CTI TOUCH SCREEN

CONTROLLER MANUAL

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OVERVIEW

The CTI chamber controller is a Programmable Logic Controller (PLC) based system. The system is comprised of two main parts, the controller and the Operator Interface Terminal (OIT). This manual discusses the operation of the controller designed specifically to control Chart Industries test chambers and systems.

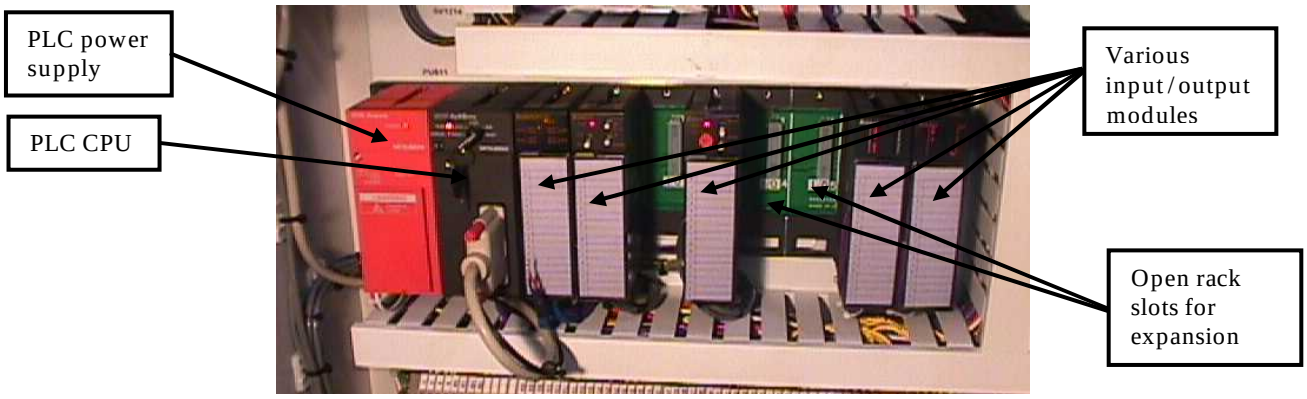
This manual does not discuss the operation, maintenance or troubleshooting of the test chamber. For information specific to the overall chamber, please refer to the Test Chamber Users' Manual, which was supplied with the chamber.

Programmable Logic Controller (PLC)

The heart of the control system is the PLC. A PLC can be configured to control many different devices, inputs, outputs, etc. in many different applications. PLCs are used all over the world with great success. The PLC used in this application was chosen based on its track record of:

- Great reliability
- Modular platform for system growth
- Availability of parts all over the world
- Industrial proven and noise immune
- Proven track record of performance and cost effectiveness

The PLC's processor holds the code written to control the chamber. Code was written to specifically handle the chamber's inputs and outputs with the desired control. All of the thinking and control signals come from the PLC. The PLC is mounted inside the electrical panel on a rack. This rack contains the CPU, input cards, output cards etc. Most often, as control programs are upgraded, it is the code in the PLC that is changed. The current code revision is displayed on the main screen when the controller is turned on. The following is a picture of the PLC rack inside the electrical panel:



Operator Interface Terminal (OIT)

The OIT of a controller is the part that users actually see and interact with. The OIT for this controller is a color touch-screen. Many people may think the touch-screen is the PLC controller. However, the touch-screen is just a device that allows the user and the PLC to communicate and pass information back and forth. The OIT is connected to the PLC with a communication cable inside the electrical panel. Specific screens were developed for this application and stored in the OIT's memory. If there are upgrades to the controller's program, there may or may not also be upgrades to the screen code that need to be made. The current PLC and OIT code revision is displayed on the main screen when the controller is turned on.

It is important to remember that the OIT is a touch-screen. The buttons that appear on the screen do not need to be pushed, they just need to be touched. If the OIT is used properly, it will provide many years of reliable operation. Selections on the touch-screen are to be made by touching the buttons with a finger. This does not include pushing the buttons, or tapping the buttons with the fingernail. Other items that should not be used to make selections on the touch-screen are:

- ✓ Pencils
- ✓ Pens
- ✓ Rulers
- ✓ Wrenches
- ✓ Small hammers
- ✓ Screwdrivers
- ✓ Any food item
- ✓ Any pointing device

*** WARNING – Do NOT touch the screen with metallic objects. Serious damage will occur!**

It may be desirable to periodically clean the OIT screen. When cleaning the screen, it is recommended to shut down the chamber and remove all power from the system by turning off the main power disconnect. This will ensure no controller selections are made when cleaning the screen. To clean the screen, gently wipe the screen with a solution of water and mild detergent. Do not use harsh chemicals, as they will damage the screen and make it inoperable.

CONTROLLER MAINTENANCE

Back-up Battery

The PLC has a back-up battery to maintain memory when power is not supplied to the controller. If the battery was to die without being changed, and the controller doesn't have the optional EEPROM, the controller will lose the code that runs the controller. The chamber will no longer be able to operate. If the battery dies while the PLC is powered on, the controller will still operate, but the battery must be replaced while the PLC is powered on. If the battery dies while the PLC is not powered up, the controller will not run the next time it is powered up. If the controller has the optional EEPROM, the controller will still be able to power up and run the chamber.

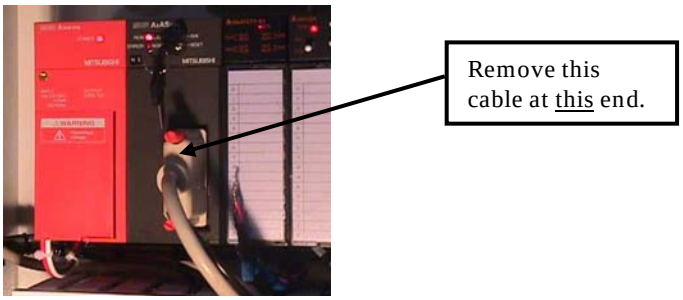
If the controller has the optional EEPROM, there is no longer a dependence on the back-up battery. The controller's code is now stored in the EEPROM rather than the controller's battery backed memory.

The batteries have a nominal life expectancy of five (5) years. *To be safe, we recommend changing the battery every four (4) years*. The battery must be replaced while power is still applied to the controller. If the battery is removed while the power is not on, the controller will lose the program. The only exception to this is if the controller has the optional EEPROM. If the controller has the EEPROM, the power can be removed from the system while changing the battery without losing the code.

If the controller is powered up, it is recommended that only trained personnel complete this procedure with extreme caution. The control panel is live with high 3-phase voltage. Safety must be observed as severe injury or death may result.

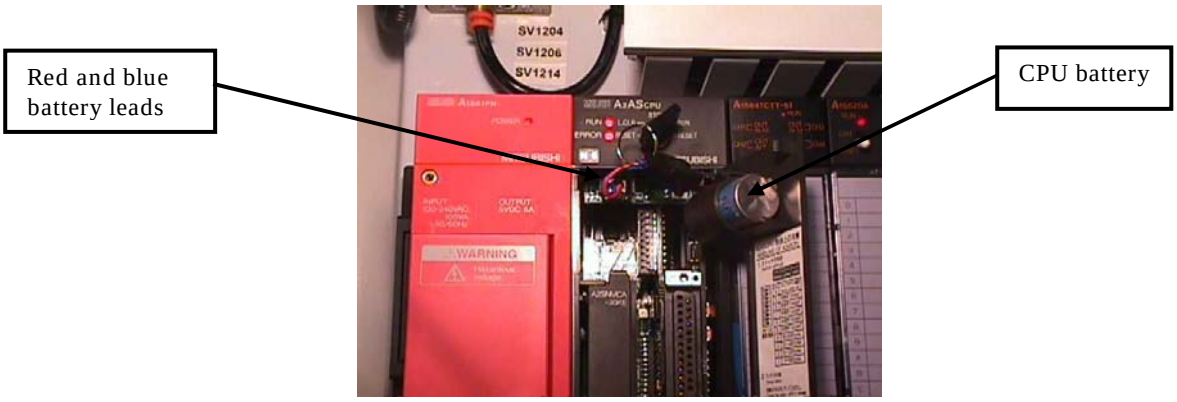
Use the following procedure to replace the battery:

1. Disconnect the cable that goes from the CPU to the OIT *at the CPU*.
   - Note the orange module is the power supply for the PLC.
   - The first black module to the right of the orange module is the CPU.



2. Open the CPU door by pulling on the bottom left corner of the door.

3. Identify the battery and its leads (red and blue wires) that are mounted to the backside of the CPU door.



4. Follow the red and blue leads from the battery to a connector on the CPU module. At the end of the leads there is a plastic connector. Squeeze the two small plastic clips on the side of the connector and pull the connector off.
   - If the controller is powered up, the removal of the battery will generate an alarm.

5. Gently pull back the retaining clips on the battery and slide it out of the plastic mounts.

6. Install the new battery with the reverse procedure.
   - When plugging in the new wire clip, be sure the blue wire is on the left and the red wire is on the right.

PLC Code Revisions

Over time, changes / upgrades to the control code may be made to enhance the operation or provide new features. To determine if there has been a new revision of code released, contact Chart at 1-888-877-3093. Before calling, shut down the controller and power it back up. When the controller powers up, the current code revisions (CPU and OIT) will be displayed on the first main screen.

Replacing EEPROMs

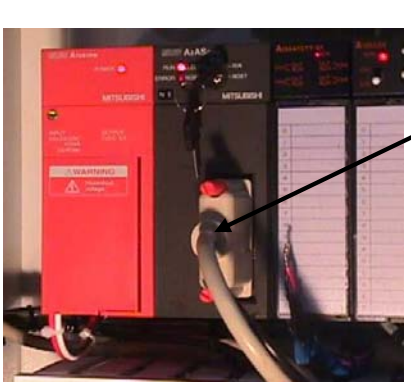
If new CPU code is needed, it is often changed most simply by changing the EEPROM. An EEPROM with the new code stored on it can be shipped out and installed in place of the previous EEPROM with the "old" code. If the controller did not originally come with an EEPROM, then installing an EEPROM with the new code will complete the upgrade.

It is important to note that all of the controller's passwords will revert to the factory originals when the EEPROM is replaced. If the user would like to continue using new customized passwords, they should be written down before the EEPROM is changed.

Use the following procedure to replace an EEPROM:

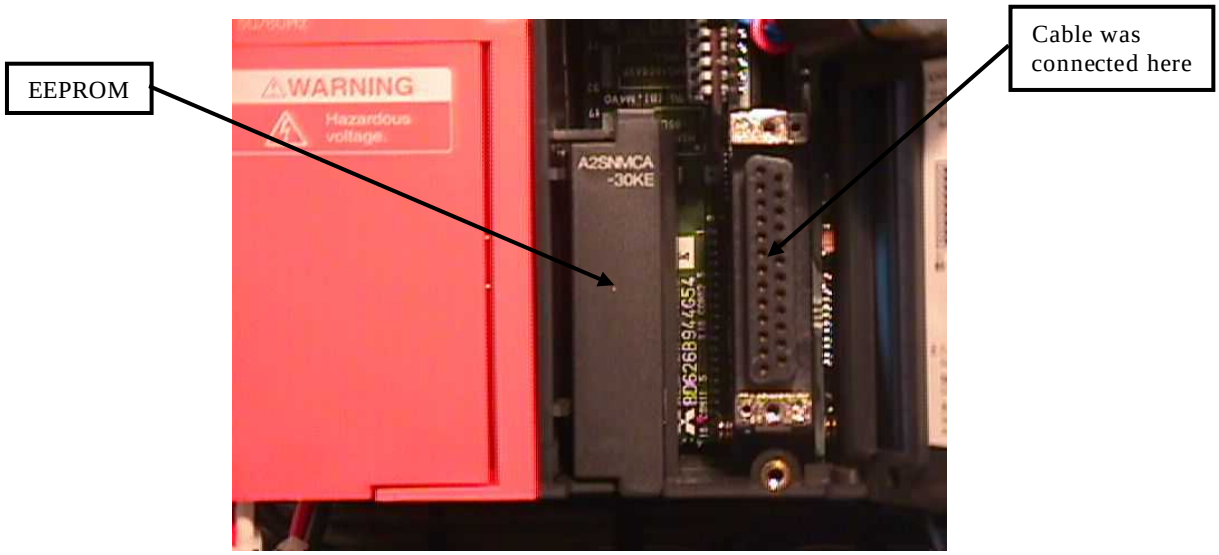
1. Shut down all power to the chamber at the main disconnect.
2. Open the electrical panel door.
3. Turn the key-switch on the CPU to the "STOP" position.

4. Remove the cable from the CPU.

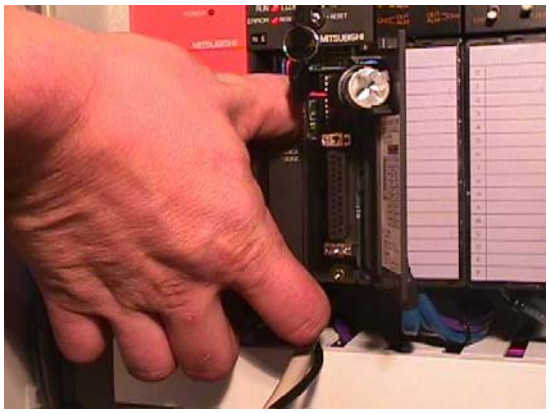


5. Open the CPU door by pulling on the bottom left corner of the door.

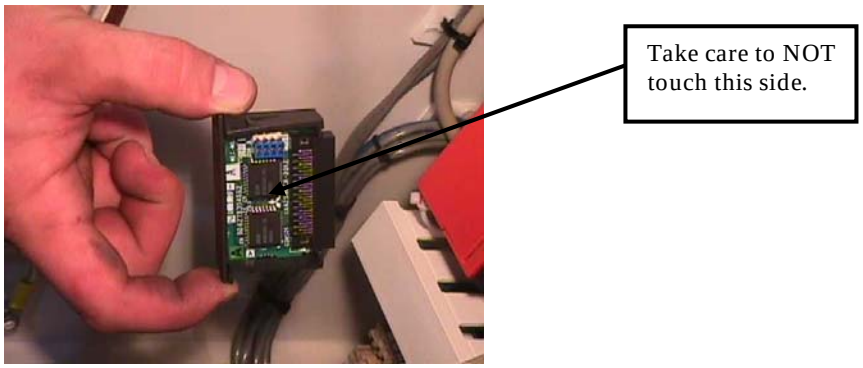
6. Locate the EEPROM, which is directly to the left of the connector the cable (removed in step #4) was connected to.



7. Gently squeeze the plastic tabs on the top and bottom of the EEPROM and pull the EEPROM out away from the CPU.



8. Be very careful not to touch the circuitry of the EEPROM. It is suggested to put it in the static proof bag the new EEPROM was supplied in.



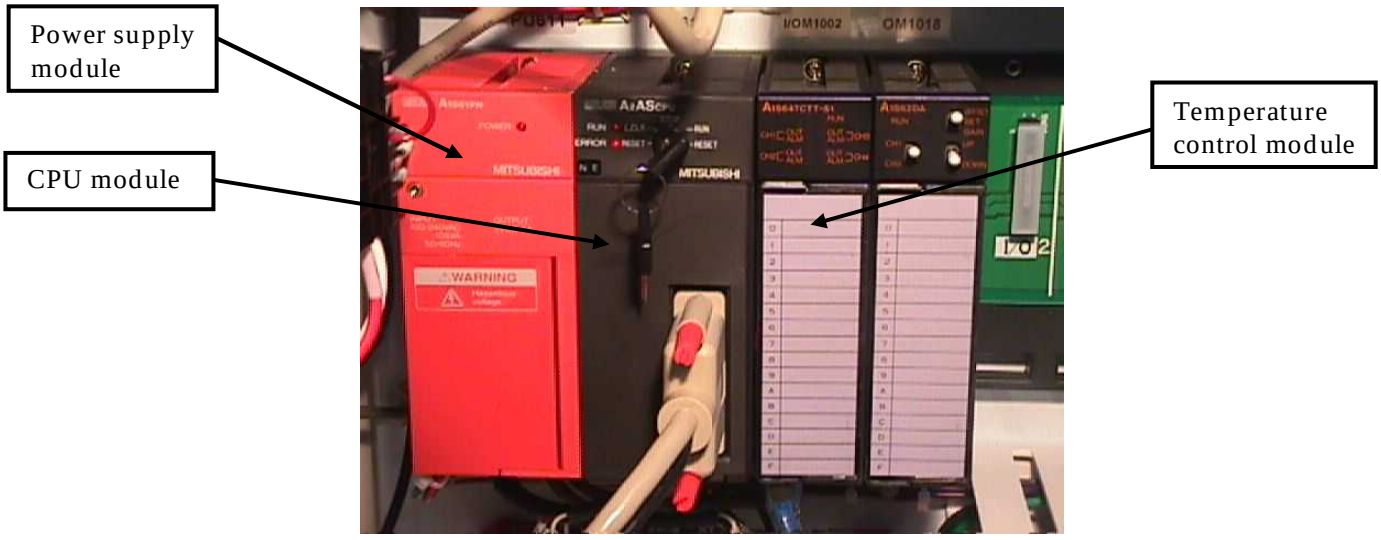
9. Noting proper orientation, insert the new EEPROM in the CPU module.
    - Take care to NOT touch the circuitry side of the EEPROM.
    - Make sure the EEPROM is firmly seated.
10. Close the CPU door.
11. Re-connect the cable removed in step #4.
12. Power up the chamber and the controller.
    - Ensure the Control Power switch on the front of the control panel is turned on.
13. Turn the key-switch back to the "RUN" position.

Calibrating the Temperature Controller

It is a good idea to calibrate the controller on a regular schedule. It is recommended to calibrate once every year. It is common for any controller's calibration to drift over time. A regular calibration schedule will help minimize these effects. The following procedure should be used to calibrate the temperature controller.

Note: The following procedure requires opening the electrical panel door. Only highly trained technicians should perform the procedure as severe injury may occur.

1. Disconnect the main power to the chamber at the disconnect handle on the front of the control box and open the control box door.
2. Identify the temperature control module on the PLC rack.
    - The temperature control module is labeled A1S64TCTT-S1 in orange letters on the top of the module.
    - The temperature control module is usually the third module on the PLC rack. Typically the first module is the orange power supply, the second module is the CPU and the third module is the temperature control module.



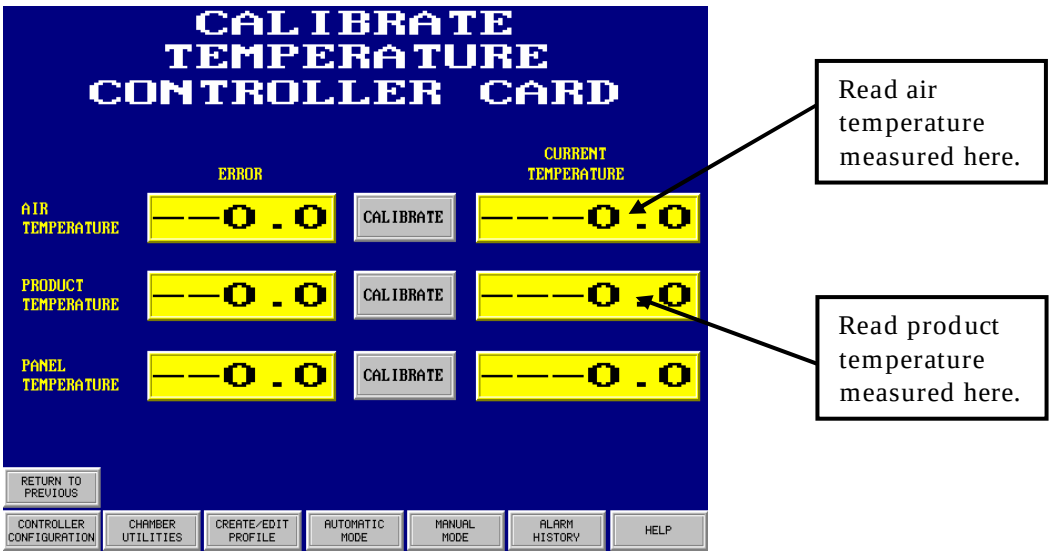
3. Open the module door by gently pulling the bottom left corner out.

4. Disconnect the thermocouple wires, for the channel to be calibrated, from the terminals on the module.
   - The following table lists the temperature channels, the terminal numbers of the module and the typical wire numbers of the thermocouple wires. Be sure to check with the electrical schematics supplied with the chamber to verify the exact wire numbers.
   - There is a third temperature channel, which records the internal control box temperature. This channel does not need to be calibrated regularly.

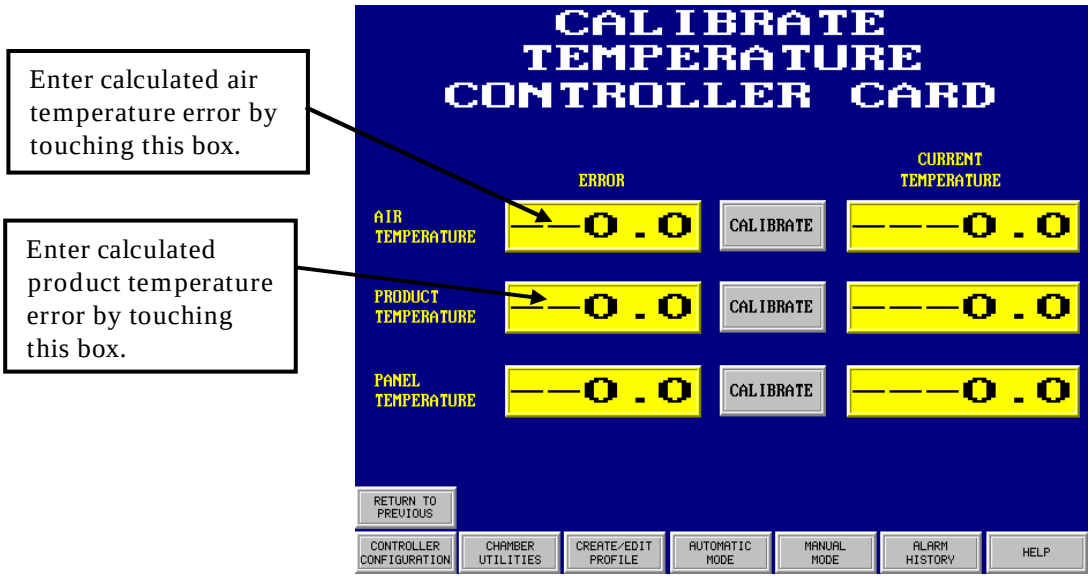
	Input Channel #1 (Air Temperature)		Input Channel #2 (Product Temperature)	
Positive wire (blue insulation on copper wire)	Terminal 9 on input card	Wire #1001	Terminal 8 on input card	Wire #1003
Negative wire (red insulation on constantan wire)	Terminal 11 on input card	Wire #1002	Terminal 10 on input card	Wire #1004

5. Connect a thermocouple calibrator / simulator to the input channel with type "T" thermocouple extension wire.
   - Be sure correct polarity is followed according to the table shown in step #4.
6. Turn the thermocouple calibrator / simulator power on.
7. Set the calibrator / simulator the desired calibration temperature in degrees C.
8. Turn the main chamber power disconnect on.
   - **Use extreme care as live-high-voltage will exist in the control panel. Severe injury could occur.**
   - Only trained technicians should perform this operation.
9. Touch the "CONTROLLER CONFIGURATION" button on the bottom of the main screen.
10. Touch the "SECURITY LOG-IN" button and enter the password for security level 2.
11. Touch the "MAINTENANCE" button, which appears on the CONTROLLER CONFIGURATION screen.
12. Touch the "CALIBRATE TEMPERATURE CHANNELS" button.

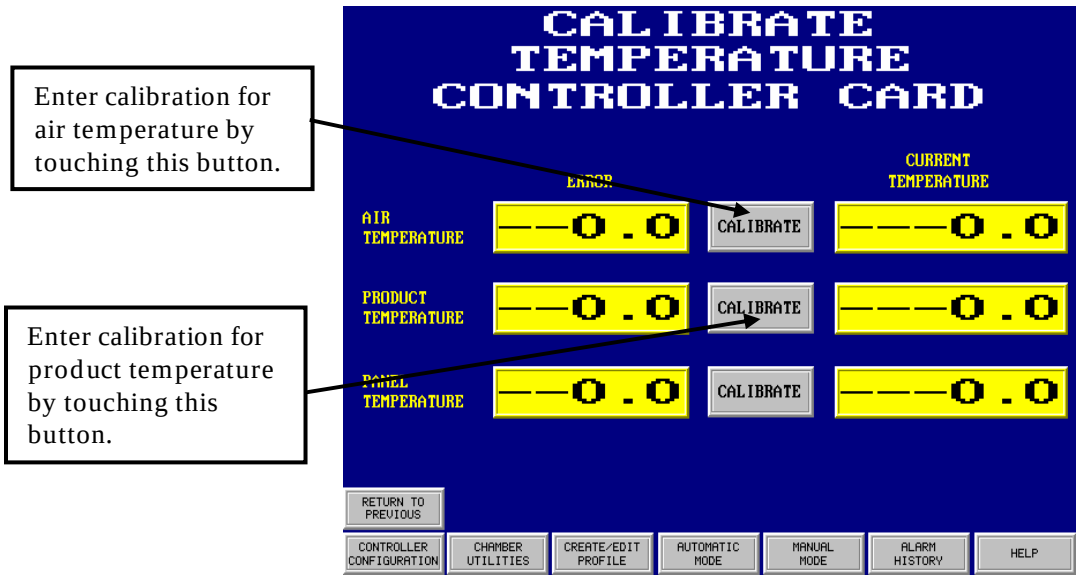
13. Observe the current temperature as measured by the card and displayed on the touch-screen.



14. Calculate the ERROR by the following calculation:
    - ERROR = Simulator Temperature (entered in step #7) – Measured Temperature (read in step #13)
15. Enter the ERROR (calculated in previous step) by touching the left box under the ERROR column for the channel being calibrated.



16. Touch the “CALIBRATE” button for the channel being calibrated.



17. Turn the chamber main power disconnect off.
18. Turn the thermocouple calibrator / simulator power off and disconnect the wires from the terminals.
19. Re-connect the thermocouple wires previously removed in step #4.
    - Be sure correct polarity is followed according to the table shown in step #4.
20. Repeat the above procedure for any other channels to be calibrated.

Calibrating Analog Inputs

The CTI uses analog inputs to read vibration signals. A signal conditioner reads the accelerometer signal. The signal conditioner generates a linear analog signal proportional to the GRMS level of vibration as measured by the accelerometer. The analog input can be calibrated so that it properly interprets the low and high signal. However, it is important to note that calibrating the controller’s analog input does not correct for any errors produced by the signal conditioner (GRMS meter) or accelerometer.

The following procedure can be used for calibrating the analog input channels:

Note: The following procedure requires opening the electrical panel door. Only highly trained technicians should perform the procedure as severe injury may occur.

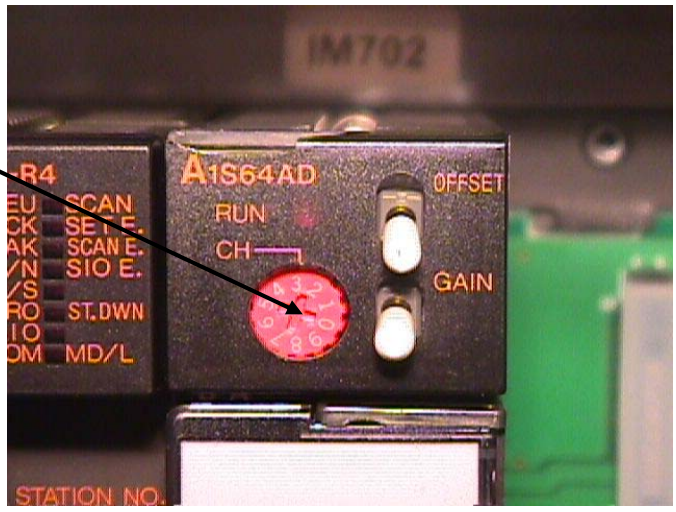
1. Open the door of the main control box.
2. Turn the main chamber power disconnect on.
    - **Use extreme care as live-high-voltage will exist in the control panel. Severe injury could occur.**
    - Only trained technicians should perform this operation.

3. Put the CPU key-switch in the “STOP” position.

NOTE: ***The CPU switch must be set to the “STOP” position before this procedure is performed. Damage to the module will occur if the procedure is performed with the CPU set to the “RUN” position.***

4. Identify the analog input module on the PLC rack.
   - The analog input module is labeled A1S64AD in orange letters on the top of the module.
   - The analog input module is usually the fifth module on the PLC rack. Typically the first module is the orange power supply, the second module is the CPU, the third module is the temperature control module, the fourth module is the communications module (if present) and the fifth module is the analog input module.
5. Open the module’s access door by gently pulling on the lower left corner.
6. Connect a jumper wire from TB1 to TB2 on the module. This will put the module into the “TEST” mode.
7. Using a small screwdriver, turn the red dial switch to select the channel to be calibrated. Channels other than 1 thru 4 will not be processed.
   - Channel #1 is used for vibration signals.

Channel selector dial.



8. Connect a DC voltage calibrator / simulator to the terminals of the channel to be calibrated.
    - Be sure to check the electrical schematics that were supplied with the chamber to ensure proper polarity.
9. Turn the calibrator / simulator power on and set the output to 0 volts DC.
10. Push and hold the "OFFSET" switch up to the "ON" position. Hold this switch in position until the module's red "RUN" LED illuminates.
11. When the module's "RUN" LED illuminates, the applied voltage is stored as the offset value for this channel. Release the "OFFSET" switch.
12. Set the output of the calibrator / simulator to +5 volts DC.
13. Push and hold the "GAIN" switch up to the "ON" position. Hold this switch in position until the module's red "RUN" LED illuminates.
14. When the module's "RUN" LED illuminates, the applied voltage is stored as the gain value for this channel. Release the "GAIN" switch.
15. Repeat steps 7 through 14 until all channels have been calibrated.
16. Remove voltage source from the module.
17. Disconnect the jumper wire from TB1 and TB2.
18. Turn the key-switch back to the "RUN" position.
19. Close the control box door.

Calibrating Analog Outputs

The CTI uses analog output channels (4-20mA DC) to control the liquid nitrogen valve for cooling (on all but the smallest chamber size) and the vibration system. These outputs are part of a closed loop control algorithm, which continuously corrects itself based on the response of the system to the control output.

Because the control system is a closed loop system, a precise analog output is not always of great concern. If the output is slightly off, (out of calibration), the controller will simply increase or decrease the output until the particular set point is achieved.

The biggest advantage of keeping the analog outputs calibrated is keeping the "zero" point accurate. If the zero point drifts, the chamber could experience small amounts of constant cooling, or small levels of vibration even when there is no set point entered.

The following procedure can be used for calibrating the analog output channels:

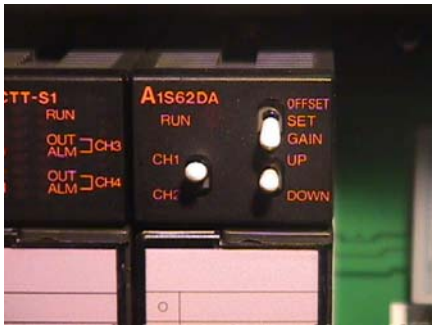
Note: The following procedure requires opening the electrical panel door. Only highly trained technicians should perform the procedure as severe injury may occur.

1. Open the door of the main control box.
2. Turn the main power disconnect on.
    - **Use extreme care as live-high-voltage will exist in the control panel. Severe injury could occur.**
    - Only trained technicians should perform this operation.

3. Put the CPU key-switch in the “STOP” position.

NOTE: ***The CPU switch must be set to the “STOP” position before this procedure is performed. Damage to the module will occur if the procedure is performed with the CPU set to the “RUN” position.***

4. Identify the analog output module on the PLC rack.
   - The analog output module is labeled with A1S62DA in orange letters at the top of the module.
   - The module is typically the fourth module from the left, including the orange power supply and CPU modules.
5. Open the module’s access door by gently pulling on the lower left corner.
6. Connect a jumper wire from TB1 to TB3 on the module. This will put the module into the “TEST” mode. Note that the module’s red “RUN” LED will begin to blink.



7. Put the “OFFSET/GAIN” switch to the middle “SET” position.
   - Note the red LED will stop blinking.
8. Use the white switch on the left of the module to select the channel to be calibrated (CH1 or CH2).
   - Typically the thermal controls are on channel #1 and the vibration controls are on channel #2, however, check with the chamber’s supplied electrical prints to be certain.
9. Connect the meter to the channel to be calibrated. See the electrical prints for the correct terminals to which the current meter will be connected.
10. Put the “OFFSET/GAIN” switch to the “OFFSET” position.
11. Use the “UP/DOWN” switch to adjust the current output as read on the meter to 4mA.

12. When the meter shows an output of 4mA, put the "OFFSET/GAIN" switch to the "SET" position.
13. Put the "OFFSET/GAIN" switch down to the "GAIN" position.
14. Use the "UP/DOWN" switch to adjust the current output as read on the meter to 20mA.
15. When the meter shows an output of 20mA, put the "OFFSET/GAIN" switch to the "SET" position.
16. Repeat steps 8 thru 15 until all channels have been calibrated.
17. Remove meter leads from the module.
18. Disconnect the jumper wire from TB1 and TB3.
    - Note that the module's "RUN" light illuminates, indicating that the module is returned to the "RUN" mode.
19. Turn the CPU key-switch to the "RUN" position.

Replacement Parts

Replacement parts are available from Chart Industries should they be needed for on-hand spares or field replacements/repairs. Consult the following table for the correct Chart part number before calling customer service at 1-888-877-3093.

Module	Mitsubishi Model Number	Chart Part Number
PLC Power Supply	A1S61P1	11500203
Temperature Control Module	A1S64TCTT-S1	11500191
Analog Input Module	A1S64AD	11532660
Analog Output Module	A1S62DA	11501687
Digital Input Module	A1SX40	11500174
Digital Output Module	A1SY80	11500182
PLC CPU	Consult factory	
Operator Interface (OIT)	Consult factory	

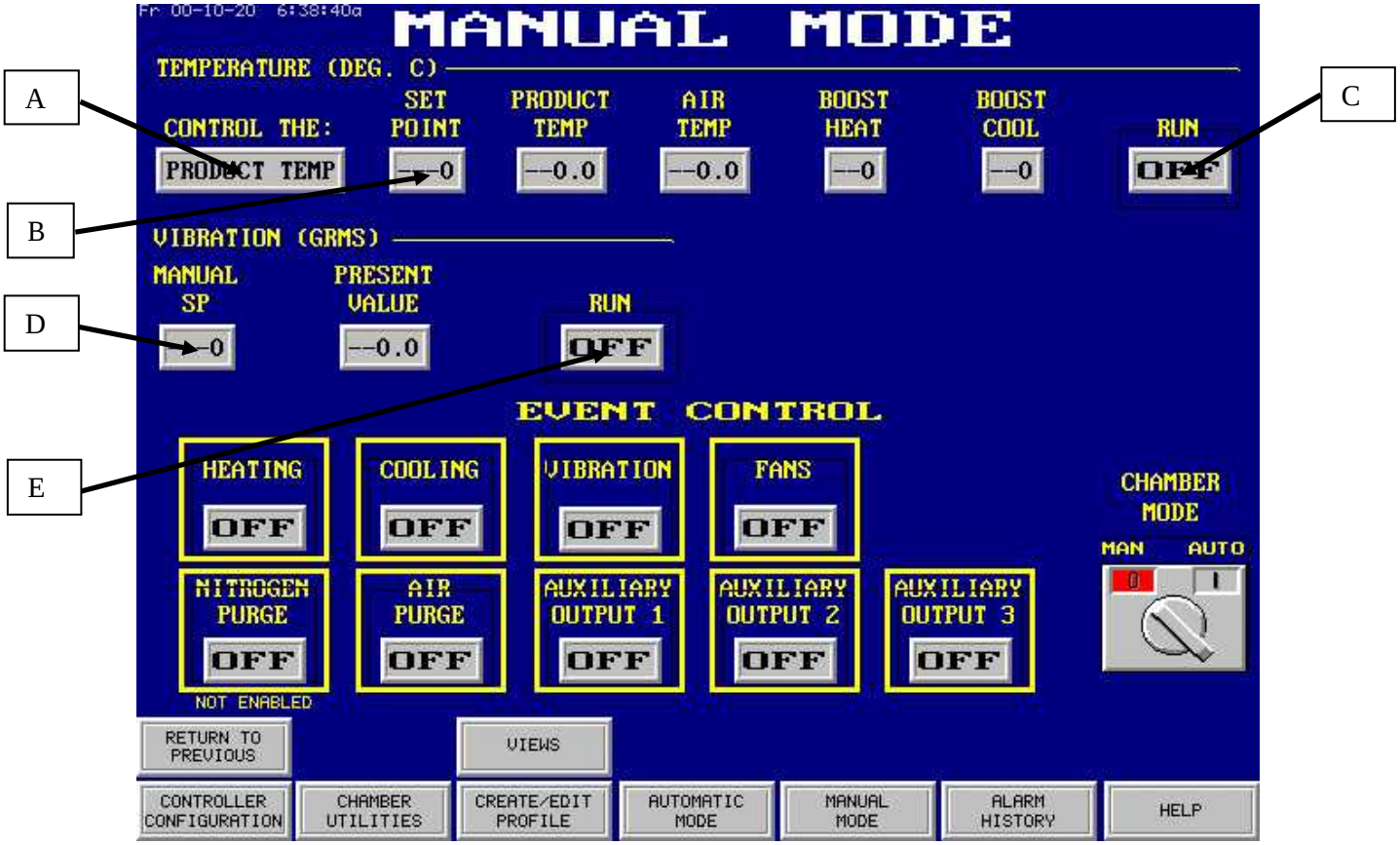
Consult the factory for replacement CPU or OIT modules. These modules are supplied with code pre-loaded. It is important to obtain the correct code version for the particular chamber. It is helpful to have the chamber's part number and serial number available before calling. These numbers can be found on a small label on the inside of the control box.

MANUAL MODE OPERATION

The controller can be run in a Manual Mode (as opposed to the Automatic Mode). The manual mode simply operates the chamber one step at a time. Instead of programming many steps ahead of time for a particular profile, the operator enters the control parameters for one step at a time. Whenever the operator would like the chamber to change conditions, he/she enters the new parameters. The Manual Mode can be useful for very simple studies and tests such as burn-in applications. In some cases, simple studies are done to help define parameters for future tests. Any tests that involve longer periods of time with few temperature parameter changes are candidates for running the chamber in Manual Mode. Running the chamber in Manual Mode is the easiest method of running the chamber.

All of the chamber's PID and configuration settings apply when operating in Manual Mode. The only set of parameters that do not apply are the "Profile Test Limits." The Profile Test Limits are high/low temperature and vibration limits that can be set at the beginning of each profile when running in Automatic Mode. This set of limits is not applied when the chamber is run in Manual Mode.

Manual Mode Screen



To control the chamber to a thermal set point in Manual Mode, use the following procedure. *In all key letter assignments, refer to the figure of the Manual Mode screen above.*

1. Put the controller in Manual Mode by touching the Chamber Mode selector switch in the bottom right corner of the screen. Touching this switch will toggle the controller between Manual and Automatic Modes.
2. Turn on appropriate Events by touching each key to toggle from "OFF" to "ON."
   - Heat Event must be turned on if the set point is greater than the current temperature.
   - Cool Event must be turned on if the set point is less than the current temperature.
   - Heat and Cool Events may both be turned on.
   - The Fans Event must be turned on for heating or cooling to take place.
   - Any other Events (i.e. Auxiliaries) may also be turned on as desired.
3. Touch key "A" to toggle between Air Temperature control and Part Temperature Control.
   - In Part Temperature Control Mode, the thermocouple in the workspace is used as the control signal. The chamber will control the air to help bring the temperature measured at the thermocouple in the workspace to set point. This is the most common mode of control.
   - In Air Temperature Control Mode, the thermocouple in the workspace is ignored and the controller controls to the thermocouple located in the plenum. In this mode, the Boost Heat and Boost Cool are not active.
4. Touch key "B" to enter a temperature set point.
5. Touch key "C" to start the chamber's thermal controls turning it to "ON."
   - The key will read "ON" when the chamber is running thermal control. If the key already reads "ON" it does not need to be touched again.
   - If the chamber had been previously running in Manual Mode, and the set point is being changed, it is not necessary to touch key "C" again, as long as it still reads "ON."
   - **NOTE**: If the chamber had been previously running in Manual Mode, and an additional Event is turned on (Heat or Cool), the "RUN" button (button "C" in diagram) will need to be turned OFF, then ON again for the additional Event to become active.
6. Watch the chamber's response.
   - The Manual Mode screen will display the current value of temperatures.
   - Touching the VIEWS button will bring three different view screens including a real time trend chart.

To control the chamber to a vibration set point in Manual Mode, use the following procedure:

1. Put the controller in Manual Mode by touching the Chamber Mode selector switch. Touching this switch will toggle the controller between Manual and Automatic Modes.
2. Turn on appropriate Events by touching each key to toggle from "OFF" to "ON."

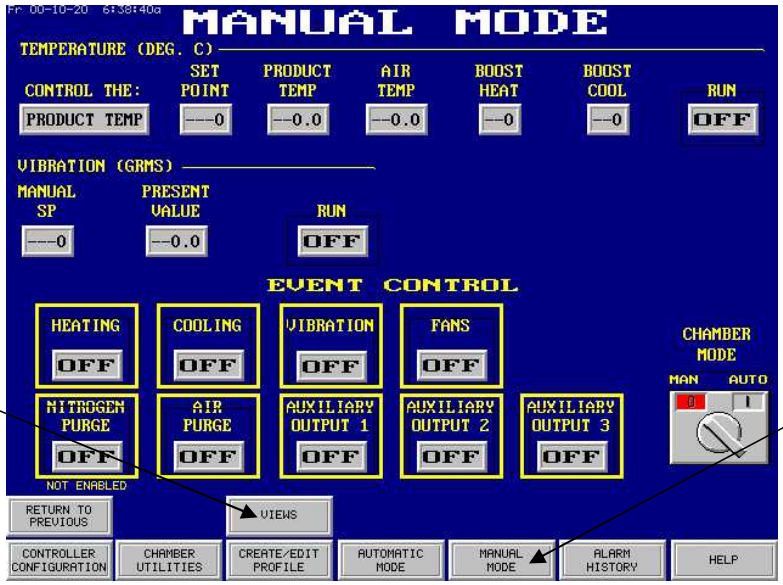
- "Fans" and "Vibration" Events must be turned on.

3. Touch key "D" to enter a vibration set point.
4. Touch key "E" to start the chamber's vibration controls turning it to "ON."
   - The key will read "ON" when the chamber is running vibration. If the key already reads "ON" it does not need to be touched again.
   - If the chamber had been running previously in Manual Mode, and the set point is being changed, it is not necessary to touch key "E" again, as long as it still reads "ON."
5. Watch the chamber's response.
   - The Manual Mode screen will display the current value of vibration.
   - Touching the VIEWS button will bring three different view screens including a real time trend chart.

Viewing Chamber Performance in Manual Mode

After set points have been entered in the Manual Mode screen, the actual chamber performance can be viewed in multiple ways. The simplest way is on the Manual Mode screen itself. Next to the set point fields, there is a box that displays current value for that parameter (temperature or vibration). That box will continue to show the current value as it changes in the chamber. Since it is placed right next to the box for the set point, it is easy to compare the chamber's current state with the set point.

To get a better representation of what the chamber is doing, the three full-screen "VIEWS" can be accessed. To use one of these views to watch the chamber's performance, simply touch the "VIEWS" button on the Manual Mode screen. After watching the chamber run in one of the "VIEW" screens, the set points can be changed by touching the "MANUAL MODE" button on the bottom of all the View screens. For more information regarding the different View screens, refer to the Operational View Screens section of this manual.



VIEWS button

Manual Mode button – this button is on the bottom of all screens.

CONTROLLER SECURITY LEVELS

The controller has multiple security levels to help keep more important controller settings from being altered by mistake. All of the common functions for operating the controller / chamber are set up for security level 0 (no security). Level zero is the lowest security level. Other items are configured with security levels as follows:

Security Level 1

- Chamber PID Settings
- Temperature Control Mode
- Create / Edit Profile Screen

Security Level 2

- Temperature Controller Card Calibration
- Site Alarm Limits
- Set Date / Time

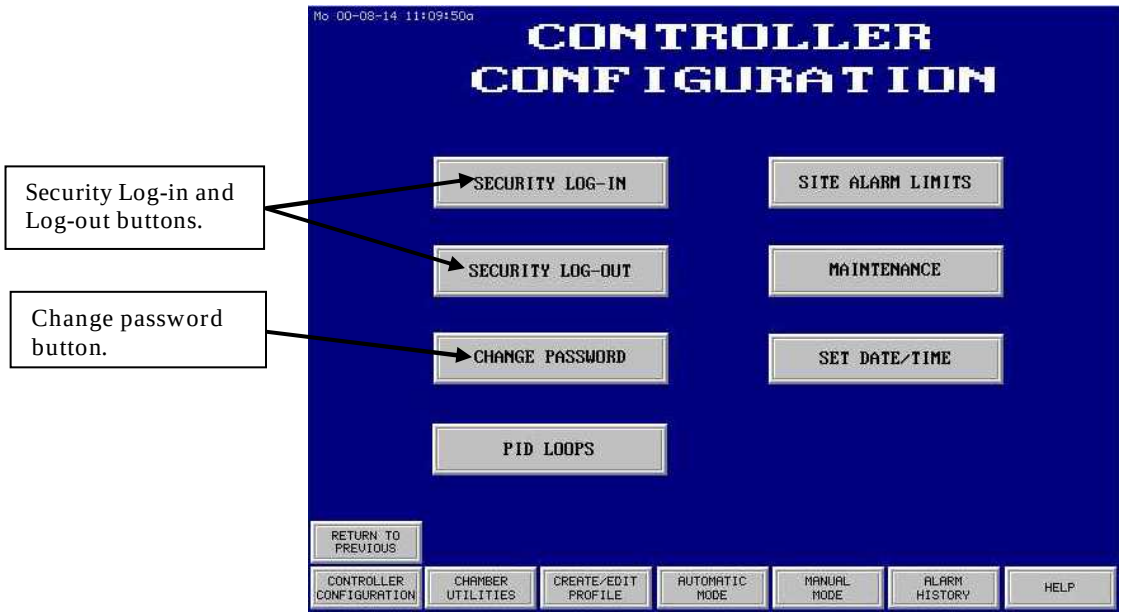
Each security level has its own password. If someone has the password for security level 2, they will also have access to security level 1. The default password for Security Level 1 is "chart". The default password for Security Level 2 will be given to the customer at time of chamber installation.

Each of the different security level passwords was supplied at the time the controller / chamber was installed. If passwords have been lost or forgotten, call Chart Technical Service at 1-888-877-3093.

Logging In/Out

To log in / out of different security levels, touch the "CONTROLLER CONFIGURATION" button on the bottom of any screen. From the Controller Configuration screen, touch the "SECURITY LOG-IN" button. This will bring up a key pad to enter the password. Once the password is entered and accepted, access will be permitted to the respective restricted menus.

When that particular person is done working with the controller, it is important that he / she logs out by touching the "SECURITY LOG-OUT" button on the Controller Configuration screen. If the operator does not log out, he / she will leave all access to anyone that walks up to the controller until the next time power is removed from the controller.



Changing Passwords

It is often a good idea to change security passwords on a routine basis. This helps reduce the odds of passwords getting in the wrong hands. Use the following procedure to change controller passwords:

1. Touch the CONTROLLER CONFIGURATION button, which is on the bottom of all the screens.
2. Touch the SECURITY LOG-IN button and log into the corresponding security level for the password to be changed.
   - For example, the user must log into security level 2 to change the password for security level 2.
   - If the user logs into security level 2, the password for security level 1 may also be changed.
   - If the user logs into security level 1, the password for security level 2 cannot be changed.
   - The password can be changed for the current security level, and any levels below that.
3. After logging-in, touch the CHANGE PASSWORD button on the Controller Configuration screen.
4. Touch the password that is to be changed.
5. Touch the CLR (clear) button on the keypad.
6. Enter the new password.
7. Log-out of the current security level by touching the SECURITY LOG-OUT button.
8. Test the new password by touching the SECURITY LOG-IN button and entering the new password.
9. Record the new password somewhere safe for future needs.

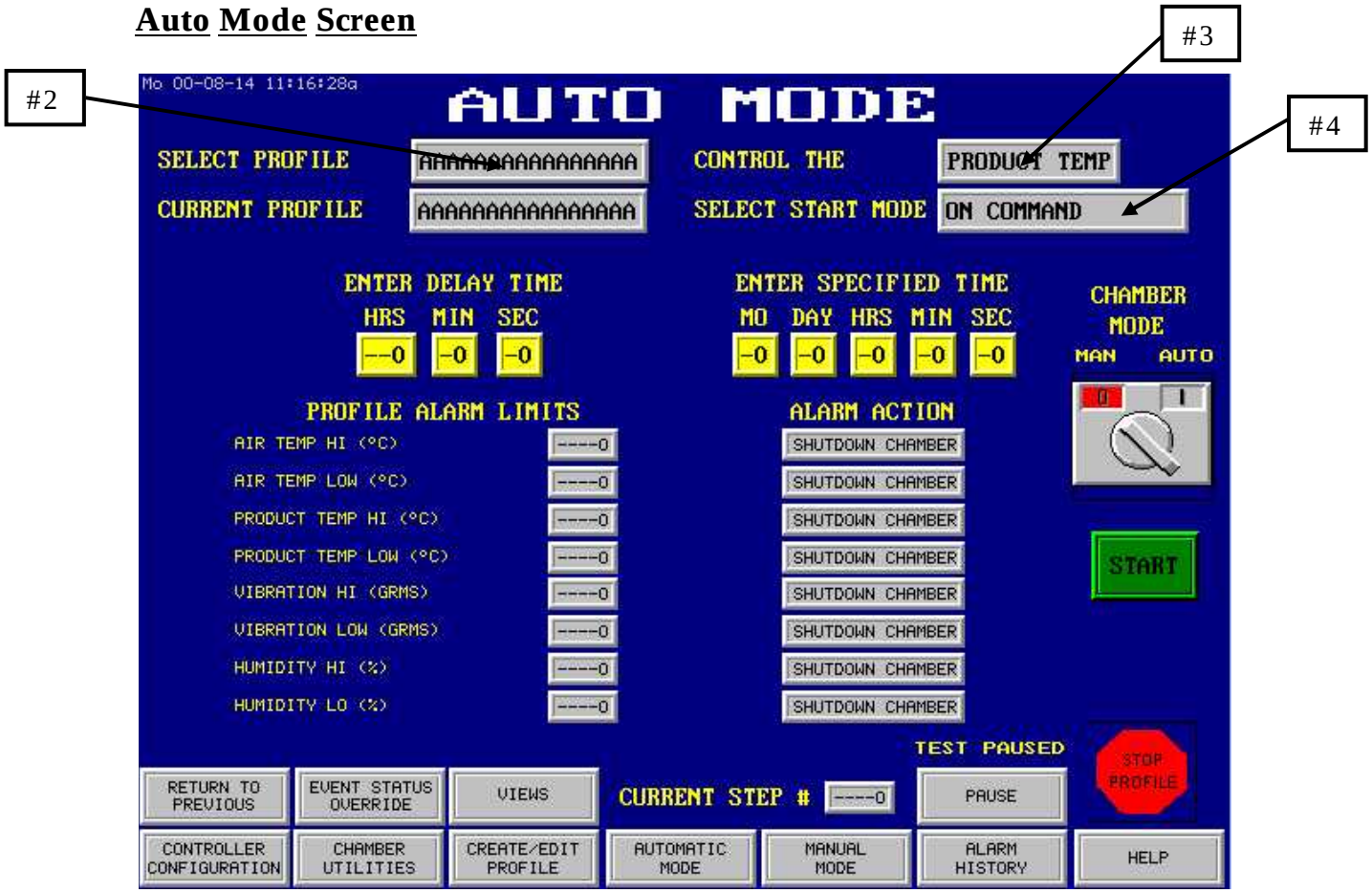
Note that if the password for security level 1 is ever forgotten, it can be reviewed by logging into security level 2 and going to the CHANGE PASSWORD screen. The

CHANGE PASSWORD screen displays all passwords for current and lower security levels.

AUTOMATIC MODE

The controller can be run in Automatic Mode (as opposed to the Manual Mode). While Manual Mode simply operates the chamber to one set point at a time, Automatic Mode controls the chamber based on a series of pre-defined set points. Automatic Mode is useful when the operator has specific profiles with which to test the product. Automatic Mode can be used to run tests without having to wait by the chamber to change set points at exactly the right time.

Auto Mode Screen



Running a Profile

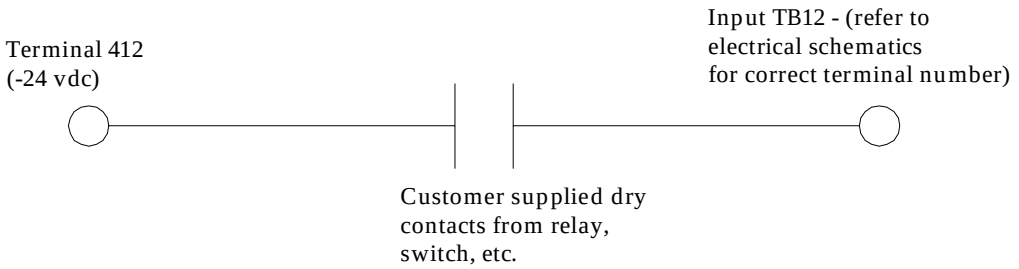
To run a profile in Automatic Mode, use the following procedure with references to the above figure:

1. Touch the Chamber Mode selector switch, toggling it to Auto Mode.
2. Touch button #2 to load a pre-defined profile. Touching this button will bring up a list of previously saved profiles. Touch the name of the profile that is to be run

3. Touch key #3 to toggle between Air Temperature control and Part Temperature Control.
    - In Part Temperature Control Mode, the thermocouple in the workspace is used as the control signal. The chamber will control the air to help bring the temperature measured at the thermocouple in the workspace to set point. This is the most common mode of control.
    - In Air Temperature Control Mode, the thermocouple in the workspace is ignored and the controller controls to the thermocouple located in the plenum. In this mode, the Boost Heat and Boost Cool are not active.
    - The user must log into security level 1 to change between Air Temperature and Product Temperature mode.
4. Touch button #4 to select a Start Mode. The options are:
    - ON COMMAND – When running a profile with this start mode, the profile will start as soon as the operator touches the START button. This is the simplest start mode and most commonly used.
    - DELAY START – When running a profile with this start mode, the controller will delay the start a period of time after the START button is touched. If this selection is made, the user will need to enter an amount of time in hours, minutes, and seconds, which the controller will delay after the button is touched.
        - ✓ If this mode is selected, the text "ENTER DELAY TIME" will appear with the "HRS" "MIN" and "SEC" labels above the three yellow data fields. This text is not present when any other start mode is selected and indicates that this data is not needed. If the text is present, that information needs to be entered.
        - ✓ Enter the number of hours, minutes and seconds to delay by touching each box under the "HRS" "MIN" and "SEC" headings.
    - @ SPECIFIED TIME – When running a profile with this start mode, the controller will start the profile at a particular date/time after the START button is touched. If this selection is made, the user will need to enter a date and time for the controller to start.
        - ✓ If this mode is selected, the text "ENTER SPECIFIED TIME" will appear with the "MO" "DAY" "HRS" "MIN" and "SEC" labels above the five yellow data fields. This text is not present when any other start mode is selected other than @ SPECIFIED TIME and indicates that this data is not needed. If the text is present, that information needs to be entered.
        - ✓ Enter the specified date and time the controller is to start by touching the boxes under the headings.
            - ❑ MO – Touch this box and enter the number of month the controller is to start (i.e. 1 = January, 7 = July, 12 = December).
            - ❑ DAY – Touch this box and enter a number representing the date the controller is to start.
            - ❑ HRS – Touch this box and enter a number in 24 hour format indicating what hour of the day the controller is to start (i.e. 9 = 9:00am, 14 = 2:00pm).
            - ❑ MIN – Touch this box and enter the minutes after the hour the controller is to start (i.e. 30 = 9:30, 45 = 9:45).

- SEC – Touch this box and enter the number of seconds after the minute the controller is to start (i.e. 15 = 9:00:15, 32 = 9:00:32).

- REMOTE START – When running a profile with this start mode, the controller will look for a signal from an external source to start the profile. The external signal will be made by generating a digital input on input #TB12. Refer to the chamber's electrical prints for the correct terminals to make common that generates this input signal. In this mode, the test profile will start the first time the controller gets the signal on input #TB12.



5. Define all of the alarm limits that are to be applied for this profile and their respective action. Note that the alarm limits and actions can be changed from one running of the profile to the next. These alarm limits only apply when the chamber is operating in Automatic Mode; they do not apply when the chamber is in Manual Mode. The following is descriptions of the alarms and actions available:
   - Available alarms:
     - ✓ AIR TEMP HI (°C) – This alarm occurs when the temperature measured in the plenum exceeds the value entered in degrees C. Acceptable values are –125°C to +225°C.
     - ✓ AIR TEMP LOW (°C) – This alarm occurs when the temperature measured in the plenum is less than the value entered in degrees C. Acceptable values are –125°C to +225°C.
     - ✓ PRODUCT TEMP HI (°C) – This alarm occurs when the temperature measured by the thermocouple in the chamber workspace exceeds the value entered in degrees C. Acceptable values are –125°C to +225°C.
     - ✓ PRODUCT TEMP LOW (°C) – This alarm occurs when the temperature measured by the thermocouple in the chamber workspace is less than the value entered in degrees C. Acceptable values are –125°C to +225°C.
     - ✓ VIBRATION HI (GRMS) – This alarm occurs when the vibration measured by the control accelerometer exceeds this value in GRMS. Acceptable values are -1 to +100.
     - ✓ VIBRATION LOW (GRMS) – This alarm occurs when the vibration measured by the control accelerometer is less than this value in GRMS. Acceptable values are -1 to +100.
     - ✓ HUMIDITY HI (%) – This alarm occurs when the humidity measured by the humidity transmitter exceeds this value in %RH. Acceptable values are 0 to +100 %RH.

- ✓ HUMIDITY LOW (%) – This alarm occurs when the humidity measured by the humidity transmitter is less than this value in %RH. Acceptable values are 0 to +100 %RH.

- Available alarm actions:
  - ✓ DO NOTHING – If this action is selected, the controller will simply log the alarm in the alarm log, but will not change the state of any controller outputs.
  - ✓ DISABLE OUTPUT – If this action is selected, the controller will disable the appropriate output as follows:
    - ❑ AIR TEMP HI (°C) – Controller disables heating output and drops out the heating contactors.
    - ❑ AIR TEMP LOW (°C) – Controller disables cooling output and closes cooling safety valve.
    - ❑ PRODUCT TEMP HI (°C) – Controller disables heating output and drops out the heating contactors.
    - ❑ PRODUCT TEMP LOW (°C) – Controller disables cooling output and closes cooling safety valve.
    - ❑ VIBRATION HI (GRMS) – Controller disables vibration output and closes vibration safety solenoid valve.
    - ❑ VIBRATION LOW (GRMS) – Controller disables vibration output and closes vibration safety solenoid valve.
    - ❑ HUMIDITY HI (%) – Controller disables humidity increase output.
    - ❑ HUMIDITY LOW (%) – Controller disables humidity decrease output.
  - ✓ SHUTDOWN CHAMBER – If this action is selected, the controller will shutdown the chamber and disable all outputs. The profile will stop and reset to step 0.

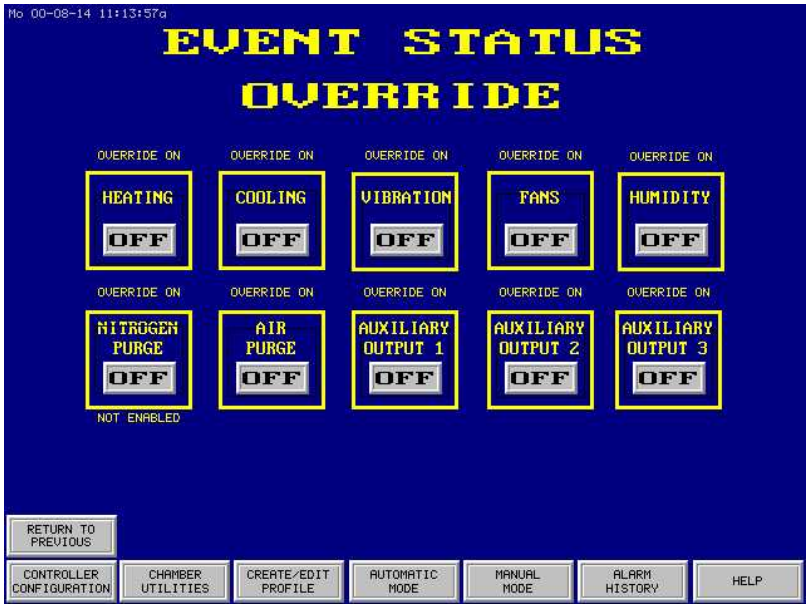
6. Touch the green START button to start the profile. The profile will now start based on your selection of the START MODE in step #4.

Once the controller has started running the profile, the current step number will be indicated and updated near the bottom of the screen. Other functions available on this screen are:

- STOP PROFILE – Touching this button twice within 5 seconds will stop the profile and return the controller to an idle mode. After touching the button the first time, the controller will display a message above the button instructing to touch the button again to stop the profile. If the button is not touched the second time while the message is displayed, the controller will ignore the first touch of the button and continue running the profile. If the button is touched the second time while the message is displayed, the profile will stop and reset to step 0.
- PAUSE – Touching this button will pause the profile in its current step. If the profile has been paused, the screen will display the text "TEST PAUSED" just above the PAUSE button. Touching it again will resume the profile from its current location. *It is important to note that when pausing a test, the heating, cooling and circulation fans all shut off.*
  - It is important to note that when the chamber resumes operation after the pause button has been touched the second time, the controller will try to obtain the temperature set point immediately. It will not follow any ramp

rates that were set in the profile. It will attempt to heat or cool as fast as allowed by the current set of PID parameters.

- VIEWS – Touching this button will bring up the first of three different operational views. Each view screen has a button to advance to the next view screen.
- EVENT STATUS OVERRIDE – Touching this button will bring up the following screen. This screen is used to override the profile's definition of Events. Any changes that are made will only hold true for the remainder of that step. Once the controller advances to the next step, it will revert to the Event definition of the profile. The user could then return to the EVENT STATUS OVERRIDE screen and override the Event if is so desired.



- RETURN TO PREVIOUS – Touching this button will return the user to the previous screen.

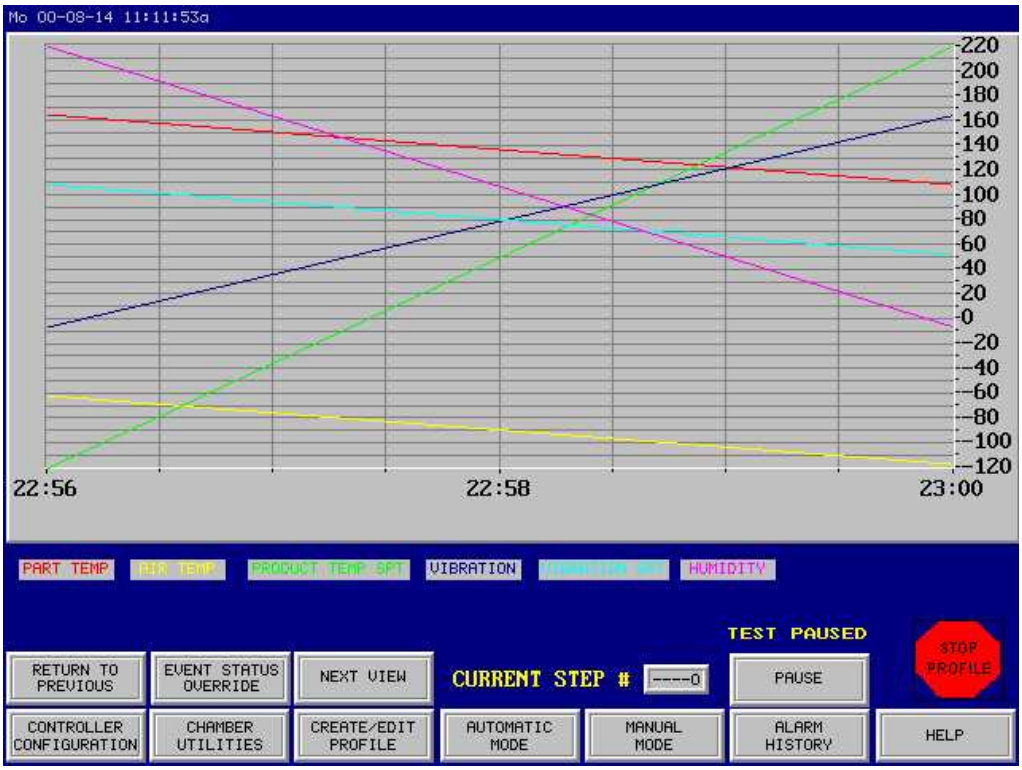
OPERATIONAL VIEWS

The controller has multiple views available for watching the chamber's performance when it's running. The user can switch between different views at any time during a test. The three views are:

1. **Large trend chart** – This view gives a color real time trend chart which allows the user to see the chamber's performance graphically. The trend chart is capable of scrolling back in time to see previous data.
2. **Small trend chart with digital values** – This view combines all the features of the trend chart with displaying actual digital values on the same screen. The graphical trend chart gives a nice graphical representation, although the resolution of the scale is slightly smaller. The digital values can be examined at the same time to find out the exact values at the time.
3. **Large digital format** – This view displays the controller's set points and current values of the process variables. This format is more useful for technicians that wish to check on the chamber's state from a distance across the lab.

The views can be accessed from the "AUTO MODE" or "MANUAL MODE" screens by touching the button marked "VIEWS." To move from one view to the next, touch the "NEXT VIEW BUTTON" which is on all three view screens.

View Screen #1



This view screen gives the largest graphical representation of the chamber's operation. The chart is continually updated in real time graphing set points and present values. Each line is shown in a different color with a legend below the chart defining each of the colors. The time axis has tick marks representing the time in the controller's clock. The most current time is on the right hand side of the chart.

The chart is capable of looking back in time at previous data. To see previous data, simply touch the chart. After touching the chart, buttons will drop down over the color legend allowing the user to scroll back and forth in time. The buttons will also allow zooming in and out such that the chart is looking at more or less time in the same window size. During all of these operations (scrolling and scaling), the time axis will change showing the clock time of the data currently being viewed. When the chart is touched, the chart stops showing real time data and just shows past data. After looking at the past data, touching the chart again will return the chart to displaying real time data and the scroll buttons will disappear.

Other buttons available in this screen include:

- STOP PROFILE – Touching this button twice within 5 seconds will stop the profile and return the controller to an idle mode. After touching the button the first time, the controller will display a message above the button instructing to touch the button again to stop the profile. If the button is not touched the second time while the message is displayed, the controller will ignore the first touch of the button and continue running the profile. If the button is touched the second time while the message is displayed, the profile will stop and reset to step 0. After a profile has been stopped, it can only be re-started from the beginning of the profile.

- PAUSE – Touching this button will pause the current profile in its current step. The profile will resume operation from this point the next time the PAUSE button is touched.

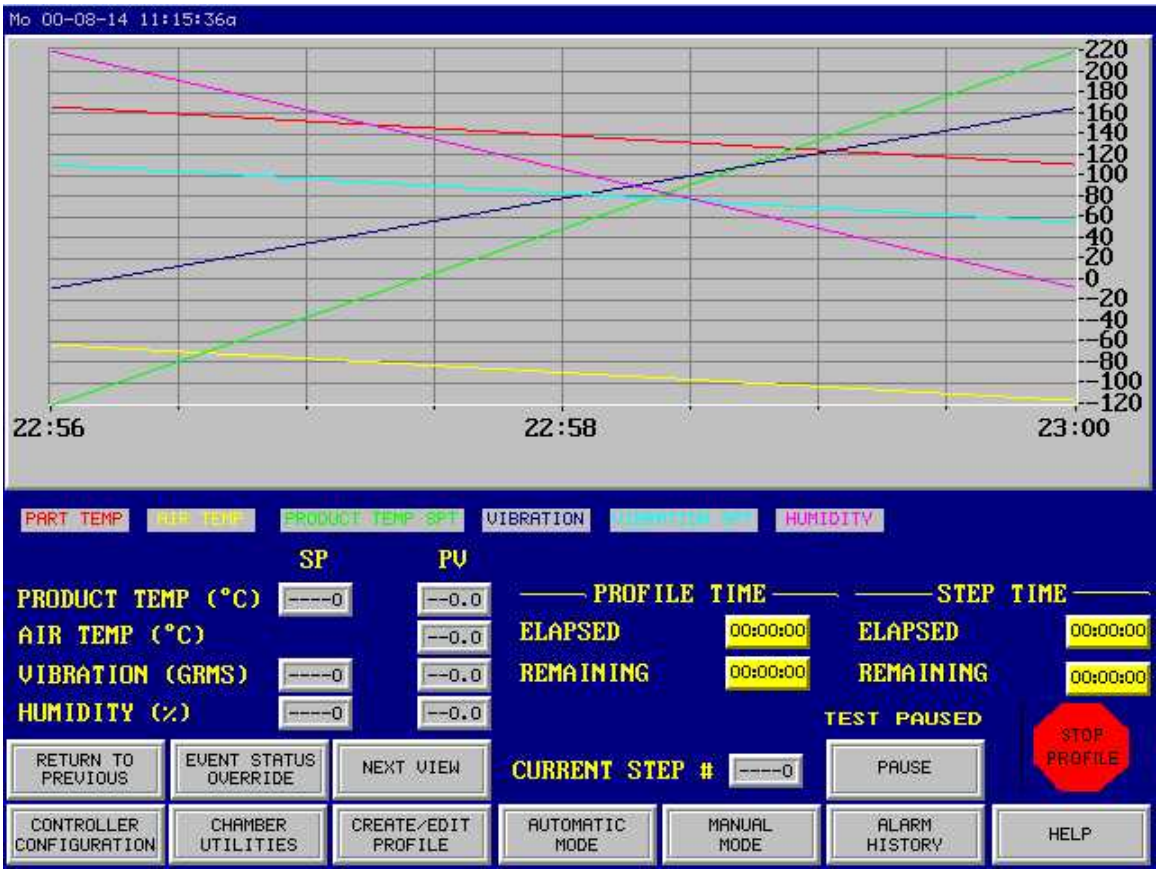
- CURRENT STEP # - This box shows the current step number of the profile currently running. The box does not allow input as it is simply a digital display.

- NEXT VIEW – Touching this box will advance the controller to the next view screen. From view screen #1, the next view screen is a smaller trend chart (same information as this screen) with the actual digital values displayed below the chart.

- EVEN STATUS OVERRIDE – Touching this button will advance to the Event Status Override Screen. From that screen, the user can change the state of pre-programmed Events when operating in Automatic Mode.

- RETURN TO PREVIOUS – Touching this button will return the user to the previous screen.

View Screen #2



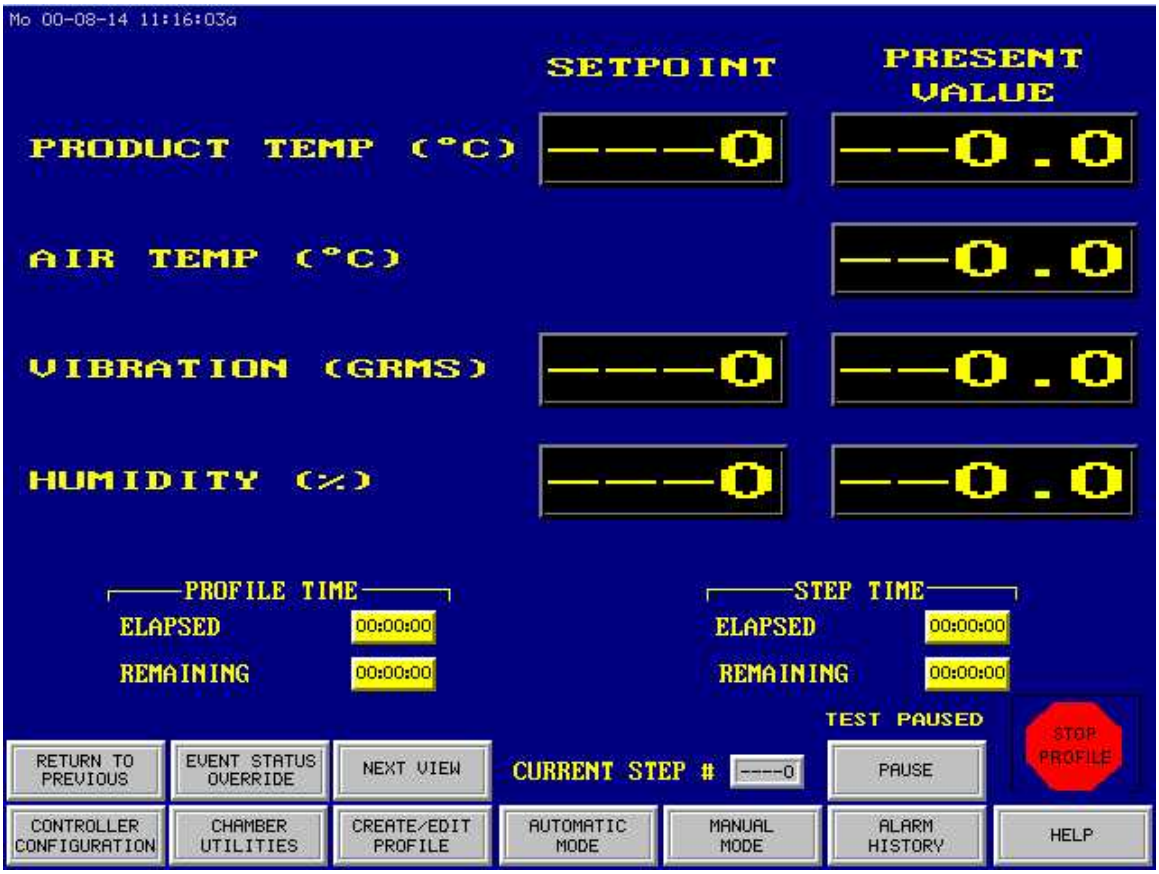
This view screen gives both a graphical and digital representation of the chamber's operation. The chart is a smaller version of the one in View Screen #1. Although the screen is a smaller size, it contains all of the same features as the larger version. For more information about the chart, refer to the View Screen #1 Section.

Below the chart is digital readouts of set points and present values. This is the same data being plotted on the trend chart. The trend chart gives a good representation of the chamber's performance, and the digital values give more precise resolution. To the right of the process variable information are readouts showing how much time has elapsed and is remaining in both the current step and the entire profile.

The following buttons are also available on this view screen. For more information on their functions, refer to the View Screen #1 Section.

- STOP PROFILE
- PAUSE
- CURRENT STEP #
- NEXT VIEW
- EVENT STATUS OVERRIDE
- RETURN TO PREVIOUS

View Screen #3



This view screen provides large digital readouts for set points and current values. The view was intended for users that want to be able to quickly check on a chamber from a greater distance. The large digital format is continuously updated with present values and is easier to see from a distance.

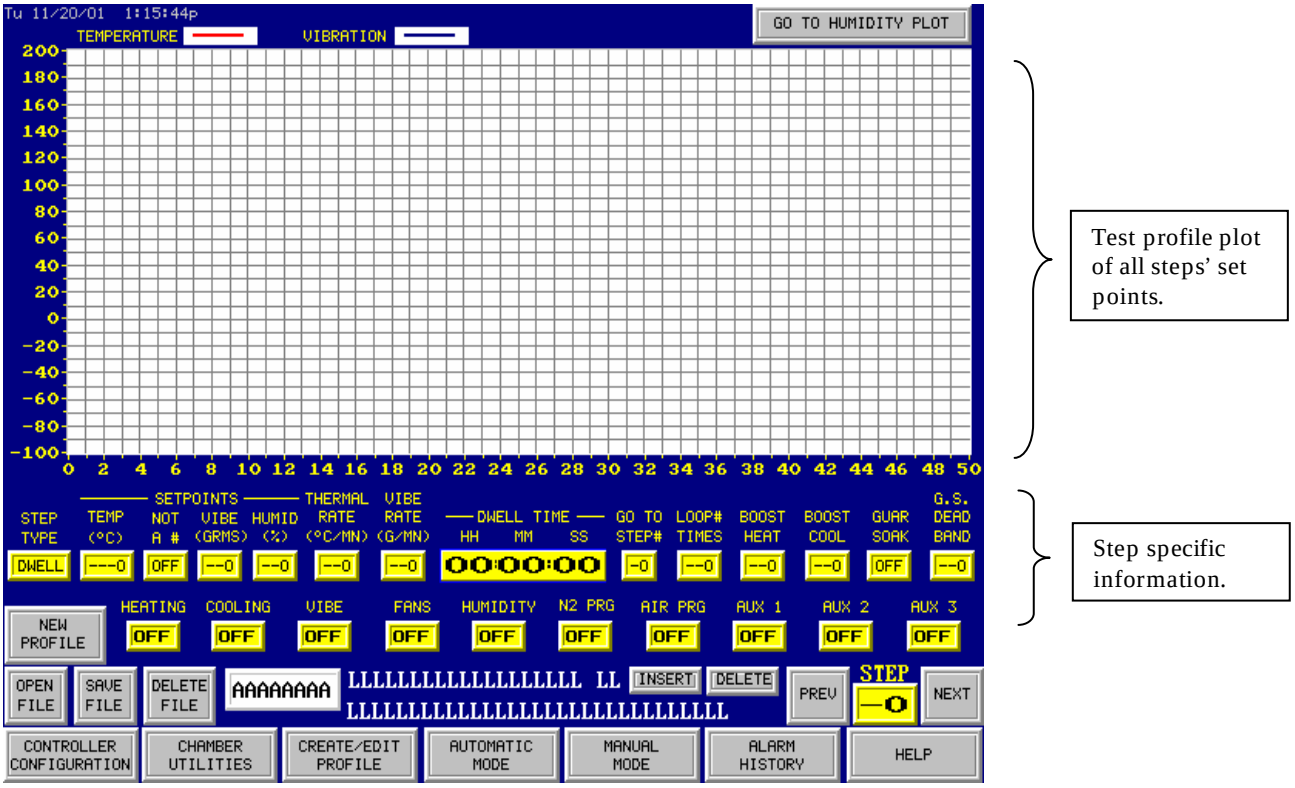
The bottom potion of the screen is very similar to View Screen #2 showing detailed time information about current step and profile. The following buttons are below the time information. For more information about their function, refer to the View Screen #1 Section.

- STOP PROFILE
- PAUSE
- CURRENT STEP #
- NEXT VIEW
- EVENT STATUS OVERRIDE
- RETURN TO PREVIOUS

TEST PROFILES

Creating a Profile

The controller can be used to create and save test profiles for future use. Test profiles can be created, edited and saved for running in Automatic Mode some time later. Defining the parameters for each step, one at a time, creates profiles. While defining each step, the top portion of the screen displays a graphical view of the profile's set points. This graphical view makes it easy for the user to see what steps have already been programmed[1]. After the profile has been defined, the user can save the data for use at a later time.



Test profile plot of all steps' set points.

Step specific information.

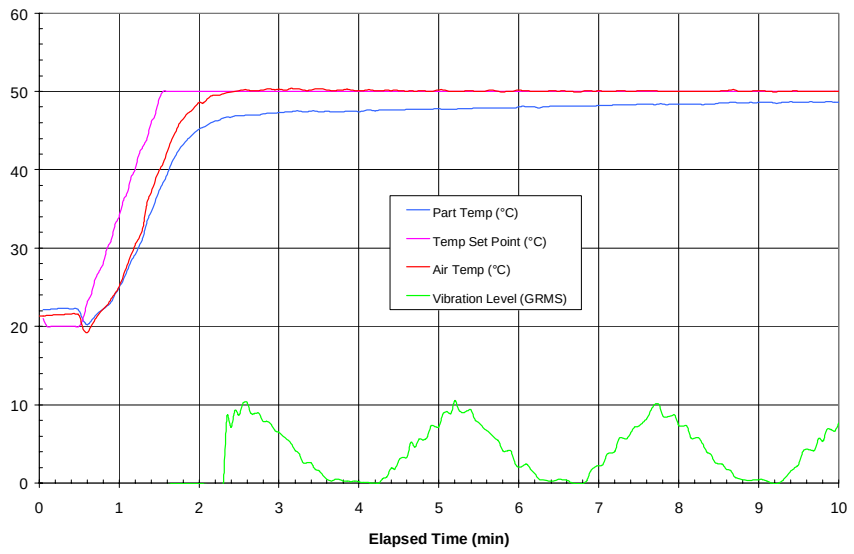
Use the following procedure to create a test profile:

1. Touch the CREATE / EDIT PROFILE button, which is on the bottom of all the screens.
   - Note this screen is protected under security level 1.
2. Touch the "NEW PROFILE" button.
3. Touch the step type button to define the type of step for step #1. The options are:

[1] Note the horizontal "time" axis is based on step number, not real time values. For example, a dwell step of 1 minute will look as long as a dwell step of 3 hours.

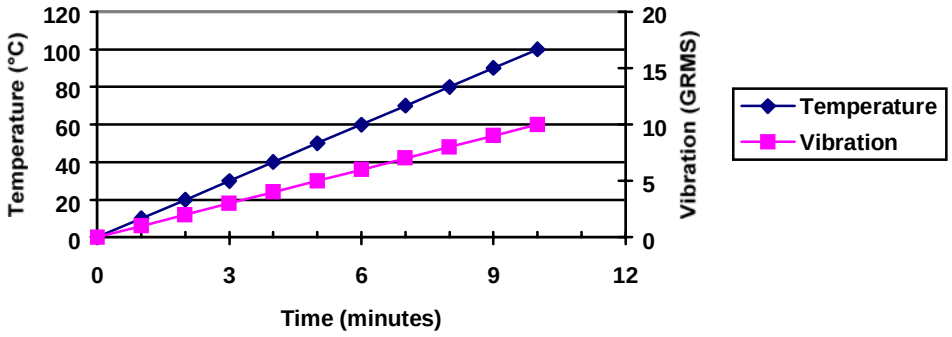
- DWELL – The controller will maintain the temperature entered in the Temperature Set Point field. If a Dwell step is selected, the user will have to specify the DWELL TIME also.
- RAMP – The controller will ramp the temperature from the previous set point to the set point entered in the Temperature Set Point field for the current step. If a RAMP step is selected, the controller will not advance to the next step until the specified temperature is achieved. If this step type is selected, the user will have to specify the RAMP RATE also.
- END – This step type identifies the end of the profile. There should only be one END step per profile. On the END step, the controller will turn off all outputs and Events (heat, cool, fans, etc.) and put the chamber into an idle state.

4. Touch the Temperature Set Point button to enter the set point in degrees C.
   - Note: If this particular step is a vibration only step (for example), then touch the "NOT A #" button next to the Temperature Set Point button. Touching this button will turn it from OFF to ON and will make the controller not control to any temperature. The heating and cooling outputs will be completely off.
5. Touch the VIBE (GRMS) button to enter the vibration set point in GRMS.
6. Touch the THERMAL RATE (°C / MN) button to enter the thermal ramp rate if the step type was selected as RAMP in step #2 above. If the step type was selected as DWELL in step #2 above, then ignore this button.
7. Touch the VIBE RATE (G / MN) button to enter a vibration ramp rate.
   - The vibration level will repeatedly ramp up and down to the value entered in the Vibration Set point field (step 5 above).

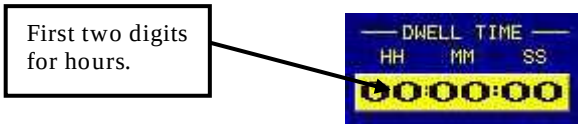


- The time duration of the step will be dictated by the thermal step characteristics. For example, if the temperature portion of the step is defined as a DWELL for two hours, the vibration will ramp up and down at the rate specified for two hours.

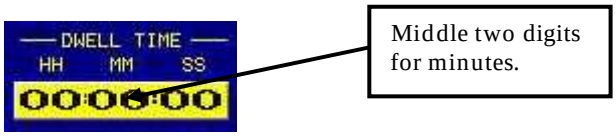
- If it is desired that both the temperature and vibration ramp from a low set point to a high set point simultaneously, and then stop, the user will have to calculate the correct ramp rates to use. For example, if the thermal step is defined as a RAMP from 0°C to 100°C at 10°C / min, it should take 10 minutes to complete that step. If the VIBE (GRMS) set point was defined as 10 Grms, and the VIBE RATE (G / MN) was defined as 1 G / MN, then it would also take 10 minutes to complete the step and both portions would finish together. This example is shown below:



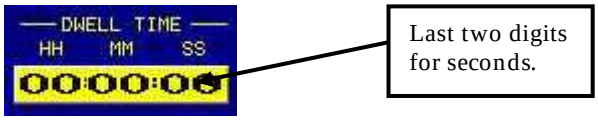
8. Enter the Dwell Time for this step if the step type was selected as DWELL in step #2 above. To enter the dwell time, three separate entries must be made as follows:
   - Touch the first two digits for hours and enter the number of hours for the dwell. If the dwell is less than an hour long, this box can be left at 00.



   - Touch the middle two digits for minutes and enter the number of minutes for the dwell. If the number of minutes is 0, this box can be left at 00.



   - Touch the last two digits for seconds and enter the number of seconds for the dwell. If the number of seconds is 0, this box can be left at 00.



9. Touch the GO TO STEP # button if using loops. The number entered in this field will be the step number the controller will go back to at the completion of the current

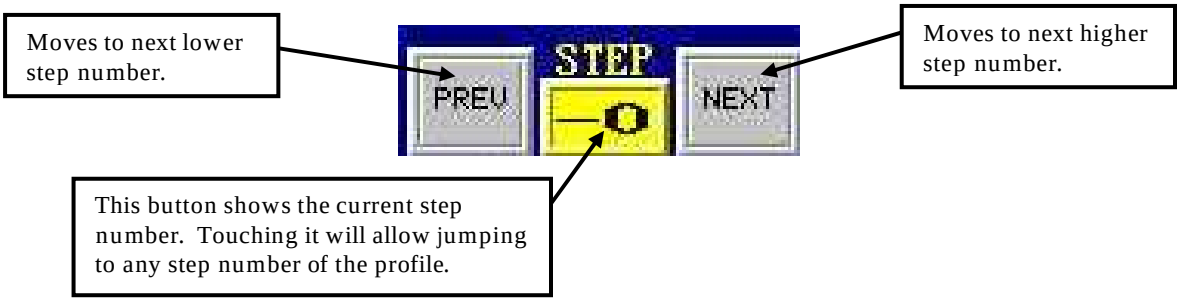
step. The step number entered in this field must be less than the current step number. For more information about loops, refer to the Loops Section of this manual.

10. Touch the LOOP # TIMES button to define the number of times the controller should loop back to the step number defined in step #7 above. The number entered in this field does include the initial pass through. For example, if the user wishes to have the controller execute steps 4-12 of a particular profile a total of 10 times, he/she should enter the number 10 in this field. This will force the controller to pass through the initial time and then repeat it 9 more times, for a total of 10 times. For more information about loops, refer to the Loops Section of this manual.
11. Touch the BOOST HEAT button to enter the appropriate value. The BOOST HEAT is defined as the number of degrees greater than the set point (entered in step #3 above) the air temperature will be controlled to until the product temperature reaches its set point. This feature is designed to help drive the product temperature faster. Once the product temperature reaches set point, the controller will reduce the air temperature to the value entered in the set point reducing any over shoot of the product temperature.
    - Note: If the controller is set in Air Temp controlling mode (see Automatic Mode – Running a Profile Section for details), the BOOST HEAT and BOOST COOL have no affect.
12. Touch the BOOST COOL button to enter the appropriate value. The BOOST COOL is defined as the number of degrees less than the set point (entered in step #3 above) the air temperature will be controlled to until the product temperature reaches its set point. This feature is designed to help drive the product temperature faster. Once the product temperature reaches set point, the controller will raise the air temperature to the value entered in the set point reducing any over shoot of the product temperature.
    - Note: If the controller is set in Air Temp controlling mode (see Automatic Mode – Running a Profile Section for details), the BOOST HEAT and BOOST COOL have no affect.
13. Touch the GUAR SOAK button to turn the Guaranteed Soak feature ON or OFF. If the Guaranteed Soak is turned on, the controller will only accumulate "soak time" if the control temperature is within G.S. DEAD BAND degrees (see next step) of the temperature set point.
14. Touch the G.S. DEAD BAND to enter the number of degrees (C) the control temperature can drift about the temperature set point and have the dwell timer continue. If the control temperature drifts farther than the G.S. DEAD BAND from the temperature set point, the dwell timer will be paused.
    - For example, if the temperature set point was entered as 100°C, and the G.S. DEAD BAND was entered as 5, the controller will accumulate dwell time if the control temperature is ≥ 95°C and ≤ 105°C. However, if for some reason the control temperature drops to 94.9°C, the controller's dwell timer will stop counting until it returns to the acceptable temperature band.
    - If the dwell time was set for 10 minutes, but the temperature drifts outside the G.S. DEAD BAND for 2 minutes, then the step time will actually last 12 minutes.

15. Turn ON / OFF any Events by touching the buttons below the labels. Each touch will toggle the Event between ON and OFF.

- HEAT EVENT must be turned on for the chamber to apply heat.
- COOL EVENT must be turned on for the chamber to apply cooling.
- VIBE (vibration) EVENT must be turned on for the chamber to apply vibration.
- FANS EVENT must be turned on for the chamber to have the fans on.
  - ✓ Fans must also be on for all other chamber functions (heating, cooling, vibration, purge) to be on.
- It is not necessary to have both HEAT and COOL Events on for any given step. However, caution should be taken when deciding to only have HEAT or COOL on, especially if Guaranteed Soak is being used.

16. All of the above steps define the parameters for one step of the profile. When all of this information is satisfactory, advance to the next step by touching the NEXT button in the lower right corner of the screen.
    - It is possible to scroll through steps (forward and backward) by touching the NEXT (moves forward from step 6 to step 7 for example) or touching the PREV (moves back to the previous step, like from 6 to 5 for example) button.
    - The current step is shown in the box below the "STEP" text.
    - The user can jump to any step number by touching the box below the "STEP" text and entering the desired step number.



17. When advancing to a new step, the status of the Heat, Cool and Fans Events are carried forward and copied to the new step. This is done to help speed the process of defining the profile. For example, it is common that the Fans Event is ON for the entire profile. This feature only makes the user define that Event the first time. The controller will assume it to be ON for the remaining steps.
    - Even though the controller carries these Events and copies them to the new step, the user can define them as OFF by simply touching the particular Event and toggling it to OFF.
    - For example, if Step #3 had the Heating Event programmed as ON, this will carry forward to Step #4. If the user then turns the Heating Event OFF if Step #4, this OFF value will carry forward to Step #5. It again can be changed to ON if the user wishes.

- Note that Event status does NOT carry forward if the user "jumps" (refer to step 15 above) between steps (i.e., does not use the "NEXT" button).

18. Continue defining steps in this same fashion to complete the test profile. When all steps are defined, save the profile by touching the SAVE button.
    - Details on saving a profile can be found in the "Saving a Profile" section.
    - A profile must be saved in order to run it in Automatic Mode later.
    - After a profile has been created and saved, refer to the "Running a Profile" (In the Automatic Mode section) section for details on running the profile.

Editing a Profile

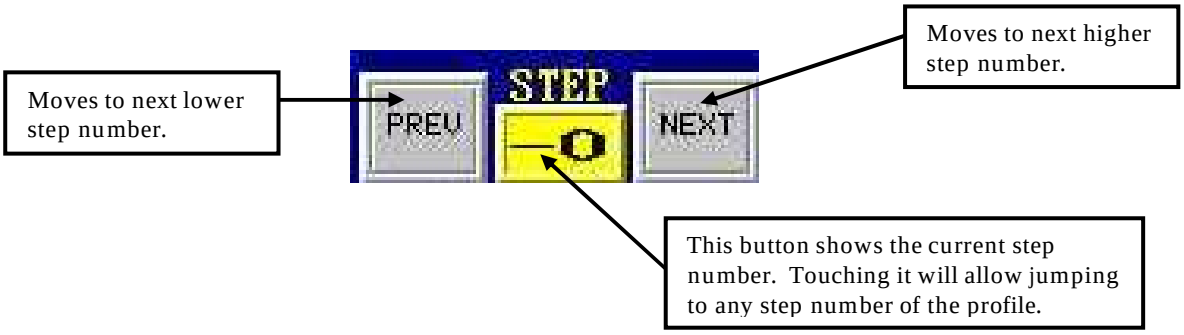
Editing a profile can be useful for making slight changes to existing profiles, or making larger changes and saving as a new profile name. It is common that many test profiles are very similar to each other, with slight differences in set points or dwell times. In this case, it is much easier to define one profile once, then make small modifications (via Editing) to it and save under different names for subsequent profiles.

To edit a profile, the user must first go to the CREATE/EDIT PROFILE screen. In that screen, open an existing profile by touching the "OPEN FILE" button shown below. Touching this button will bring up a list of previously saved profiles. Select the profile to open by touching on the name of the profile.

When the profile is opened, the top of the Create/Edit Profile Screen will show the plot of the set points and the bottom of the screen will show all the detailed information for step #1 of that profile.

With the profile open, the user can navigate through the steps by either scrolling up and down one step at a time with the "NEXT" and "PREV" buttons, or going directly to a step by touching the step number button and entering a step number. When at any given step, any of the information can be changed including:

- Temperature set point
- Vibration set point
- Thermal ramp rate
- Dwell time
- Step type
- Heat Boost
- Cool Boost
- Loop information
- Event status



In addition to changing information about particular steps, it is also possible to insert and delete steps. To delete a step, first go to the step that is to be deleted by either using the "NEXT" and "PREV" buttons or touching the step number button and going directly to it. After confirming this is the step that is to be deleted, simply press the "DELETE" button shown below. After deleting the step, all of the steps after that step will move up one step number. For example, if step #6 was deleted, step #7 will become step #6, step #8 will become step #7, step #9 will become step #8 and so forth. When the step is deleted, the graphical plot on the top of the screen will also re-draw the profile reflecting the deleted step.

Similarly, it is possible to insert a step in an existing profile. To insert a step, go to the step number that the inserted step should come before. For example, if the new step is to be inserted between steps 5 and 6, the user should navigate to step #6 in the profile. Once at the correct step number, touch the "INSERT" button shown below. After touching the "INSERT" button, the controller will move all of the remaining steps back to one higher step number. For example, step #10 will become step #11, step #11 will become step #12, step #12 will become step #13 and so forth. Once the new step is inserted, complete the step by defining all of the set points, step type and times etc. As the step's information is defined, the graphical plot on the top portion of the screen will update showing the inserted step etc.

Care should be taken when inserting or deleting steps in profiles that have loops programmed. If the user is not aware of the loops he/she may accidentally insert steps into a loop when it was not intended. It would also be possible that the user accidentally delete a step that defines a loop, which would remove the loop completely.

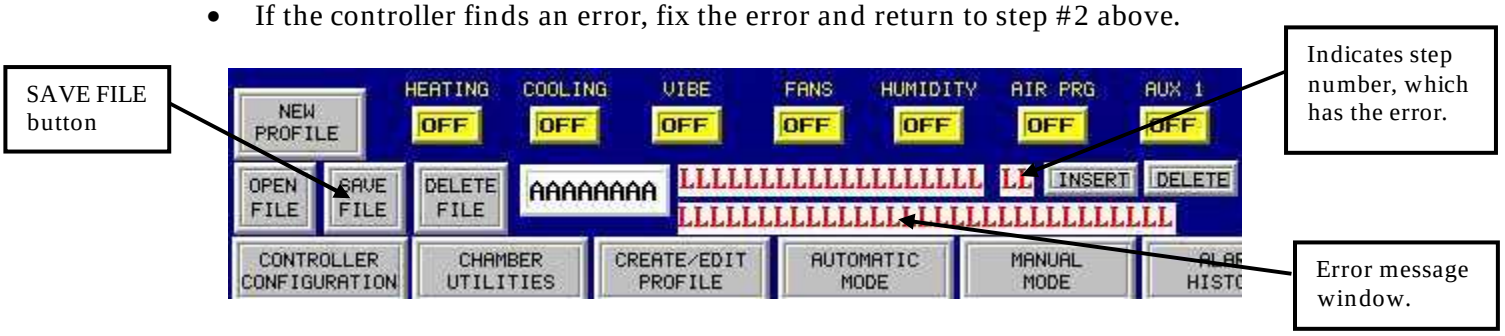
Once all changes to the profile have been made (editing, inserting/deleting steps etc), the profile should be saved to keep the changes. The profile can either be saved under its original name, or it can be saved under a different name. If it is saved as its original name, the original version will be over-written with the new profile.

Saving a Profile

When a profile has been defined, it can be saved in the controller's memory[2] for future use. This allows running the profile in Automatic Mode, or using it as a template for defining other, similar profiles as previously discussed.

To save a profile, use the following procedure:

1. Create the profile that is to be saved. This can be done by:
   - Creating a brand new profile.
   - Opening an existing profile and modifying it.
2. Touch the "SAVE FILE" button on the Create / Edit Profile Screen.
3. The controller will do an error checking routine looking for any obvious profile programming mistakes.
   - If the controller finds an error, it will print a message indicating the error and the step in which the error was found in the window as shown below. It will also jump to that step number in the profile for immediate review.
   - If the controller finds an error, fix the error and return to step #2 above.

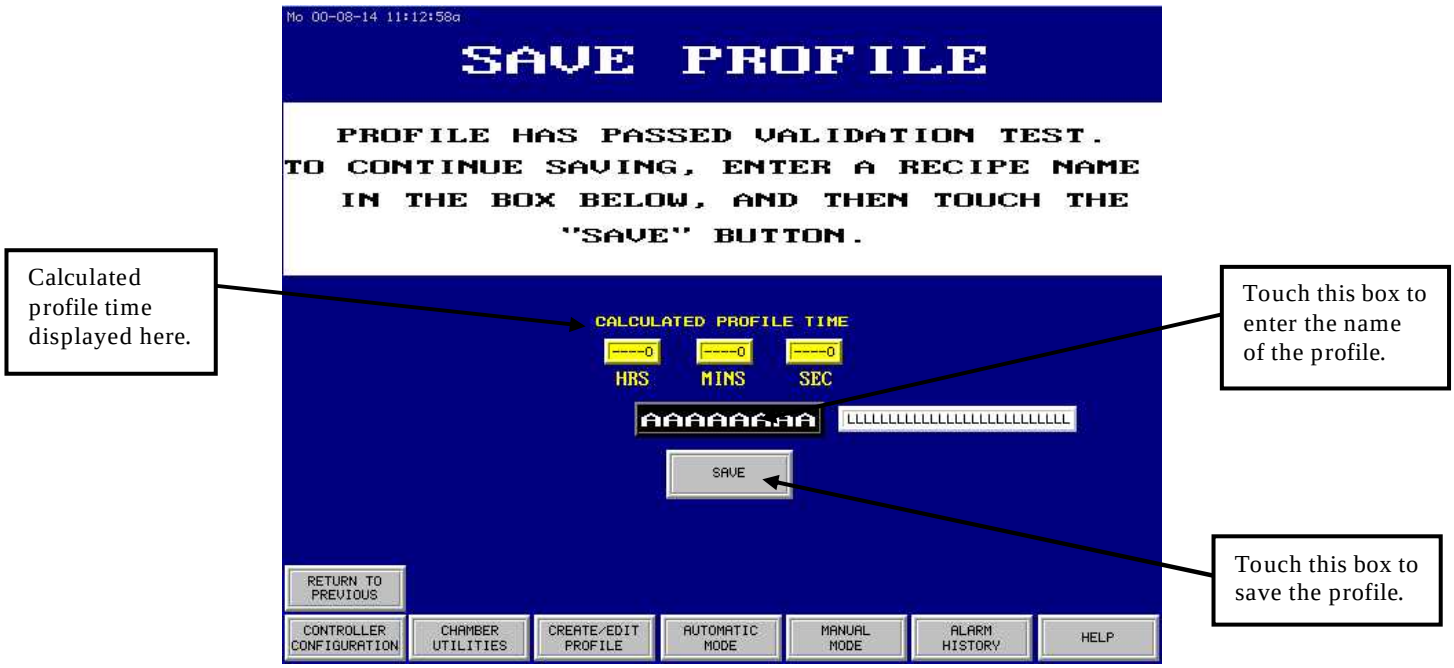


4. If the controller did not find any obvious mistakes, it will continue to the next screen.
5. The controller will go through the profile and calculate the total duration of test time for that profile and display it on the new screen.
6. Touch the long black box below the calculated profile time (shown below) to enter a name for the profile.
   - The profile name may not include any of the following 13 characters:

<	>	:	#
(	)	‘	÷
=	*	/	.
+			

7. Touch the "SAVE" button to save the profile to memory.
8. If the profile saved successfully, the controller will return to the Create / Edit Profile Screen.

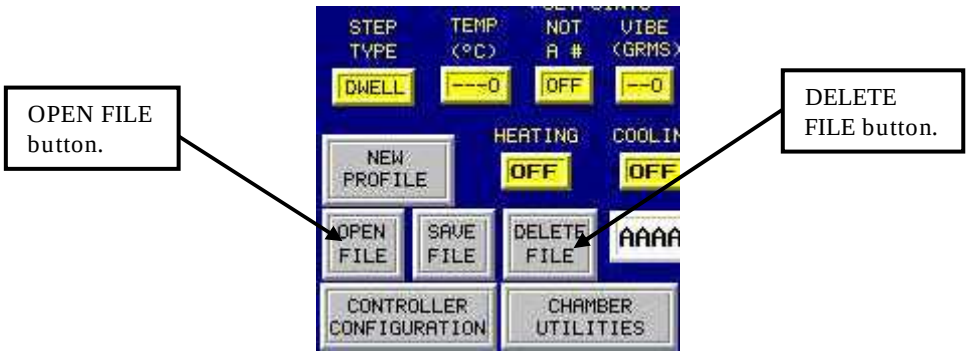
[2] Profiles are actually stored in the memory of the touch screen, not the PLC.



Deleting Existing Profiles

As a method of "file management" it may be necessary to delete existing profiles. These may be profiles that were once used but no longer have use. Use the following procedure to delete an existing profile:

1. Open the CREATE / EDIT PROFILE screen.
2. Touch the "OPEN FILE" button (see below).
3. Select the profile to delete by touching its name on the list of profiles to open.
4. The controller will open that profile and display the graphical representation of the set points in the upper portion of the screen.
5. Verify that this is the profile to be deleted.
6. Touch the "DELETE FILE" button (see below).
7. Select the profile to delete by touching its name on the list of profiles given.
8. Confirm desire to delete this file by pressing "yes".

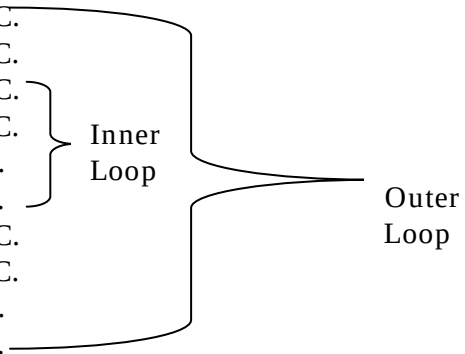


Loops

The controller has the capacity to store 50 profiles that are 50 steps long. Loops in programs do not count as additional steps. For example, if one profile loops on a series of 10 steps 20 times, that does not count as 200 steps, it only counts as 10 steps. Using loops can make programming long test profiles very easy and efficient, as well as save controller memory.

It is also possible to use nested loops in a profile. A nested loop is a loop within a loop. The following profile is an example of a nested loop:

1. Ramp to 20°C.
2. Dwell at 20°C.
3. Ramp to 100°C.
4. Dwell at 100°C.
5. Ramp to –50°C.
6. Dwell at –50°C.
7. Ramp to 80°C.
8. Dwell at 80°C.
9. Ramp to –30°C.
10. Dwell at –30°C.
11. Ramp to 70°C.
12. Dwell at 70°C.
13. Ramp to 20°C.
14. Dwell at 20°C.
15. End.



In this example, the controller would go from step 8 to step 5 and repeat the specified number of times. Once it has repeated the specified number of times, it will continue to step 9 and on to step 12. After the profile gets through step 12, it will return to step 3. It will follow this process until it has completed the specified number of outer loops.

Programming loops is simple and is done in the main Profile Edit screen. To program the above example loops, go to step 8 of the Profile definition. Then, where it says “Go to step #”, enter the number 5. Where it says “Loop # times” enter the number of times it should repeat steps 5-8. Then, go to step 12 of the profile and where it says “Go to step #,” enter the number 3. Where it says “Loop # times” enter the number of times it should repeat steps 3-12.

CONTROLLER CONFIGURATION

The Controller Configuration menu gives different menus that allow setting up certain features of the controller. Some of these features include security levels, alarm limits, maintenance, setting the date / time etc. The Controller Configuration Screen can be accessed from any screen by touching the "CONTROLLER CONFIGURATION" button on the bottom of the screen.

Site Alarm Limits

The controller has a set of Site Alarm Limits that can be programmed by a site manager. These limits help ensure that process variables stay within a general envelope. The intent is that these limits will be outside the limits set on a profile by profile basis in Automatic Mode. Therefor, the technicians using the chamber can adjust alarm limits from day to day for different profiles without nuisance tripping of the Site Alarm Limits. In this way, the site / lab manager can determine that of all the products that will be tested in this chamber, none of them (known at that time) should exceed these limits. This still gives the technician the freedom to change a set of limits on a test by test basis, but be protected by this higher set of limits.

If the chamber is operating in Manual Mode, the Site Alarm Limits are the alarm levels that are applied. The Profile Alarm Limits do not apply when the chamber is in Automatic Mode running a profile. When operating in Manual Mode, an action that is set as "GO TO 20°C" will be ignored. If the alarm action is defined as "DISABLE OUTPUT" or "SHUTDOWN CHAMBER", those alarms will execute as expected, but an action of "GO TO 20°C" will be ignored in Manual Mode.

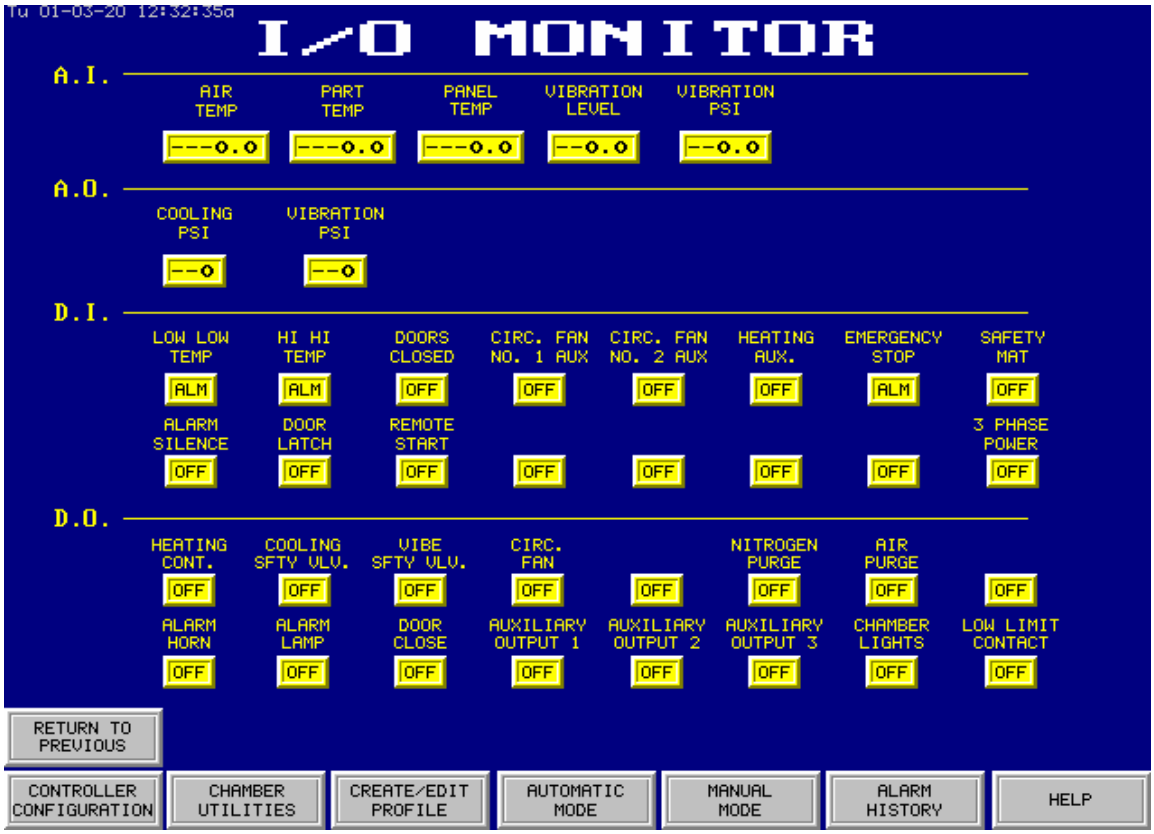
For detailed information about each of the alarms and the available actions, refer to the Automatic Mode Section of this manual. This page of alarm limits is protected under security level 2.

Maintenance Menu

The controller's Maintenance Menu (available in the Controller Configuration Screen) provides two utilities useful for troubleshooting the controller/chamber. The two options are the I/O Monitor and the Run Time Data Screen. The following sections describe these sections.

I/O Monitor

The I/O (Input/Output) Monitor Screen is a tool for looking at all of the controller's inputs and outputs on one screen. This screen can be very helpful for troubleshooting the chamber. The screen only allows viewing the information. It is not possible to enter information from this screen.

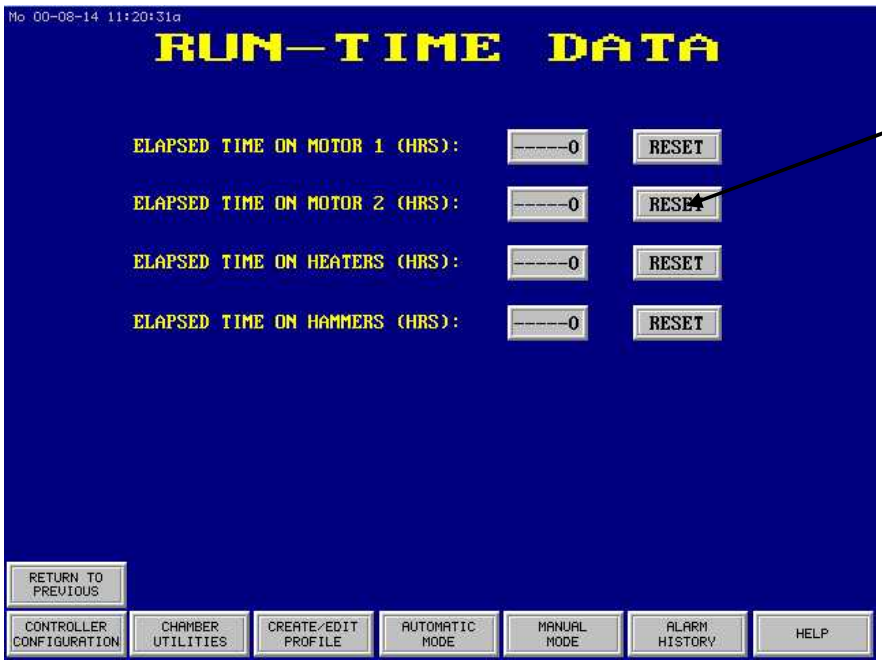


On the screen there are four different headings. The fields are arranged under the four headings. The headings are:

- A.I. – Analog Inputs
- A.O. – Analog Outputs
- D.I. – Digital Inputs
- D.O. – Digital Outputs

Run Time Data

The run time data screen has counters that keep track of the accumulated time on the chamber's blower motors, heaters and vibration hammers. Each counter accumulates the number of hours on each item. There is only one counter for the group of vibration hammers. Each individual hammer does not have its own counter. The counters can be reset if a part is replaced by a Chart technician as the "RESET" button is password protected.



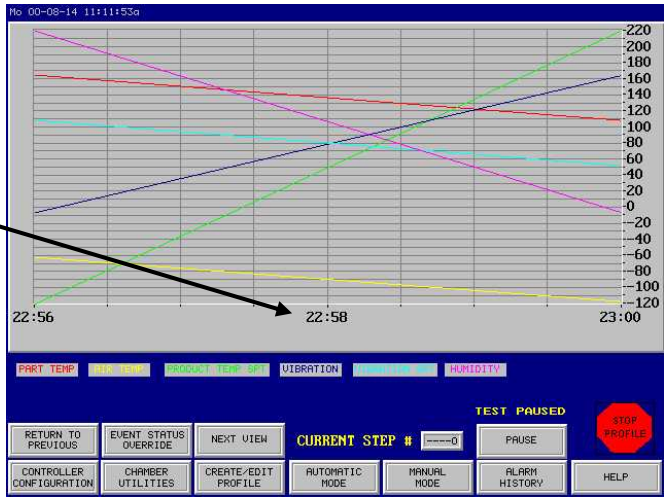
All RESET buttons are password protected for Chart technicians only.

Setting Date/Time

It is important to set the controller's date and time. The current date and time are displayed in the upper left corner of all screens for convenience. More importantly, the correct date and time are needed for the START @ SPECIFIED TIME feature. If the current date and time are not entered, it will be very difficult for the user to enter an appropriate date and time for the START @ SPECIFIED TIME feature.

In addition, two of the run time views have real-time trend charts on them. These trend charts use actual clock time as the time axis. The clock time displayed is that which is set based on the controller's clock. If the controller's date and time are incorrect, the time axis on the trend charts will also be incorrect.

Time axis displays ticks based on actual controller clock time in 24-hour format.



The set date/time screen is set up with fields to enter the various parameters. In addition to the standard menu at the bottom of the screen, the "RETURN TO PREVIOUS" button will return the user to the previous screen. The following is a picture of the screen:

Use the following procedure to set the controller's date and time:

1. Touch the box next to the "SELECT DAY OF WEEK" text. Touching this box will bring up a list of the days of the week. Select the current day by touching its name from the list.
2. Touch the box below the "YEAR" label. Touching this box will bring up a keypad to enter the last two digits of the current year. For example:
   - If current year is 2000, enter "00".
   - If current year is 2002, enter "02".
   - If current year is 2010, enter "10".
3. Touch the box below the "MONTH" label. Touching this box will bring up a keypad to enter a two-digit number representing the current month. For example:
   - If the current month is January, enter "01".
   - If the current month is April, enter "04".
   - If the current month is December, enter "12".
4. Touch the box below the "DATE" label. Touching this box will bring up a keypad to enter a two-digit number representing the current date of the month. For example:
   - If the current date is June 6, enter "06".
   - If the current date is October 12, enter "12".

5. Touch the box below the "HOURS" label. Touching this box will bring up a keypad to enter a two-digit number representing the current hour of the day in 24-hour format. For example:
   - If the current time is 1:xx am, enter "01".
   - If the current time is 11:xx am, enter "11".
   - If the current time is 12:00 noon, enter "12".
   - If the current time is 2:xx pm, enter "14".
   - If the current time is 12:00 midnight, enter "24".
6. Touch the box below the "MINUTES" label. Touching this box will bring up a keypad to enter a two-digit number representing the current number of minutes after the hour. For example:
   - If the current time is 1:00 am, enter "00".
   - If the current time is 11:43 am, enter "43".
   - If the current time is 3:19 pm, enter "19".
7. Touch the box below the "SECONDS" label. Touching this box will bring up a keypad to enter a two-digit number representing the current number of seconds after the minute. For example:
   - If the current time is 1:00:00 am, enter "00".
   - If the current time is 7:30:15 am, enter "15".
8. After all of the above fields have been updated with the appropriate values, touch the "SET TIME" button. Touching this button will change the controller's date and time. The individual fields do not get updated when changing their values (as done in steps #1 - #7), only when the "SET TIME" button is touched.
9. Cycle power OFF then ON. The clock will not update until the power is cycled.

PID Parameters

PID parameters are used to help tailor the response of the controller to changes in set points. Adjusting the PIDs (P = Proportional, I = Integral, D = Derivative) will play a significant role in determining if the chamber overshoots the set-point, takes a long time to get to set-point, oscillates about the set-point without settling on it etc.

There are a set of PID parameters for the thermal response, and an independent set of PID parameters for the vibration response. Each of these sets of parameters must be adjusted (often called tuning) independently and are non-interactive. It is important to note that the response of a particular set of PID parameters is also strongly dependent on the load on the chamber. For example, assume the chamber has a 2 pound piece of aluminum in the chamber while the PID parameters are tuned. The chamber will now respond well (minimal overshoots, minimal oscillations etc) for that particular product. However, if the next test object is a 200 pound steel object, the chamber will not respond well at all. In that case, it will tend to react much slower to the heavy steel object. In this new case, the chamber will respond better if the PID parameters are re-tuned for the new test conditions (the heavy steel object).

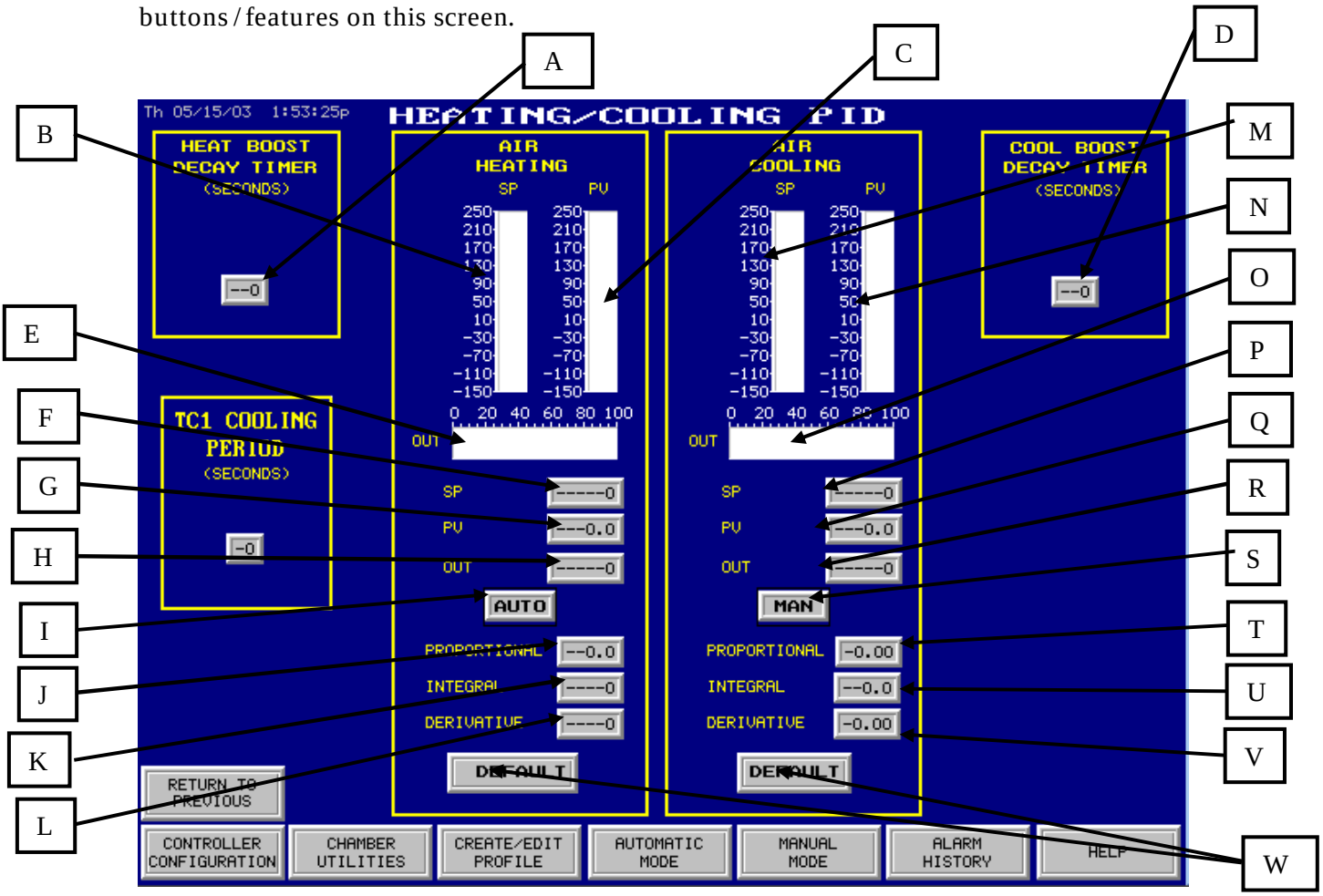
A good analogy is driving cars. Assume a driver is used to driving a 1984 Ford Escort and knows that he/she has to push the accelerator quite a bit when trying to accelerate onto the highway within 10 seconds. On the driver's birthday he/she gets a brand new

Corvette. If the driver pushes on the accelerator with the same force in the Corvette as he / she used to do in the Escort, the Corvette will accelerate to highway speed in a small fraction of the time the Escort did. The car will probably over-shoot the highway speed by a great margin as well. As the driver learns the response of the Corvette and drives it differently over time to be in more control, the driver is essentially "tuning" his / her PIDs.

Tuning PID loops is as much of a science as it is an art. There are many published technical sources available to help the user better understand and more efficiently tune PID loops. A thorough teaching of PID loops and tuning is beyond the scope of this manual. It is suggested that the user seek additional material on PID loops to gain a better understanding and most efficiently tune the controller's parameters.

PID Tuning Screen

The following is a picture of the temperature PID tuning screen. Following the picture is a general overview and explanation of the basic functions of the different buttons / features on this screen.



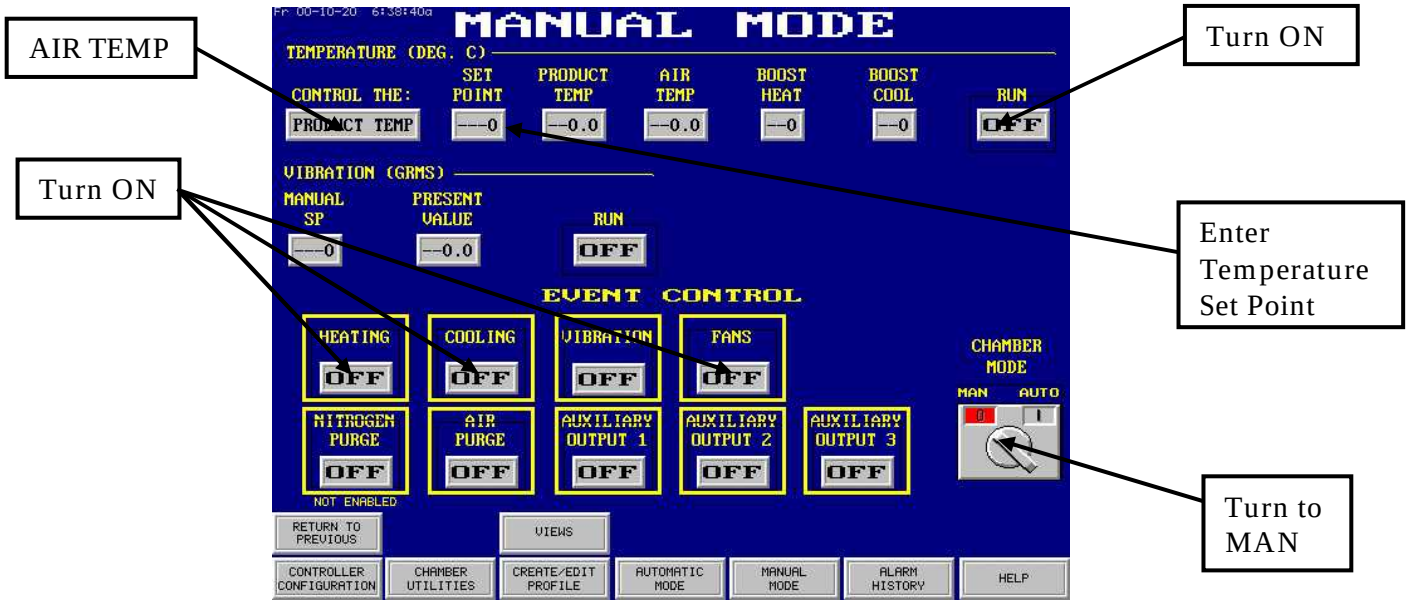
A. A tuning factor that automatically adjusts the amount of allowable air temperature over-shoot to help keep part temperature near set-point as chamber thermal conditions settle out.

B. Vertical bar graph illustrating the current temperature set point (°C) of the heating loop.
C. Vertical bar graph illustrating the current "air" temperature (°C) measured.
D. A tuning factor that automatically adjusts the amount of allowable air temperature over-shoot to help keep part temperature near set-point as chamber thermal conditions settle out.
E. Horizontal bar graph illustrating the current output percentage being sent to the primary PID loop for heating purposes.
F. Digital field indicating the current temperature set point (°C) for the "air" temperature. There is no input allowed from the user.
G. Digital field indicating the current "air" temperature (°C) measured. There is no input allowed from the user.
H. Digital field indicating the current output percentage being sent to the outer PID loop for heating purposes. There is no input allowed from the user.
I. Button allowing the user to put the heating PID loop in manual (MAN) or auto (AUTO) control mode. Modes are toggled back and forth by touching this button.
   - Do not change any PID parameters while the loop is in AUTO mode.
J. Button allowing entering a new value for the proportional value for the heating PID loop.
K. Button allowing entering a new value for the Integral value for the heating PID loop.
L. Button allowing entering a new value for the Derivative value for the heating PID loop.
M. Vertical bar graph illustrating the current temperature set point (°C) of the cooling loop.
N. Vertical bar graph illustrating the current "air" temperature (°C) measured.
O. Horizontal bar graph illustrating the current output percentage being sent to the primary PID loop for cooling purposes.
P. Digital field indicating the current temperature set point (°C) for the "air" temperature. There is no input allowed from the user.
Q. Digital field indicating the current "air" temperature (°C) measured. There is no input allowed from the user.
R. Digital field indicating the current output percentage being sent to the outer PID loop for cooling purposes. There is no input allowed from the user.
S. Button allowing the user to put the cooling PID loop in manual (MAN) or auto (AUTO) control mode. Modes are toggled back and forth by touching this button.
   - Do not change any PID parameters while the loop is in AUTO mode.
T. Button allowing entering a new value for the proportional value for the PID loop for cooling purposes.
U. Button allowing entering a new value for the Integral value for the PID loop for cooling purposes.
V. Button allowing entering a new value for the Derivative value for the PID loop for cooling purposes.
W. Buttons for returning the PID set to the factory set default. The factory default PID values were generated to run an empty (un-loaded) chamber with respectable response. Touching this button will restore the PIDs to these default values.

Tuning Thermal PIDs

Use the following procedure for tuning the controller's thermal PID loops:

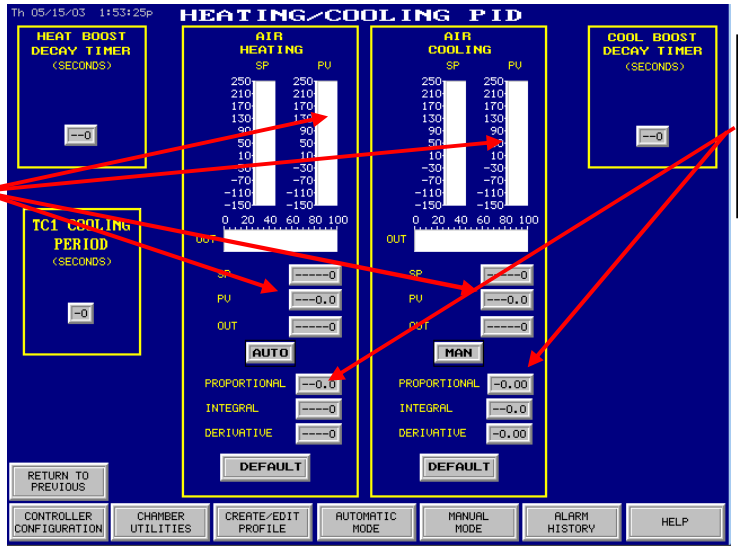
1. Touch the MANUAL MODE button on the main menu at the bottom of any screen.
2. In the EVENT CONTROL section of the screen, do the following:
   - Turn CHAMBER MODE to MAN
   - Turn the FANS Event ON
   - Turn the HEATING Event ON
   - Turn the COOLING Event ON
   - Select to control the AIR TEMP
   - Turn the thermal control (labeled RUN) ON
   - Turn the vibration control (labeled RUN) OFF
   - It is recommended (not required) that all other Events be turned OFF as well.



3. Enter a temperature set point.
4. Turn the controller to RUN.
5. Touch the CONTROLLER CONFIGURATION button on the main menu at the bottom of the screen.
6. Touch the PID LOOPS button on the CONTROLLER CONFIGURATION screen.
7. Touch the TEMPERATURE button on the PID LOOPS screen.

8. Tune the heating or cooling thermal loops (represented by the AIR HEATING and AIR COOLING section) by the following procedure:
   a) Ensure all control modes are in AUTO, not MAN.
   b) Watch the chamber's response in the vertical bar graph or the digital temperature readout in the box next to PV (present value) in the portion of the screen.
   c) Adjust the values of Proportional, Integral, and Derivative by touching the appropriate box in the AIR HEATING and AIR COOLING sections and entering the new value in the keypad.
      - It is recommended to observe and understand the affects of changing the Proportional first, then the Integral and the Derivative last.
      - Typically, a Derivative coefficient is not needed in fast acting chambers. It is recommended to leave this factor set at 0.00.
      - **Note it is recommended to press the CLR button before entering any new values.**

Chamber response can be observed by watching these bar graphs, or by watching the digital values in the PV fields.



Adjust these two sets of PID parameters to tune the heating and cooling loop. The heating and cooling can be adjusted independently of each other.

   d) Continue this process until optimal response is obtained.
      - Be sure to include factors like over-shoot, speed to set point, oscillations, etc.
      - The user must enter a new "set-point" after changing any PID parameters to see the affect of the new PID values.

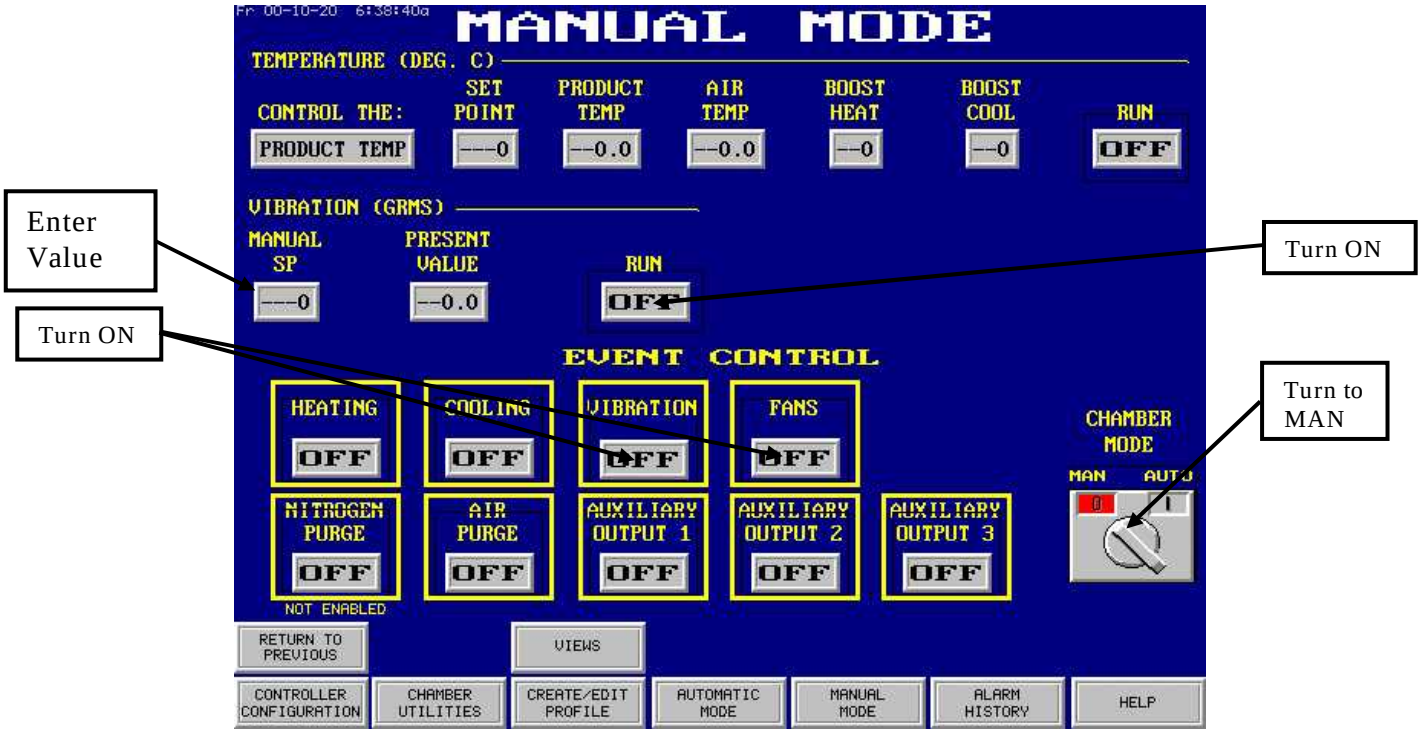
Tuning Vibration PIDs

The default PID vibration values are typically sufficient to achieve adequate vibration response. However, further vibration tuning could be required for a specific product weight and vibration level combinations. Use **Procedure A** for tuning the controller's vibration PID loops for chambers equipped only with the touch screen and use **Procedure B** for tuning vibration PID loops with chambers equipped with the touch screen and the SCADA data collection package:

Procedure A:

1. Log into security level 1 (see Controller Security Levels section).
2. Touch the MANUAL MODE button on the main menu at the bottom of any screen.
3. In the EVENT CONTROL section of the screen, do the following:

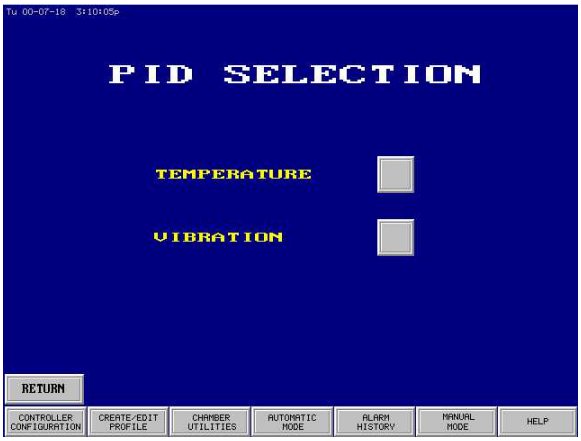
- Turn the CHAMBER MODE to MAN
- Turn the VIBRATION Event ON
- Turn the vibration control (labeled RUN) ON
- It is recommended (not required) that all other Events be turned OFF as well.



4. Touch the field next to "SP" to enter a set point for vibration in GRMS.
   - It is suggested to start with a low value such as 5 or 10.

5. Touch the CONTROLLER CONFIGURATION button on the main menu at the bottom of the screen.
6. Touch the PID LOOPS button on the CONTROLLER CONFIGURATION screen.

7. Touch the VIBRATION button on the PID LOOPS screen.



8. Verify that the test object, or something similar to the test object is mounted on the vibration table.

- If the vibration PIDs have never been tuned, or the user is inexperienced at tuning PIDs, it is suggested to start tuning without the actual test product on the table. If the PIDs are incorrect, the system could see very high levels of vibration and damage to the test object could occur.

9. If a minimum output percentage is going to be used, enter that value in the field shown below. The minimum output percentage is a value that determines a minimum output for the vibration system. Whenever the vibration system is enabled and a vibration set point has been entered, the controller will generate this minimum output. As the PID loop demands more output, the output will grow from the minimum value, as entered in this field, to a level that satisfies the current set point.

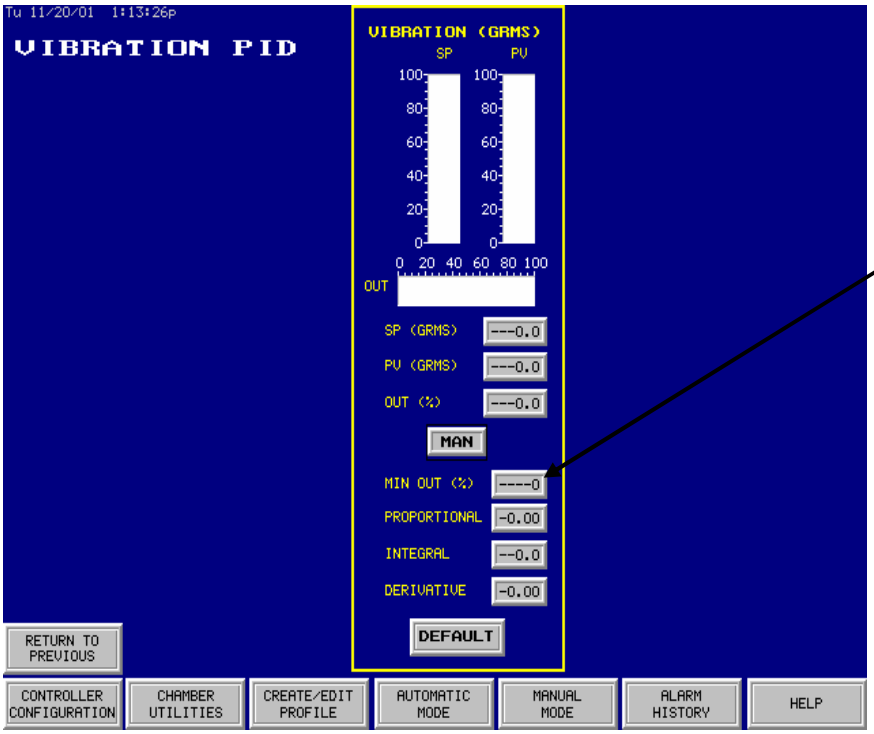
   This feature should be used when either or both of the following conditions are noticed:
   - The vibration takes a long time to get started after the set point has been entered.
   - When it does get started, it tends to quickly over-shoot the set point.

   - Using a correct minimum output percentage can make the vibration system get “jump started” and start up much quicker and reduce the chances of hammers “sticking.”

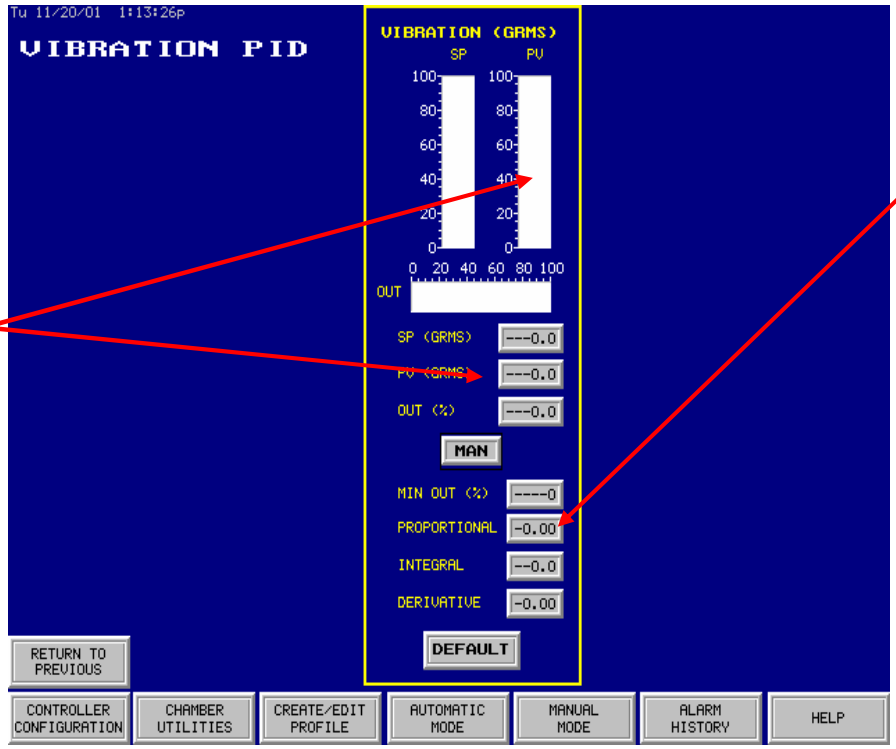
   - It should be noted that if the minimum output percentage is set too high, it is possible that lower G levels will not be attainable. If the output required to obtain 3 Grms is 8%, but the user has entered a minimum output percentage of 9%, the controller will output no less than 9% and the resulting vibration level will be higher than the desired set point.

   - Typical values of MIN OUT % are 7, 8 or 9%.

- If this feature is not to be used, enter a value of zero in this field.



9. Tune the vibration loops by the following procedure:
   e) Ensure all control mode is in AUTO, not MAN.
   f) Watch the chamber's response in the vertical bar graph or the digital temperature readout in the box next to PV (present value) in the portion of the screen.
   g) Adjust the values of Proportional, Integral, and Derivative by touching the appropriate box in the vibration section and entering the new value in the keypad.
      - It is recommended to observe and understand the affects of changing the Proportional first, then the Integral and the Derivative last.
      - Typically, a Derivative coefficient is not needed in fast acting chambers. It is recommended to leave this factor set at 0.00.
      - **Note it is recommended to press the CLR button before entering any new values.**
      - Be sure to include factors like over-shoot, speed to set point, oscillations, etc.



Chamber response can be observed by watching this bar graph, or by watching the digital values in the PV field.

Adjust these sets of PID parameters to tune the vibration loop.

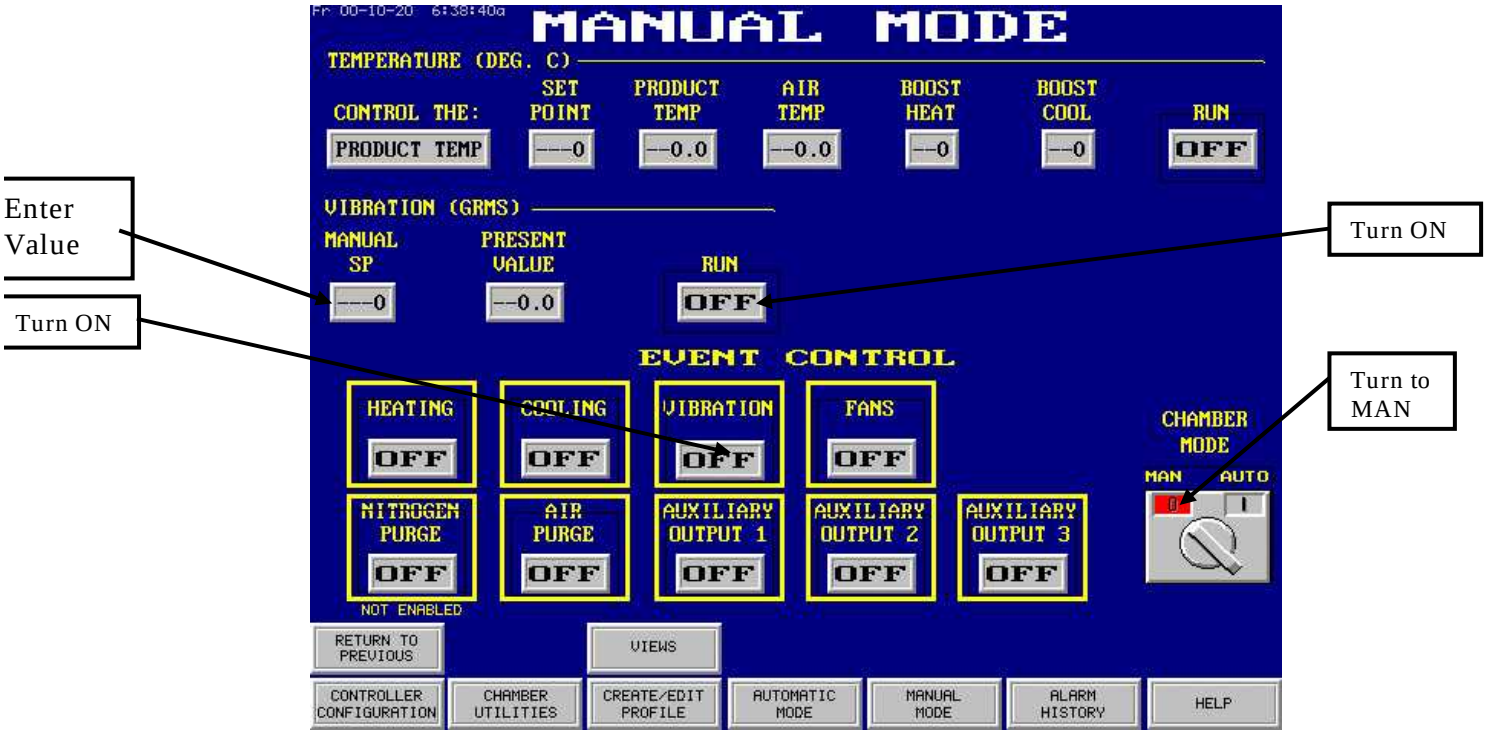
10. Repeat steps #4-9 for tuning at different vibration levels and variation in products .

Procedure B:

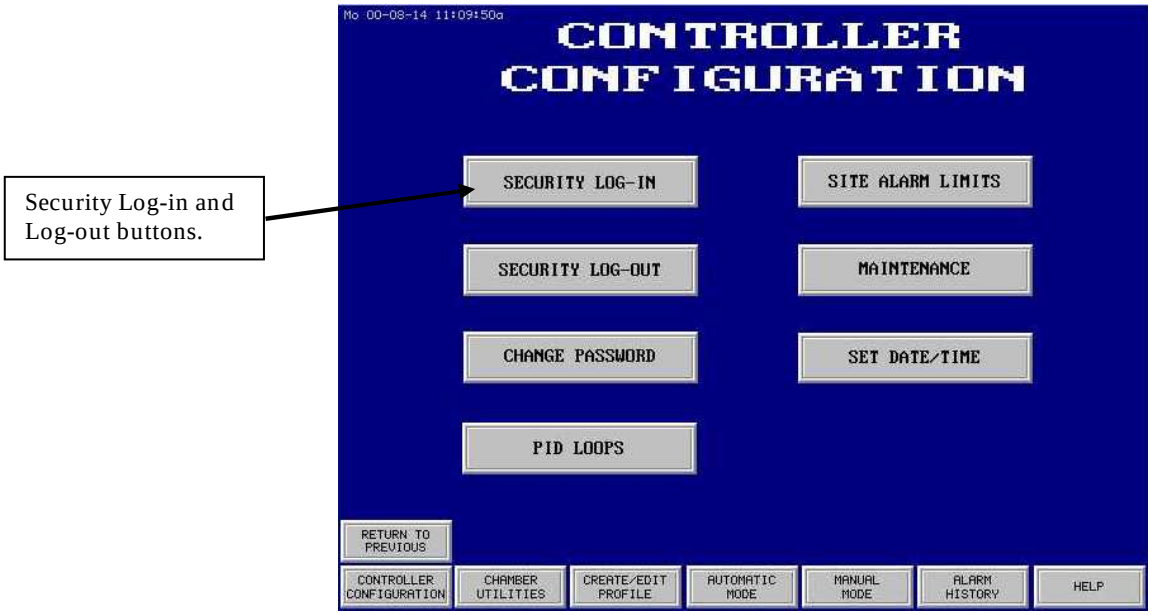
Vibration PID tuning:

1. Setup the chamber and vibration table the way it will be used during testing including weight and table location of parts.

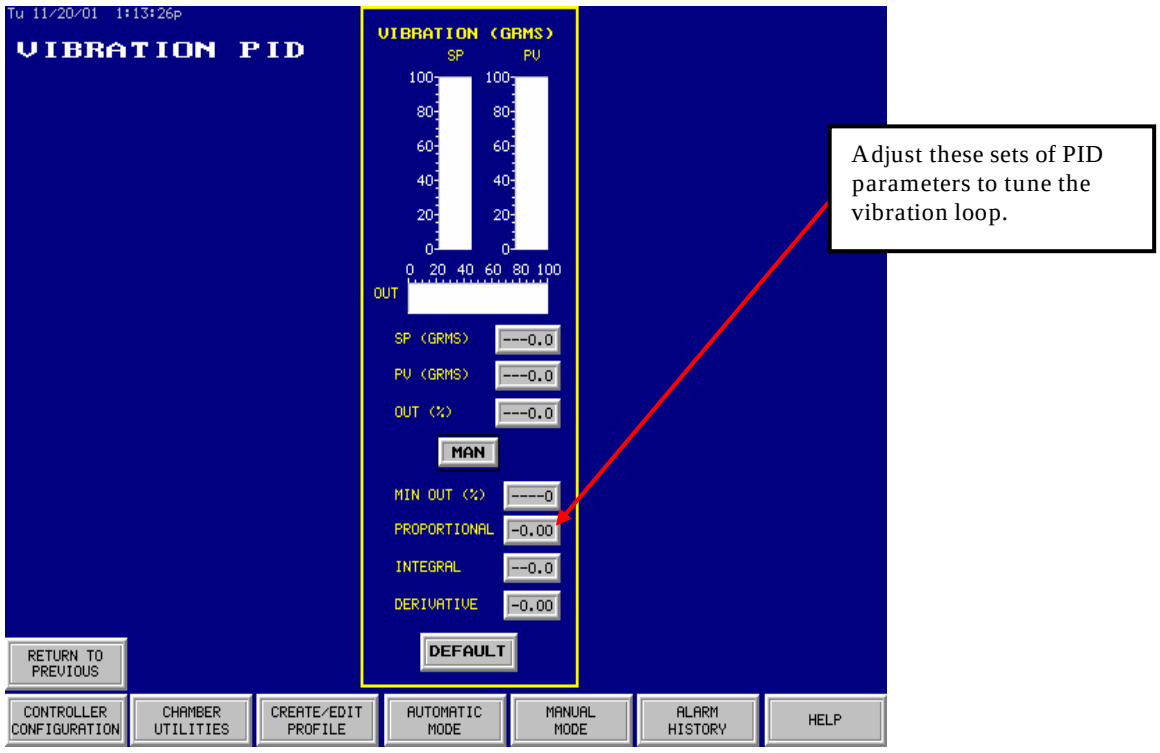
2. Run vibration at the setpoint testing will be done at (if variable setpoint use the average of the range used).



3. Log into security level 1 (see Controller Security Levels section).

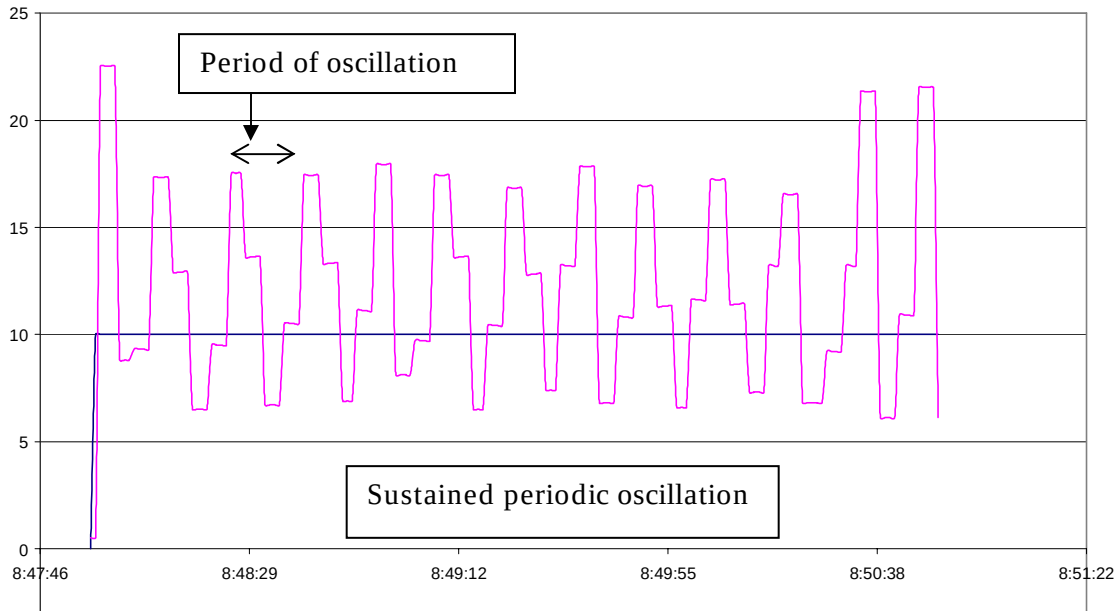


4. On the touch-screen under "Controller Configuration" go to "PID loops" and then "Vibration".



5. Set the proportional gain to 0.05, the integral gain to its minimum value of 0.1, and the derivative gain to 0.

6. Slowly increase the proportional gain until there is a distinct periodic oscillation in the vibration output. An increase of 0.02 in proportional gain each time should allow oscillation to be found. Note: Let the chamber run for ~5 minutes at each setting to ensure consistent operation.



7. Once a proportional gain which produces oscillation similar to the image above is found record it for future use, this value is called the ultimate gain. You will need to use the SCADA package to be able to accurately view chamber performance real time and data log vibration levels. See SCADA manual for instructions.

8. Calculate the period, in seconds, of the oscillation. Record this value as the ultimate period.

9. Return one final time and set the PID values as seen in the chart below.

Proportional	Ultimate gain / 1.7
Integral	Ultimate period / 2
Derivative	Ultimate period / 8

Example:
If you found the ultimate gain to be 0.15 and the ultimate period to be 15 seconds you would set the PID values to 0.09, 7.5, and 1.88 respectively.

AUXILIARY OUTPUTS

The CTI controller is supplied with three standard auxiliary discrete outputs. These outputs can be used in manual mode or in automatic mode to control outside equipment. Potential uses for these outputs are not limited to, but may contain the following:

- Turning power on / off to units under test
- Turn indicator lights on / off to signify when a test is in process
- Turn an indicator light or audible buzzer on to signify when a test has completed
- Send discrete signals to other test equipment to mark a particular step of the test

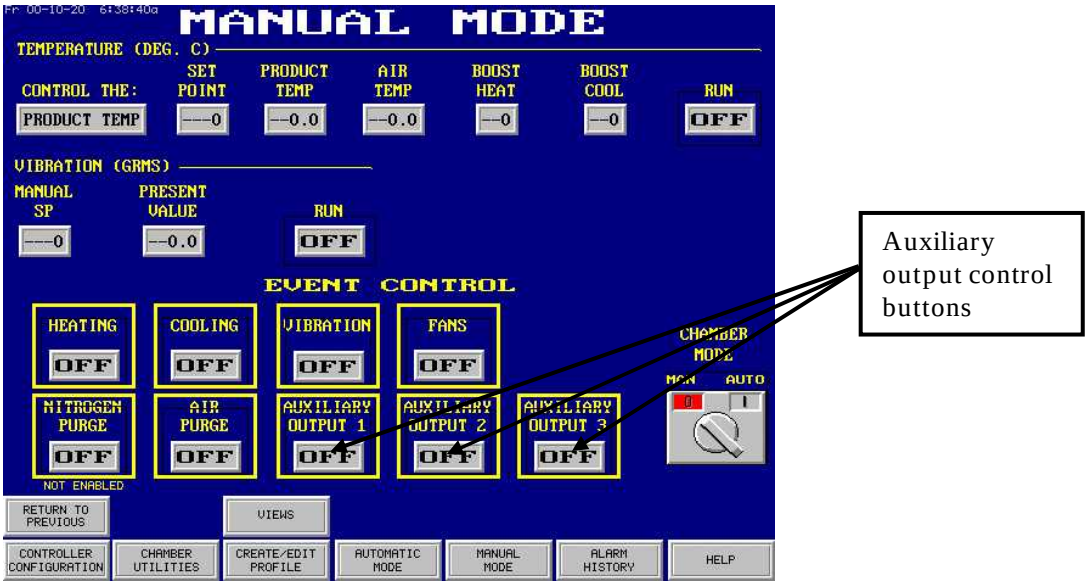
The outputs are wired to relays which provide dry contacts for use as needed when running the test. The contacts are rated to 250 V / 6 amps. In most cases, outputs TB14, TB15 and TB16 control these auxiliary outputs. Most often they are wired to control relays CR1224, CR1226 and CR1228 respectively. It is recommended to refer to the electrical schematics that were supplied with the chamber for the exact connection terminals.

Automatic Mode

The auxiliary outputs can be programmed to operate independently in Automatic Mode. Each output can be programmed to be ON or OFF for each step of the program. When defining the profile, simply touch the yellow button for the auxiliary output to toggle it between ON and OFF.

Manual Mode

The auxiliary outputs can also be controlled while in Manual Mode. To change the state of the outputs in Manual Mode, simply touch the button to toggle it between ON and OFF. The user can change the state of the auxiliary outputs at any time in Manual Mode. He/she does not have to wait until a change in thermal or vibration set point take place. In Manual Mode, changing the state of the outputs takes place immediately.



Thermal Protection Auxiliary

The CTI has a standard feature that allows protecting devices in temperature alarm conditions. Many users like to use this output to help remove power from the device under test in alarm conditions. The output is wired to an auxiliary relay which provides the user dry contacts to interface with. The auxiliary relay gives both a normally open and a normally closed contact to work with.

The output is energized, or "ON" when the current temperature is within the high and low alarm limits. The output is de-energized, or "OFF" when any of the following occur:

- Profile High Temperature Alarm
- Profile Low Temperature Alarm
- Site High Temperature Alarm
- Site Low Temperature Alarm

Typically, this output is TB18 and wired to control relay CR1232[3]. The control relay is wired to three terminals providing one common, one normally open and one normally closed contact. The contacts are rated for 250 V, 6 amps.

[3] The user should refer to the electrical schematics that were supplied with the chamber for exact wiring information.

CONTROLLER ALARMS

The CTI has many different alarms in place to ensure efficient and safe operation of the chamber. The user defines most of the alarm set points. Some of the alarm set points are pre-programmed at the factory. When the user defines the alarm set point, he/she is also able to program the action the controller should take if the alarm condition were to occur. The available actions are:

- ✓ DO NOTHING – If this action is selected, the controller will continue controlling as if no alarm has been activated. The controller will log the alarm, sound the horn, and the Alarm Silence light will blink. The user should acknowledge the alarm, but the test will not be interrupted because of the alarm.

- ✓ DISABLE OUTPUT – This alarm action will shut down the output that is pertinent to the particular alarm. For example, on a high temperature alarm, the controller will disable the heating output. Similarly, on a low temperature alarm, the controller will disable the cooling output. The test profile will continue without that particular output. The output will turn back on when the alarm has been acknowledged, and the condition has returned within the alarm constraints.

- ✓ GO TO 20 DEGREES – With this selection, the controller will control the temperature of the chamber to 20°C. For example, if the alarm was a high temperature alarm, the controller will not disable an output, but it will stop the test profile and assume a set point of 20°C. After the alarm is acknowledged, the controller can then be stopped from its 20°C set point. The test profile will then need to be re-started.

- ✓ SHUTDOWN CHAMBER – If this action is selected, the controller will shutdown all outputs (heat, cool, vibration, circulation fans, purges, Auxiliary outputs, etc) of the chamber. The chamber will sit idle until the alarm is acknowledged and started back up. If the chamber has pneumatic doors (TC/TVC-9, 16, REAL-30 & REAL-48), the doors will also open. The test profile will then need to be re-started.

Alarm History

Any time an alarm is issued, the date, time and alarm description is logged in the controller's memory. The alarm is logged even if the action "DO NOTHING" is selected.

The alarm history can be viewed at any time by touching the "ALARM HISTORY" button on the bottom of every screen. This screen allows viewing alarm details for many alarms, which have happened some time in the past. In addition to the alarm description, the history screen also logs the date/time the alarm occurred, and the date/time the alarm was acknowledged. The Alarm History screen has the following buttons along the right side of the screen:

- ✓ ESC – Touching this button will leave the alarm history screen and return to the previous screen.
- ✓ PLUS SIGN ICON – Touching this button will make the font size of the text get bigger.
- ✓ MINUS SIGN ICON – Touching this button will make the font size of the test get smaller.
- ✓ WATCH ICON – Touching this button once will display the date/time the alarms occurred. Touching the button a second time will display the date/time the alarms were acknowledged. Touching the button a third time will display the date/time the alarms were resolved. Continuing to touch this button will cycle through these various date/time displays.
- ✓ CLR – Touching this button will delete all of the alarms from memory. This button is security protected and is only used by the factory.