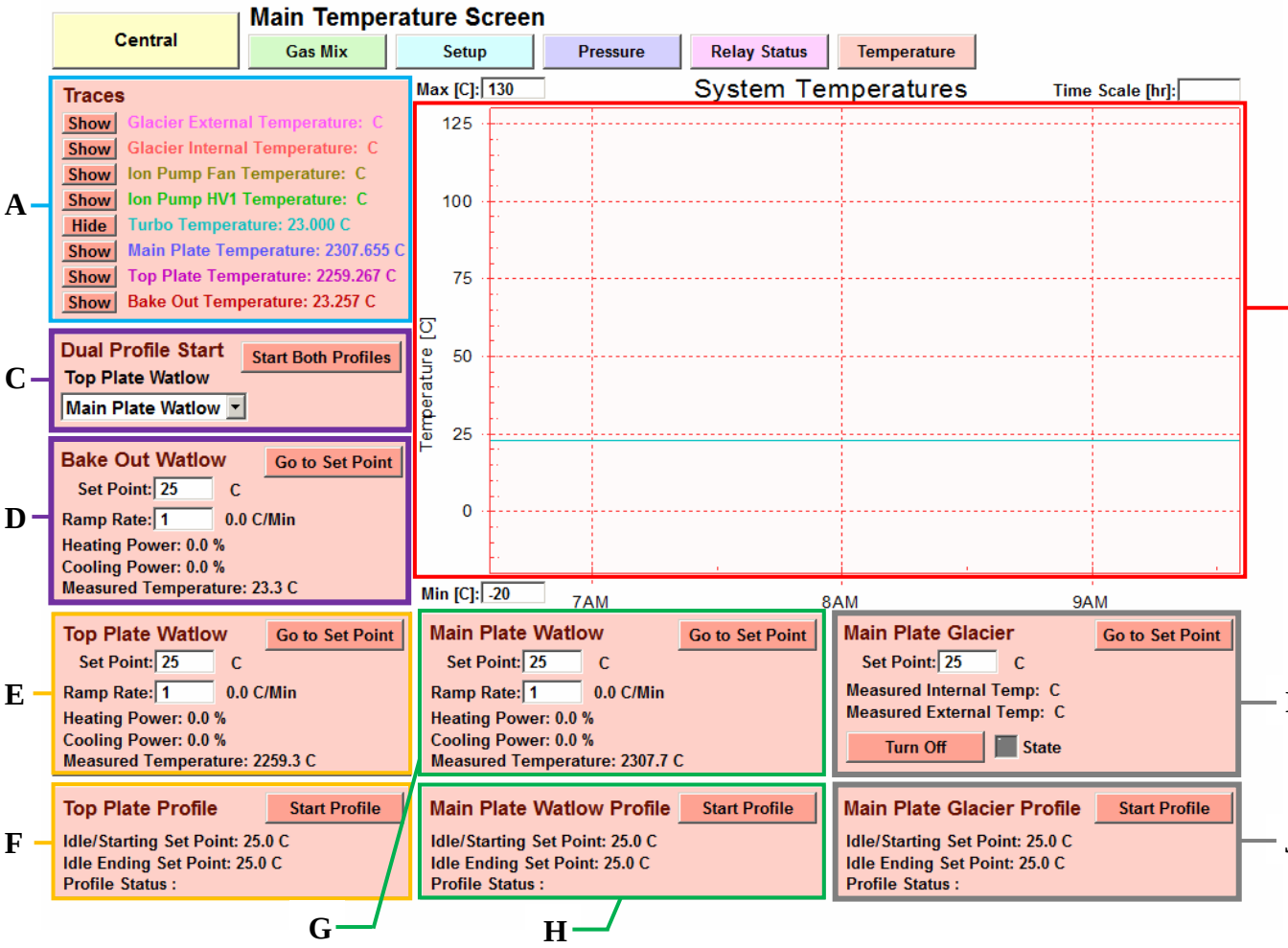


C – **Dual Profile Start** (start two profiles at the same time)
User selects a profile to run on the main plate (choice is between the Glacier or Watlow). When the "Start both profiles" button is pressed, the profile selected as well as the top plate Watlow profile will begin. If the main plate Watlow profile is chosen, the Glacier is turned off. If the main plate Glacier profile is chosen, the Watlow's set point will be set to -200 and its ramp rate will be set to 5. This is done automatically to prevent the glacier and Watlow from fighting each other; only one of the two main plate temperature options should be active at a time. This function only works if the selected profiles are both in the stopped status.

D –**Bake Out Watlow** allows the user to choose a **Set Point** and the **Ramp Rate to Set Point**. It also displays the **Heating Power [%], Cooling Power [%]** and the **Measured Temperature[C]** from the Watlow.

E –**Top Plate Watlow** allows the user to begin ramping by clicking **Go to Set Point**. Users will be able to choose a**Set Point** and the **Ramp Rate to Set Point**. The panel will also display the **Heating Power [%], Cooling Power [%]** and the **Measured Temperature[C]** from the Watlow.

Note: The Watlow controller controlling the Top Plate/Bake Out has no active cooling ability, so the user should not expect the controller to ramp to set points that are lower than the current temperature of the plate.



F –**Top Plate Profile** allows the user to begin profile by clicking **Start Profile**. The panel will display the **Idle/Starting Set Point**, **Idle Ending Set Point** and **Profile Status**.

G –**Main Plate Watlow** allows the user to begin ramping by clicking **Go to Set Point**. Users will be able to choose a **Set Point** and the **Ramp Rate to Set Point**. The panel will also display the **Heating Power [%], Cooling Power [%]** and the **Measured Temperature[C]** from the Watlow.
Note: The Watlow controller in this panel has no active cooling ability, so the user should not expect the controller to ramp to set points that are lower than the current temperature of the plate.

H – **Main Plate Profile** allows the user to begin profile by clicking **Start Profile**. The panel will display the **Idle/Starting Set Point**, **Idle Ending Set Point** and **Profile Status**.
Note: The Watlow controller in this panel has no active cooling ability, so the user should not expect the controller to ramp to set points that are lower than the current temperature of the plate.

I – **Main Plate Glacier** allows the user to turn on/off the cooling to the Main Plate using the Glacier50 cooling bath. The user is able to input the **Set Point** temperature. The panel will also display the measured internal and external temperature of the Glacier50. The **Target Set Point** will be displayed for the user.

J –**Main Plate Glacier Profile** allows the user to begin profile by clicking Start Profile. The panel will display the **Idle/Starting Set Point**, **Idle Ending Set Point** and **Profile Status.**

Note: For further details of thermal control refer to the Glacier 50 and Watlow manuals.

Maintenance and Cleaning

Cleaning the Stainless Steel Components - The Stainless Steel components may be cleaned with a cleaner approved for use with Stainless Steel. Non-abrasive cleaners are recommended to preserve the surface finish. Non-abrasive scouring pads are recommended. Scrapers and non-metallic scouring pads may be used on heavily soiled areas. If scrapers are used caution must be used to not damage the chamber surface. Rinse all areas with water using a sponge or towel. Dry thoroughly.

NOTE: DO NOT RINSE ELECTRICAL EQUIPMENT UNDER RUNNING WATER!!!

Recommended Cleaning Agents (Cannot contain oil)

Sparkle -Ammonia Free Cleaner	non-abrasive

Decontamination – No hazardous materials are used in this equipment. In the event of a hazardous material spill by the user or outside source, immediately contact your laboratory safety officer or the manufacturer of the material for instructions on clean up or other decontamination procedures. Reference your Material Safety Data Sheets (MSDS) for instructions on proper clean-up and handling procedures.

Calibration

Calibration of all components is subject to user's internal calibration standards.

Service and Returns

In the event a product purchased from Abbess Instruments needs service or must be returned please follow the outlined procedures below

Contact Abbess Instruments Technical Support Department

Before returning any product to Abbess Instruments for any reason, please contact Abbess Instruments at 508-881-8811. Support is available Monday through Friday from 8:30 AM to 5:00 PM EST. Support is available free of charge to customers of Abbess Instruments in good standing for all products sold by Abbess Instrument.

Pack the Product for Return Shipment

The product should be packaged in its original shipping carton or crate if available. If other packaging is required, use a suitable shipping container, which will allow a minimum of 2 inches clearance between the product and the walls of the shipping carton or crate. Peanuts, semi rigid foam, cardboard, and other items may be used inside for packaging. Care should be taken when packaging heavy items. Some packaging, such as peanuts, will allow the item to shift in transit and may result in damage.

Insurance

Most common carriers offer insurance. UPS and Federal Express automatically insure your product up to $100 without charge. It is highly recommended that you insure your product. Abbess Instruments is not liable for any return shipping damages.

Documentation

When returning items to Abbess Instruments, a packing slip or other document must be included with the following information: Contact person's name and phone number, return address, and statement of the problem.

How Will Your Return be Handled?

Abbess Instruments will evaluate the returned item for damage. If the return is a repair, the product will be examined for problems and a repair estimate will be made. The contact person will be contacted, at which time a Purchase Order will be requested. After the PO is issued, the product will be repaired and return shipped. The repair will be done in an expeditious manner. The contact person will be notified immediately in the event any shipping damage has occurred.

Shipping – Claims for Damage or Shortage

Abbess Instruments makes a sincere effort to ensure your purchase is properly packed and all items listed on the packing slip are in fact enclosed with the shipment. In the event that your purchase is damaged or if any items are missing, please follow the procedures below.

All packaging material must be retained until the issue is resolved.

Thoroughly search all packing material for missing items. Review your packing list for back ordered items and the manual for a list of items affiliated with your purchase.

Contact Abbess Instruments immediately at 508-881-8811.

Carrier is responsible for breakage in transit! Goods shipped by Abbess Instruments were delivered to the carrier in good condition. They were packed with great care using standard approved packaging methods.

If you receive damaged goods, please follow these steps so that we can ensure proper credit to you:

Contact the carrier damage inspection. Hold original carton and merchandise for the inspector.

Please notify Abbess Instruments immediately—(508) 881-8811. DO NOT return damaged goods to Abbess Instruments without authorization. DO NOT return goods that have not been inspected by the carrier.

We are willing to assist you in every possible manner, but please be aware that if you fail to follow the above procedure, the freight carrier or Abbess Instruments may not honor your claim

STANDARD WARRANTY

ABBESS INSTRUMENTS PRODUCT (THE UNIT) WAS CAREFULLY TESTED AND INSPECTED BEFORE LEAVING THE FACTORY.

WE WARRANT THIS PRODUCT TO BE FREE FROM DEFECTS IN MATERIAL AND WORKMANSHIP UNDER NORMAL USE AND SERVICE FOR 12 MONTHS FROM THE DATE OF RECEIPT, WITH THE FOLLOWING EXCEPTIONS:

ABBESS ACRYLIC LIDS AND ACRYLIC VACUUM CHAMBERS ARE DESIGNED TO BE ROBUST, HOWEVER DUE TO THE NATURE OF ACRYLIC, ARE NOT MEANT TO WITHSTAND BEING DROPPED, HAVING A POINT LOAD PLACED OF THEM OR WITHSTANDING SHARP BLOWS. THEY ARE ALSO PRONE TO BECOMING SCRATCHED AND ABRADED, ESPECIALLY WHEN CAUSTIC SAMPLES ARE PLACED INSIDE OF THE CHAMBER OR WHEN SOLVENTS CONTAINING CAUSTICS OR ABRASIVES ARE USED TO CLEAN THE ACRYLIC COMPONENTS OF THE CHAMBER. FOR THESE REASONS ABBESS WILL ONLY WARRANTY THESE ACRYLIC PARTS FROM DEFECTS IN THE WORKMANSHIP AND THE MATERIAL THEMSELVES, BUT NOT FOR ANY EFFECTS OF MISHANDLING OR OTHERWISE NORMAL USE THAT CAN BE DETRIMENTAL TO ACRYLIC.

ALL REFRIGERATION/COOLING UNITS ARE WARRANTEED FOR NINETY (90) DAYS.

THE COMPONENTS OF ABBESS VACUUM CHAMBER SYSTEMS ARE, BY THEIR NATURE, DELICATE. ABBESS INSTRUMENTS STRONGLY RECOMMENDS THAT ALL SYSTEMS CONTAINING ELECTRONICS BE SHIPPED BY AIR. ABBESS CANNOT BE RESPONSIBLE FOR COMPONENTS BECOMING LOOSE OR DAMAGED DURING TRANSIT. WE HAVE FOUND THROUGH OUR EXPERIENCES THAT REGARDLESS OF HOW WELL ELECTRONICS ARE PACKED FOR SHIPPING THEY ARE PRONE TO DAMAGE. FOR THAT REASON WE WILL ONLY SHIP SYSTEMS CONTAINING VACUUM COMPONENTS AND ELECTRONICS VIA AIR UNLESS SPECIFIED OTHERWISE BY THE CUSTOMER. IF A CUSTOMER CHOOSES TO SHIP ANOTHER MODE OF TRAVEL THE CUSTOMER MUST TAKE FULL RESPONSIBILITY, IN WRITING, FOR ANY DAMAGE INCURRED IN SHIPPING.

WARRANTIES WILL BECOME VOID IF VACUUM CHAMBERS ARE KEPT IN AN ENVIRONMENT THAT CAUSES CONTAMINATION TO THE CHAMBER AND ANY OPERATING DIFFICULTIES CAUSED BY DIRT OR CONTAMINATION WILL NOT BE COVERED BY WARRANTY.

IN THE EVENT OF DEFECT IN MATERIALS OR WORKMANSHIP, WE WILL EITHER REPAIR OR REPLACE, AT OUR OPTION, ANY PART WHICH IN OUR JUDGMENT SHOWS EVIDENCE OF SUCH DEFECT.

THIS WARRANTY DOES NOT COVER WEAR OR EXPENDABLE ITEMS SUCH AS GASKETS/O-RINGS/GASKETS OR OIL. THIS WARRANTY DOES NOT APPLY IF, IN OUR OPINION, THE UNIT HAS BEEN MISUSED, ABUSED, ALTERED, TAMPERED WITH, OR USED IN LIFE-CYCLE TESTING. ABBESS WILL ONLY BE RESPONSIBLE UP TO THE COST OF THE UNIT. THIS WARRANTY DOES NOT COVER ANY CONSEQUENTIAL DAMAGES. AT THE END OF THE WARRANTY PERIOD, ABBESS SHALL BE UNDER NO FURTHER WARRANTY OBLIGATION EXPRESSED OR IMPLIED.

FOR THIS WARRANTY TO BE VALID A COPY OF THE PACKING LIST MUST BE SIGNED, DATED AND RETURNED TO ABBESS WITHIN 2 DAYS OF RECEIPT OF THE UNIT.

FOR SERVICE PLEASE REQUEST A RETURN MATERIAL AUTHORIZATION (RMA) NUMBER FROM ABBESS BY CALLING 1-508-881-8811 AFTER AN RMA HAS BEEN ASSIGNED, SHIP THE UNIT, FREIGHT PREPAID,IN THE ORIGINAL CRATING, PREPAID.

THERE WILL BE A CHARGE FOR ALL REPAIRS MADE THAT ARE NOT, UNDER ABBESS JUDGMENT, MADE AS WARRANTY REPAIRS.

CONTACTING ABBESS INSTRUMENTS

Shipping Address:
Abbess Instruments and Systems, Inc.
70 Bartzak Dr.
Holliston, MA 01746
USA

Mailing Address:
Abbess Instruments and Systems, Inc.
PO Box 498
Ashland, MA 01721
USA

Phone: 508-881-8811
Fax: 508-881-4884
Email: abbess@abbess.com

Appendix A~Watlow EZ-ZONE PM – PID Temperature Controller setup
Note – Please read EZ-ZONE PM User's Manual for detailed information.

The setup menu for the PM6 Watlow is reached by pressing the up and down arrow keys at the same time for 6 seconds until "set" appears in green. The arrow keys can then be individually used to move throughout the menus and the green button can be used to select which menu you would like to enter. The infinity key is used to go back to the previous menu.

WATLOW Configuration (PM4R1CA-1AAAAAA)

PM- Panel Mount
4 – 1/4 DIN Horizontal
R – PID controller w/universal input and Profiling Ramp and Soak
1 – 100 to 240VAC
CA – Output 1 = Switched DC Open Collector / Output 2 = None
1 – EIA 485 Modbus RTU.
AAA – Future Options None
A – Isolated Input Option
AA – Standard EZ Zone PM Face Plate.

For each of the Watlows the setup is as follows:

Setup Menu:

Ai(analog input):

- SEn(sensor):tC(thermocouple)
- Lin(linearization):K
- FiL(Filter):0.5
- i.Er(error latching):off
- dEC(decimal places):0.0
- i.CA(calibration offset):0.0

Lnr(linearization): unused(all defaults)

Pv(process value): unused(all defaults)

Dio)Digital Input/ Output: unused(all defaults)

Loop Menu:

- h.AG (heat algorithm): Pid(Proportional, Integral, Derivative)
- c.AG (cool algorithm):Off
- C.Cr (cool output curve):Off
- PIDs will vary depending on tuning see manual for details
- Db(dead band):1
- t.tun (TRU-TUNE+^{TM}): Off
- A.tSP (autotune at setpoint):100%
- t.AGr (tuning aggressiveness): Crit(critical)
- P.dl (Peltier Delay):0
- UFA(User Failure Action): USEr
- FAIL: USEr
- L.dE (open loop detection):no
- Rp (ramp):Stpt
- r.SC (Ramp Scale): Min
- r.rt (Ramp Rate): Set by computer input.

- L.SP (Low Set Point): -100
- H.SP (High Set Point):150
- C.SP(closed loop setpoint): whatever you are trying to get to (same as green number on main)
- Id.S(idle setpoint): 24
- SP.Lo(set point open limit low):-100%
- SP.hi(set point open limit hi):100%
- C.M(command mode): auto

Otpt->1(Output 1):

- Fn (function): Heat
- O.Ct (Time Base Type): Ftb (Bake Out and 2nd Plate Watlows)

  Utb (Main Plate Watlow)
- Fi (functional instance): 1
- o.Lo (scale low):0
- o.hi (scale hi): 100

ALM(alarm): unused(all defaults)

Fun(Function Key): unused(all defaults)

gLbL(Global):

- C_F(display units):C

  Everything else is default

CoM(communications):

- Ad.S (Standard Bus Address): According to program
  -Bake Out: 3
  -Main Plate: 4
  -2nd Plate: 2

  Everything else is default