THERMOTRON®

A Venturedyne, Ltd. Company

3200 Programmer/Controller Operator Manual

Revision 2: May 12, 2010

This generic manual is intended for reference purposes only and is not intended to be used to operate your equipment. For operating instructions and a description of the features used on your specific control system, see the hard copy manual set for your Thermotron product.

This manual provides the most current generic operating instructions for this controller at the time of its revision date. Therefore this manual may not include some recent software changes. This manual may also cover features that are not available on your current controller. Examples within this manual are for typical configurations that may not apply to the configuration of your control system.

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Section 1: Getting Started

This section provides the basic information you need to start using the 3200. This includes an introduction to the instrument, a brief hardware description, and instructions for operating in manual mode, running a program, and checking the chamber status.

- For additional hardware information, see "3200 basic functions" later in this section.
- For more detailed hardware information, see the *CM2 Control Module Technical Manual*.
- For information on 3200 setup, see Section 2 of this manual.
- For information on programming the 3200, see Section 3 of this manual.
- For definitions of many of the terms used in this manual, see the glossary at the end of this manual.

Introduction to the 3200

The 3200 is a microprocessor-based programmer and controller. The programmer function allows you to program temperature, temperature/humidity, or other types of tests and store them in program memory. You can use these programs to operate the controller functions of the 3200.

Most 3200 programmer/controllers are configured for either single-channel operation (temperature only), or dual-channel operation (temperature and humidity). If your 3200 is configured for dual-channel operation, it can operate as a temperature-only system or as a temperature/humidity system.

- Typically, channel 1 is dedicated to chamber air temperature using a dry bulb thermocouple. Channel 1 operates the chamber's heating and cooling systems.
- Typically, channel 2 is dedicated to humidity using either a solid-state humidity sensor or a wet bulb thermocouple. Channel 2 operates the chamber's humidifying and dehumidifying systems.
- Channel 3 may be configured for product temperature control (PTC). PTC is a heating and cooling process that controls the process variable based on the product temperature rather than the test space air temperature. **NOTE**: Product temperature control and humidity cannot be run at the same time.

Although the 3200 can be configured for up to three programmable channels, for ease of use this manual is based on the more common one- and two-channel configurations. Three-channel operation follows the same basic principles described in this manual.

The 3200 can be programmed and operated locally using the display screen, function keys, and keypad. The 3200 also can be programmed and operated from a host computer. For more information, refer to the *3200 Programmer/Controller Computer Interface Manual*.

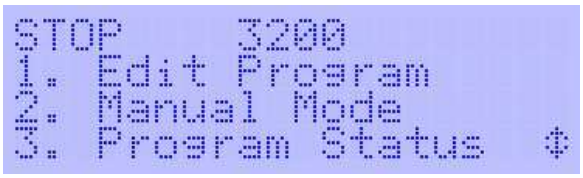
The controller functions operate the chamber and its attached equipment. Analog and transistor-transistor logic (TTL) level signals control and monitor the system. The chamber's conditioning systems, printers, chart recorders, and solid-state relay devices are operated from the controller signals. Other analog devices also can be monitored and operated.

Thermocouples can be mounted throughout the operating systems to feed diagnostic information back to the controller.

Before operating the 3200, several setup procedures must be completed. Most of the setup procedures were performed at Thermotron; however, these procedures may need to be performed again if requirements change. Refer to Section 2 for setup instructions.

Display module

The 3200 is operated using the 4-line by 20-character display (illustrated to the right) and keypad.



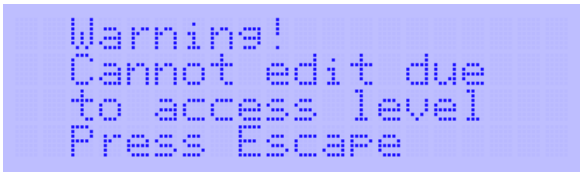
Accessing other screens and functions

NOTE: In this manual function keys are indicated in bold letters. For example, "Press **RUN**. When the run program screen appears, choose what program you would like to run."

NOTE: For CDS-5 chambers, enter 72776 (SETUP) on the numeric keypad to access the main menu.

For most 3200 operations you start from the startup main screen (shown above) and use function keys to access other screens and functions. To return to the startup main screen from any other screen, press the **ESC** key repeatedly until the main screen is displayed.

- To display the cause of the last chamber stop, press **STOP**. **NOTE**: Pressing **STOP** while a program is running will stop the program.
- To turn the chamber light(s) on or off from any screen, press the **ESC (LIGHT)** function key and hold for one second.
- If you try to access a function that is not available at the current access level, this screen will appear:

  For more information on access levels, see "Changing the access level or password" in Section 2 of this manual.

3200 basic functions

The following sections provide brief descriptions of some of the 3200 functions.

Control channels

Control channels receive inputs from thermocouples and/or other sensing devices used to monitor the environmental conditions inside the chamber's test space. The 3200 adjusts its control outputs based on those inputs.

- Typically, channel 1 uses a thermocouple mounted in the chamber airflow to sense air temperature. Its outputs control the heating and cooling systems.
- Typically, channel 2 uses a solid-state humidity sensor to monitor chamber humidity. The reading from the sensor is used together with the reading from the channel 1 thermocouple to calculate chamber humidity. The channel 2 outputs control the humidity system's steam generator and dehumidify coil.
- Channel 3, if available, can sense temperature or linear inputs. These channels commonly are configured for such options as product temperature control or altitude.
- Channels 5 through 8 can be programmed at the factory as constant control channels. Each channel can be set at the factory to sense either temperature or linear inputs.

Chamber conditioning system signals

The chamber conditioning signals are used by the controller to operate chamber systems such as heating, cooling, and humidity. These signals are dedicated to the system and are internally programmed.

- The system, refrigeration, and humidity enable outputs allow their respective systems to turn on.
- The heat and cool outputs control their systems. For example, the channel 1 cool output normally operates the solenoids that regulate the flow of refrigerant into the chamber's evaporator coil.
- The auxiliary cool output operates any auxiliary cooling system, such as liquid nitrogen (LN_2) or carbon dioxide (CO_2).

Alarm output signals

The alarm output transistor-transistor logic (TTL) signals indicate when the chamber temperature or humidity exceeds the programmed limits. Two types of alarms are available for each channel:

- ***Deviation alarms*** are activated when the chamber temperature, humidity, or other process variable is outside the channel's deviation alarm band. A deviation alarm band restricts how far the process variable can be from set point. For example, a deviation alarm band of 5°C activates the alarm output if the chamber temperature is more than 5°C from set point.

  Deviation alarms can be set for each manual mode test or program interval. For more information, see "Running in manual mode" below, or Section 3 later in this manual.

- ***Process alarms*** are activated when the chamber temperature, humidity, or other process variable is outside the process limits. The process alarm settings restrict the high and low limits of a test. A process alarm stops the programmer/controller. For example, if the high process alarm limit is +125°C, the alarm is activated if the temperature equals or exceeds +125°C.

  Process alarms are a configuration setting that can be adjusted only in setup mode. For more information, see Section 2 later in this manual.

Auxiliary outputs

Auxiliary outputs provide programmable TTL level outputs. There can be up to two groups of eight auxiliary outputs. These outputs are programmed on and off during each program interval or during manual mode operation. These outputs normally are used to program systems on and off. For information on your chamber's auxiliary outputs, see your chamber manual.

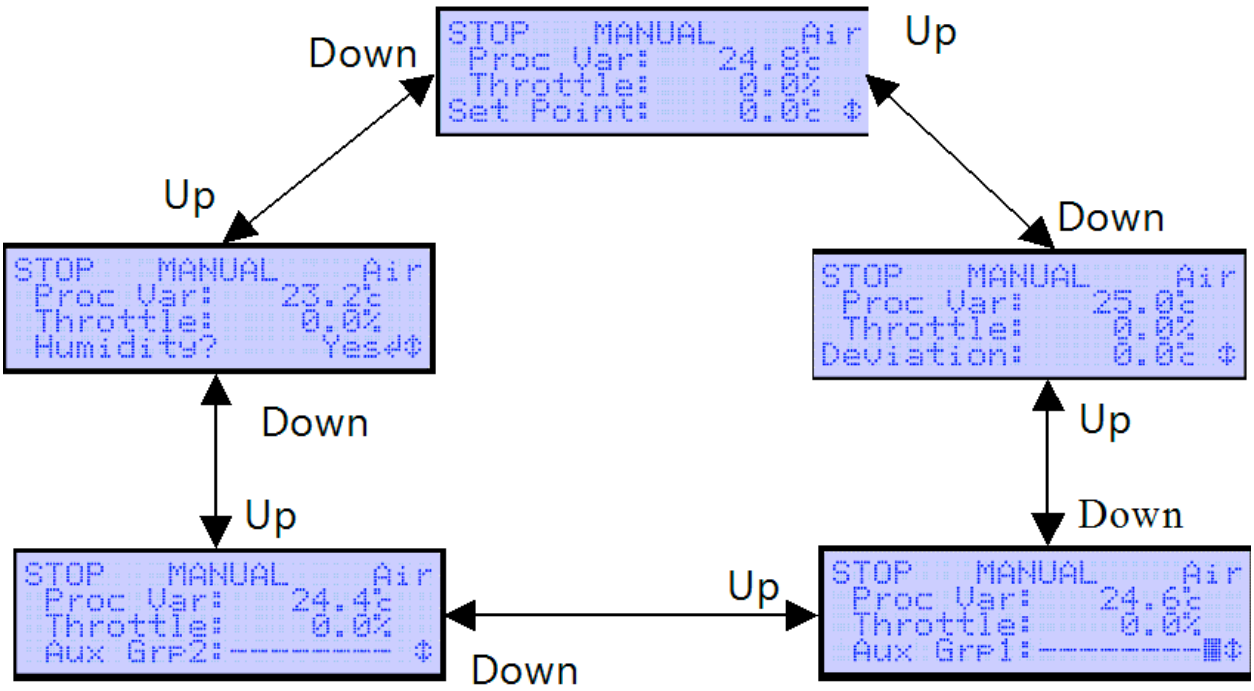
Running in manual mode

Manual mode allows you to operate the 3200 controller functions. Manual mode operates the chamber using set point settings. You can enter manual mode when the system is in stop mode.

Manual mode

1. From the main screen select option **2. Manual Mode**. The manual mode screen will appear:

2. Use the up and down arrow keys to cycle through the following screens.



3. The following list describes the manual mode values displayed:

   - **Set Point**: Enter the desired value for each active channel. When the ramp rate is not zero, the set point will change toward this new value at the selected rate.
   - **Aux Grp1** and **Aux Grp2 (auxiliary groups 1 and 2)**: Enter the numbers of the auxiliary relays you want to activate. Auxiliaries are active only when the 3200 is running. For more information on auxiliary relays, see "Auxiliary outputs" earlier in this section.

- **Hum (humidity)**: Enables the optional humidity system. **NOTE**: Humidity is disabled if product temperature control (**PTC**) is enabled.
- **PTC (product temperature control)**: Enables the optional PTC control method. **NOTE**: PTC is disabled if humidity is enabled.
- **Control Parameters**: For more information on parameter groups, see "Adjusting standard control parameters" or "Adjusting PTC control parameters" in Section 2 of this manual.
- **Throttle**: Positive values indicate heating or humidifying; negative values indicate cooling or dehumidifying.
- **Deviation**: Enter the value for how far you will allow the temperature or other process variable to be from set point. The deviation setting will be monitored and the deviation alarm will be activated if the value is exceeded. Enter a positive number only; the 3200 will monitor both positive and negative deviations.

4. To start running in manual mode using the settings entered above, press **RUN**.
5. To stop manual mode operation, press **STOP**.

Running a program

The programmer function operates the 3200 using programs. Each program consists of a group of intervals. In each interval the controller cycles the chamber toward a final temperature and/or other process variable in a specified amount of time. Once the interval is completed, the 3200 either transitions to the next interval or loops back to an earlier interval.

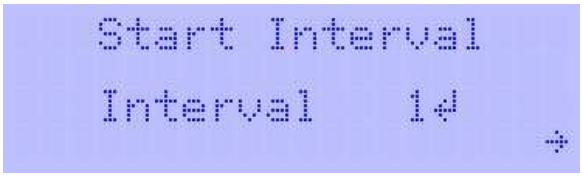
Once a program is entered into memory it can be run immediately. To create a program, see Section 3 of this manual.

Program mode

1. From any screen, press **RUN**. (**NOTE**: The run program screen will not appear when in program edit mode or while a program is running.) The run program screen will appear:

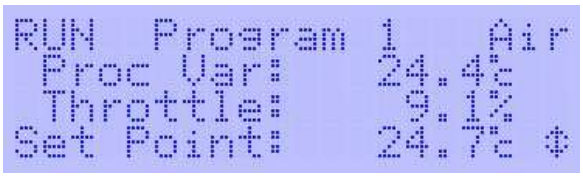
2. Select option 1 for program 1, interval 1. **NOTE**: To create a program, see Section 3 of this manual.
3. Select a starting interval. Then press the right arrow key to run the selected program.

   NOTE: The start interval screen will only appear when there is more than one interval created.

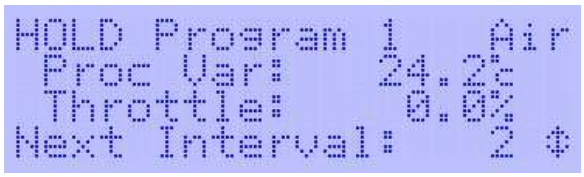


4. The 3200 will enter run program mode and the chamber status screen will appear:

   For more information on the chamber status screen, see "Chamber Status" later in this section.



5. To suspend the interval at its current settings, press **HOLD**. The 3200 will enter hold program mode. From the top level menu, pressing the run key, while **RUNP** (run program) is displayed in the top left corner, will display the message **HOLD**.



   NOTE: In hold program mode the 3200 will maintain the chamber test space at the last set point.

6. To enter temporary values into the current interval, use the numeric keypad to enter a new value. For additional information, go to step 4 of "Edit from hold" later in this section.
7. To resume running a suspended test, press **RUN**.
8. To stop a running test, press **STOP**.

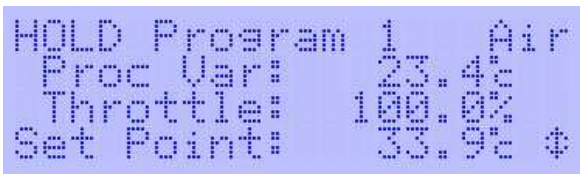
Edit from hold

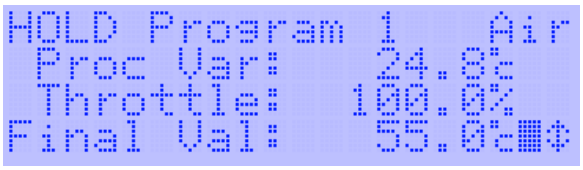
Edit from hold allows you to place a running program in hold program mode and enter temporary values into the current interval. Once the interval is run and completed, the temporary values are discarded. The next time the interval is run, the original programmed values apply. **NOTE**: In hold program mode the 3200 will maintain the chamber test space at the last set point.

To operate in edit from hold mode, follow these steps:

1. While a program is running, go to the main screen and select **3. Program Status**.
2. Press the **RUN** key. This will display the message **HOLD** in the top left corner.
3. Use the up and down arrow keys to select the setting(s) to edit. For more detailed descriptions of the settings, see Section 3 of this manual.

   NOTE: In edit from hold mode only final values, deviations, time left, auxiliaries, next interval, and number of loops may be edited.
4. When all the settings are acceptable, press **ESC**. To return to the main menu screen.
5. To resume running the current interval with the settings entered in step 3 above, press **RUN**.



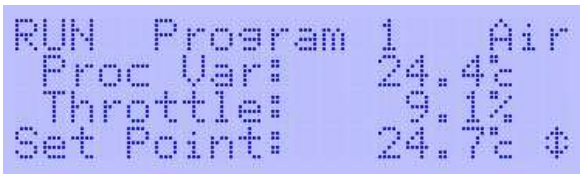


Chamber status

The program status screen allows you to view the current operating conditions of the chamber, such as set points, process variables, and throttles.

NOTE: The sample screen shows the display for a one-channel 3200 configuration. The 3200 can display only one channel at a time.

1. From the main screen, select **3. Program Status**. The status screen will appear:
2. Use the up and down arrow keys to scroll through the following status display values (for more detailed descriptions of these values, see Section 3 of this manual):



- **Throttle**
- **Init Val**: initial value
- **Final Val**: final value
- **Time**
- **Time Left**
- **Aux Grp1**
- **Deviation**
- **Current Interval**
- **Next Interval**
- **Opt**: options enabled
- **Process Var**: process variable
- **Aux Grp2**

Section 2: System Setup

This section provides instructions for viewing or adjusting the following functions:

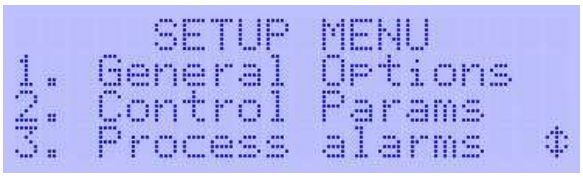
- Temperature scale
- Access level and password
- Audible key beep
- Software version
- Diagnostics
- Process alarms
- Brightness
- Computer interface setup
- System events
- Chamber model
- Monitor channels
- Contrast
- Light timeout
- Control parameters

NOTE: For CDS-5 chambers, enter 72776 (SETUP) on the numeric keypad to access the main menu.

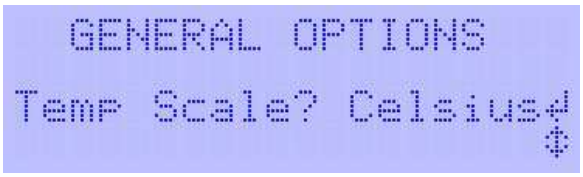
Changing the temperature scale

This setting changes the temperature scale for all displayed variables.

1. From the main screen, select **4. Setup**. The setup menu screen will appear:

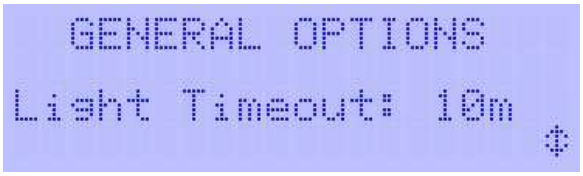


2. Select **1. General Options**. Use the up and down arrow keys to cycle through the options.
3. Press the **ENT** key to toggle between Celsius and Fahrenheit.



Changing the light timeout

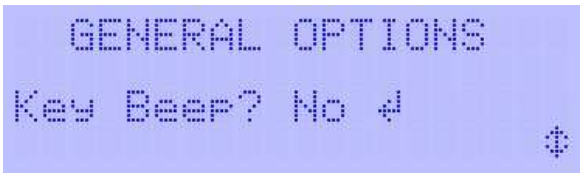
1. From the main screen, select **4. Setup**. The setup menu screen will appear:
2. Select **1. General Options**. Use the up and down arrow keys to cycle through the options.



3. Use the numeric keypad to enter the number of minutes before the light timeout is activated.
4. Press **ENT**.

Enabling or disabling the key beep

1. From the main screen, select **4. Setup**. This setup menu screen will appear:
2. Select **1. General Options**. Use the up and down arrow keys to cycle through the options.



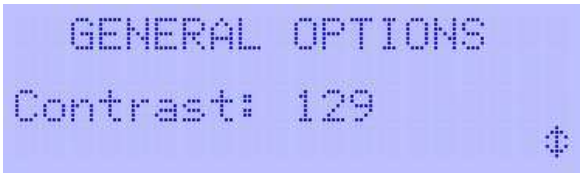
3. Press the **ENT** key to toggle between **Yes** and **No**.

Changing the brightness

1. From the main screen, select **4. Setup**. The setup menu screen will appear.
2. Select **1. General Options**. Use the up and down arrow keys to cycle through the options.
3. Use the numeric keypad to enter the number for the level of brightness. The range for brightness is from 100 to 191.

Changing the contrast

1. From the main screen, select **4. Setup**. The setup menu screen will appear.
2. Select **1. General Options**. Use the up and down arrow keys to cycle through the options.
3. Use the numeric keypad to enter the number for the contrast level. The range for contrast is from 120 to 150.

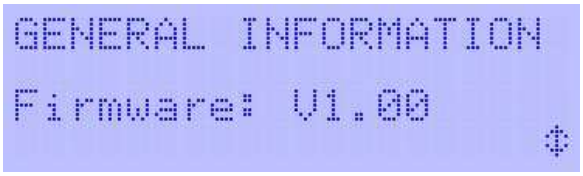


Viewing the chamber model

1. From the main screen, select **9. General Info**.
2. From the general information screen use the up and down arrow keys to cycle through the information. From this screen you can see the chamber model.

Viewing the software version

1. From the main screen, select **9. General Info**.
2. From the general information screen use the up and down arrow keys to cycle through the information. From this screen you can see the software version.



Adjusting standard control parameters

CAUTION: The 3200 programmer/controller was factory-tuned and should not need to be re-tuned unless the product requirements change enough to affect the performance of the chamber. Incorrect values could damage your equipment and/or product.

NOTE: Tuning the 3200 control parameters is a time-consuming procedure that will take a minimum of two to three hours to complete.

Control parameters adjust the performance of the chamber around the set point. As the chamber nears the set point, the 3200 adjusts the chamber throttles to provide a smooth ramp to the set point. To prevent overshooting and oscillation around the final set point, the refrigeration, heating, and other systems must be damped as they approach the set point. To maximize chamber performance, you must also compensate for lag times.

The control parameters are tuned in manual mode. The same procedure is used to tune up each channel. The adjustments are made to the proportional band and integral time parameters.

Proportional band parameters

The proportional band parameters are a **coarse** adjustment (1 to 9,999 units) to the control algorithm. These parameters set the proportional bandwidth around the set point for the control channel's process variable. As the process variable nears the set point, it enters the proportional band. Once inside the proportional band, the throttle is backed off in proportion to the difference between the set point and the current process variable. **NOTE**: The proportional bands use the same units of measurement as the process variable.

- Smaller proportional bands can result in faster transitions.
- If the proportional band is too large it can result in very slow transition times — the chamber may never reach set point.
- If the proportional band is too small it can result in overshoot or oscillation around the set point.
- As a rule for the proportional band, **smaller = faster** response, **larger = slower** response. Generally, you should adjust the proportional band to the smallest value possible without the process variable excessively overshooting or oscillating around the set point.

Integral time parameters

The integral time parameter is a **fine** adjustment to the control algorithm. The integral time parameter is used when the process variable nears the set point and the throttle is backing off. The integral time parameter adjusts the throttle to take the droop out of the proportional band setting and allows the chamber to reach the set point.

Droop is an effect, such as natural heat loss through the test space walls, that prevents the process variable from reaching the final set point. The integral time parameter determines how quickly the throttle will be adjusted to compensate for droop. Without an integral time entered, the process variable will not reach or remain at the set point. **NOTE**: The integral time parameter is programmable from 0 (integral off) to 1,000 seconds.

- Longer integral times result in longer times to reach the set point.
- Shorter integral times result in shorter times to reach the set point.

- If the integral time is too short, the process variable will oscillate indefinitely when it reaches the set point.
- As a rule for the integral time, **shorter = faster** response, **longer = slower** response. Generally, shorter integral times mean shorter transition times.

Tuning up the proportional band and integral time parameters

The proportional band and integral time parameters must be "tuned up" to produce an efficient, controlled environmental test cycle. First you tune up the proportion band for quality control near set point, then you tune up the integral time to achieve accuracy.

For the optimal combination of performance and quality, each control channel is tuned to be critically damped. This occurs when the process variable overshoots the set point slightly and then oscillates around the set point slightly until it stabilizes at the set point. This level of control becomes available only with properly tuned proportional band and integral time parameters.

When tuning up chamber parameters with two or more control channels, tune up one channel at a time, always tuning the proportional band parameters first. Additionally, each control channel's reference channel should be tuned up first. For example, for humidity operations, tune up the temperature channel first because it is the reference channel for the humidity channel. The control stability of the temperature channel directly affects the control stability of the humidity channel. **NOTE**: For most chambers channel 1 is temperature and channel 2 is humidity.

Example starting parameters			
Heat proportional band	20	Heat integral time	60
Cool proportional band	40	Cool integral time	90

Record the original parameter settings

1. From the main screen, select **4. Setup**. Then select **2. Control Params**. Use the up and down arrow keys to cycle through the values shown.
2. To edit, use the numeric keypad to enter a value. Press **ENT**.
3. If needed, select the parameters screen for the channel you are tuning by pressing the right or left arrow keys for **Air**, **Hum**, and **PTC**.
4. Write down the heat and cool proportional band (**Prop Band**) settings.
5. Use the up and down arrow keys to cycle through the values.
6. Write down the heat and cool integral time settings.

Obtain a performance baseline

7. Press **ESC** until the main menu screen appears.
8. Select **2. Manual Mode** to edit the settings.

9. Use the up and down arrow keys to select and edit the settings for the channel you are tuning:
    a. Set the **Deviation** to 0.
    b. Enter a new **Set Point** based on which parameters you are tuning, such as a heating set point for tuning the heating parameters.

       NOTE: When tuning parameters, the heating parameters are usually tuned before the cooling parameters. Normally you should select the set point based on the tests you are running.
    c. Disable all unnecessary auxiliaries.
    d. Make sure product temperature control (**PTC**) is disabled. **NOTE**: If you are tuning the temperature channel in a temperature-humidity system, disable humidity (**HUM**) for best results.
10. Press **RUN**. The chamber will enter run manual mode.
11. Watch the process variable (**Proc Var**) for the channel you are tuning as it approaches set point and then stabilizes for 10 to 15 minutes.
12. If the current parameter settings are correct, the process variable will overshoot the set point slightly and then oscillate around the set point slightly until it stabilizes at the set point.
    - If the process variable oscillates near the set point, the proportional band is too small.
    - If the process variable takes too long to reach the set point, the proportional band is too large.
    - If the process variable undershoots the set point slightly until it finally reaches the set point (if it ever does), the integral time is too large.
    - If the process variable overshoots the set point, the integral time is too small.

Adjust the setting

13. To adjust the proportional band:
    a. Change the set point (**Set Point**) to back the process variable away from the set point you will use to tune the parameter.
    b. From the main screen select **4. Setup**, then select **2. Control Params** (control parameters).
    c. Change the heating or cooling proportional band (**Heat/Cool Prop Band**) for the channel you are tuning.
14. Repeat steps 8 through 11 to see the effect of the new proportional band setting. The ideal proportional band setting is obtained when the process variable stabilizes near set point (for example, within ±2°C or ±2% RH). As it stabilizes, it oscillates in decreasing amounts until it droops just above or below the set point. **NOTE**: The integral time function will adjust the set point up or down to compensate for this droop.
    - If the process variable continues oscillating, you will need to increase the proportional band setting just until the oscillation stops.
    - If the process variable is not oscillating, you will need to decrease the proportional band setting just until oscillation begins, then increase the setting until the oscillation stops.

15. If necessary, you can tune the current channel's integral time parameter once you have tuned the channel's proportional band parameter.
    a. Change the set point to back the process variable away from the set point you will use to tune the parameter.
    b. From the main screen select **4. Setup**, then select **2. Control Params** (control parameters).
    c. Change the heating or cooling integral time (**Heat/Cool Integral Time**) for the channel you are tuning.
16. To see the effect of the integral time setting, repeat steps 8 through 11. The ideal integral time setting is obtained when the process variable equals the set point.
    - If the process variable oscillates around the set point, you should increase the integral time.
    - If the process variable takes too long to achieve the set point, you should decrease the integral time.

Repeat as needed

17. Once the first set of parameters (such as the heating parameters) have been tuned up, the other set of parameters can be tuned up.
18. Once the parameters for the first channel have been tuned up, the next channel's parameters can be tuned up.
19. Once you have finished tuning up all the channels, record the parameter settings. Keep these values on record with the 3200 manual.

Summary

When adjusting the control parameters you should follow this general outline:

1. Run a heat-up test to see how the chamber controls. If necessary adjust the heat parameters.
2. Run a cool-down test to see how the chamber controls. If necessary adjust the cool parameters.
3. Run a heat-up test to see the effect of the changes from step 1. If necessary adjust the heat parameters again.
4. Run a cool-down test to see the effect of the change from step 2. If necessary adjust the cool parameters again.
5. Continue to run alternating heat-up and cool-down tests, adjusting the heat and cool parameters as needed to achieve the desired level of control.

Adjusting PTC control parameters

CAUTION: The 3200 programmer/controller was factory-tuned and should not need to be re-tuned unless the product requirements change enough to affect the performance of the chamber. Incorrect values could damage your equipment and/or product.

NOTE: Tuning the 3200 control parameters is a time-consuming procedure that will take a minimum of two to three hours to complete.

Control parameters adjust the performance of the chamber around the set point. As the chamber nears the set point, the 3200 adjusts the throttles to provide a smooth ramp to the set point. To prevent overshooting and oscillation around the final set point, the refrigeration, heating, and other systems must be damped as they approach the set point. To maximize chamber performance, you must also compensate for lag times.

The product temperature control (PTC) control parameters are tuned in manual mode. The adjustments are made to the gain, integral time, and offset parameters.

Gain parameters for PTC

The gain parameter is a **coarse** adjustment to the PTC control algorithm. The larger the gain, the longer the 8200 will wait to start slowing down the throttle as the load temperature approaches the load setpoint.

$$\textbf{gain} = \frac{\textbf{maximum offset}}{\textbf{proportional band}}$$

For example, if the maximum offset is 10°C and the desired proportional band is 5°C, the gain would be set to 10°C/5°C = 2.

The temperature channel will still perform using the air parameters, but the offset parameters control the set point of the temperature channel in relation to the PTC channel's set point. When a PTC program is run, the temperature channel immediately cycles beyond the set point by the maximum offset. With the chamber air at maximum offset, the product cycles toward the final set point at its maximum rate. The temperature channel remains at the maximum offset above the PTC channel's set point until the product temperature enters the proportional band near final set point. The throttle of the temperature channel is reduced in relation to the PTC channel until the final set point is reached.

The gain parameter is related to the time constant of the load. The greater the time constant of the load, the more gain is required to change the temperature of the load. Increase the gain parameter for a faster load response. Additionally, a higher gain causes the load to proportion into the set point when the temperature is closer to the final set point.

As a rule for the gain setting, **smaller = slower** response, **larger = faster** response. Generally, you will want the largest gain setting possible without the process variable excessively overshooting the set point.

Integral time parameters for PTC

The integral time parameter is a **fine** adjustment to the PTC control algorithm. The integral time parameter is used when the process variable nears the set point and the throttle is backing off. The integral time parameter adjusts the throttle to take the droop out of the proportional band setting and allows the chamber to reach the set point.

Droop is an effect, such as natural heat loss through the test space walls, that prevents the process variable from reaching the final set point. The integral time parameter determines how quickly the throttle will be adjusted to compensate for droop. Without an integral time entered, the process variable will not reach or remain at the set point. **NOTE:** The integral time parameter is programmable from 0 (integral off) to 1,000 seconds.

- Longer integral times result in longer times to reach the set point.
- Shorter integral times result in shorter times to reach the set point.
- If the integral time is too short, the process variable will oscillate when it reaches the set point and will continue to oscillate indefinitely.
- As a rule for the integral time, **shorter = faster** response, **longer = slower** response. Generally, shorter integral times mean shorter transition times.

Offset parameters for PTC

The offset is the number of degrees Celsius that the air temperature set point will be allowed to exceed the load temperature set point when attempting to move the load temperature to the new load set point. The offset allows the air temperature channel to overshoot the set point by up to ±100°C.

- Larger offsets can result in faster transitions.
- If the offset is too large it can result in overshoot, and may trip process alarms.
- As a rule for the offset, **smaller = slower** (less aggressive), **larger = faster** (more aggressive). Generally, you should adjust the offset to the highest value possible without the process variable excessively overshooting the set point.

The maximum offset should be programmed to allow the chamber air to overshoot the final value by an amount that will not damage any portion of the load. For example, if the final set point is +100°C and the load could be damaged by temperatures above +110°C, then the maximum heat offset should be +10°C.

CAUTION: It is your responsibility to program the offset value correctly to avoid damaging any products under test.

Tuning up the PTC gain, integral time, and offset parameters

The gain, integral time, and offset parameters must be "tuned up" to produce an efficient, controlled environmental test cycle. First you tune up the gain parameter for quality control near set point, then you tune up the integral time and offset parameters to achieve accuracy.

For the optimal combination of performance and quality, each control channel is tuned to be critically damped. This occurs when the process variable overshoots the set point slightly and then oscillates around the set point slightly until it stabilizes at the set point. This level of control becomes available only with properly tuned PTC control parameters.

NOTE: The PTC parameters should be tuned only after the air temperature control parameters have been tuned, and only with a product load in the chamber.

Example starting parameters					
Heat gain	3.0	Heat integral time	200	Heat offset	10
Cool gain	3.0	Cool integral time	400	Cool offset	-10

Record the original parameter settings

1. From the main screen, select **4. Setup**. Then select **2. Control Params**. Use the up and down arrow keys to cycle through the values shown.
2. Use the left and right arrow keys to cycle through the values shown on the last line of the display until **PTC CONTROL PARAMS** appears.
3. Use the up and down arrow keys to cycle through the values.
4. Write down the heat and cool gain settings.
5. Write down the heat and cool integral time settings.
6. Write down the heat and cool offset settings.

Obtain a performance baseline

7. Press **ESC** until the manual mode screen appears.
8. Use the up and down arrow and alphanumeric keys to select and edit the settings for the PTC channel (usually channel 3):

   a. Set the **Deviation** to 0.

   b. Enter a new **Set Point** based on which parameters you are tuning, such as a heating set point for tuning the heating parameters.

      NOTE: When tuning parameters, the heating parameters are usually tuned before the cooling parameters. Normally you should select the set point based on the tests you are running.

   c. Disable all unnecessary auxiliaries.

   d. Make sure product temperature control (**PTC**) is enabled. **NOTE**: If you are tuning the PTC channel in a temperature-humidity system, disable humidity (**HUM**) for best results.

9. Press **RUN**. The chamber will enter run manual mode.
10. Watch the PTC channel's process variable (**Proc Var**) as it approaches set point and then stabilizes for 10 to 15 minutes.
11. If the current parameter settings are correct, the process variable will overshoot the set point slightly and then oscillate around the set point slightly until it stabilizes at the set point.
    - If the process variable oscillates near the set point, the gain setting is too small.
    - If the process variable takes too long to reach the set point, the gain setting is too large.
    - If the process variable undershoots the set point slightly until it finally reaches the set point (if it ever does), the integral time is too large.
    - If the process variable overshoots the set point, the integral time is too small.

Adjust the setting

12. To adjust the gain, change the **Set Point** to back the process variable away from the set point you will use to tune the parameter.
13. From the main screen, select **4. Setup**. Then select **2. Control Params**.
14. Use the left and right arrow keys to cycle through the values shown on the last line of the display until **PTC CONTROL PARAMS** appears.

    Change the heating or cooling **Gain** for the channel you are tuning.

15. Repeat steps 7 through 10 to see the effect of the new gain setting. The ideal gain setting is obtained when the process variable stabilizes near set point (for example, within ±2°C). As it stabilizes, it oscillates decreasing amounts until it droops just above or below the set point. **NOTE**: The integral time function will adjust the set point up or down to compensate for this droop.
    - If the process variable continues oscillating, you will need to decrease the gain setting just until the oscillation stops.
    - If the process variable is not oscillating, you will need to increase the gain setting just until oscillation begins, then decrease the setting until the oscillation stops.
16. If necessary, you can tune the current channel's integral time parameter once you have tuned the channel's gain parameter.
    a. Change the set point to back the process variable away from the set point you will use to tune the parameter.
    b. From the main screen, select **4. Setup**. Then select **2. Control Params**.
    c. Use the left and right arrow keys to cycle through the values shown on the last line of the display until **PTC CONTROL PARAMS** appears.
    d. Change the heating or cooling **Integral Time** for the channel you are tuning.

17. To see the effect of the integral time setting, repeat steps 7 through 10. The ideal integral time setting is obtained when the process variable equals the set point.
    - If the process variable oscillates around the set point, you should increase the integral time.
    - If the process variable never achieves the set point, you should decrease the integral time.
18. If necessary, you can tune the current channel's offset parameter once you have tuned the channel's gain and integral time parameters.
    a. Change the set point to back the process variable away from the set point you will use to tune the parameter.
    b. From the main screen, select **4. Setup**. Then select **2. Control Params.**
    c. Use the left and right arrow keys to cycle through the values shown on the last line of the display until **PTC CONTROL PARAMS** appears.

d. Change the heating or cooling **Offset** for the channel you are tuning.

19. To see the effect of the offset setting, repeat steps 7 through 10. The ideal offset setting is obtained when the process variable equals the set point.
    - If the process variable overshoots the set point, you should decrease the offset.
    - If the process variable undershoots the set point, you should increase the offset.

Repeat as needed

20. Once the first set of parameters (such as the heating parameters) have been tuned up, the other set of parameters can be tuned up.
21. Record the parameter settings. Keep these values on record with the 3200 manual.

Summary

When adjusting the PTC control parameters you should follow this general outline:

1. Run a heat-up test to see how the chamber controls. If necessary adjust the heat parameters.
2. Run a cool-down test to see how the chamber controls. If necessary adjust the cool parameters.
3. Run a heat-up test to see the effect of the changes from step 1. If necessary adjust the heat parameters again.
4. Run a cool-down test to see the effect of the change from step 2. If necessary adjust the cool parameters again.
5. Continue to run alternating heat-up and cool-down tests, adjusting the heat and cool parameters as needed to achieve the desired level of control.

Setting process alarms

CAUTION: It is *your* responsibility to set process alarm limits appropriate for your product. Process alarms will not guarantee the safety of your product. To protect your product from temperature extremes, you must properly configure and use a product protection device such as a Therm-Alarm. If you are testing expensive products, you should have an additional back-up product protection device.

Each channel of the 3200 can be programmed to activate an alarm if the temperature, humidity, or other process variable exceeds high or low limits you select. If the variable exceeds the high or low limit, the 3200 enters stop mode.

Factory-specified limits are programmed into the 3200. The typical factory settings for temperature-humidity systems are -87°C to +191°C and 0 to 100% RH.

1. From the main screen, press option **4. Setup**, then press option **3. Process Alarms**. The process alarm screen will appear:
2. Use the left and right arrow keys to select and edit the alarm limit settings.
3. To view the process alarms for channel 2 (**Hum**) or channel 3 (**PTC**), press the right or left arrow keys.

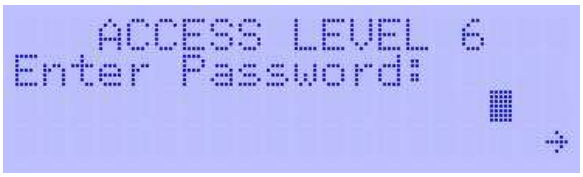
Changing the access level or password

The access level function allows you to select from seven different levels of access to the 3200 functions. The following table provides a general overview of which functions are available at each access level.

Level	Name	Functions available
0	Locked	All functions locked out. Most information may be viewed but not edited.
1	User level 1	Program run, stop, and hold modes are enabled.
2	User level 2	Manual mode operation is enabled.
3	Programmer	Program creation/editing and clock setting are enabled.
4	Lab manager	System parameters, process alarms, and system events can be set.
5	Calibration lab	Calibration, manual throttle, and other functions are enabled.
6	View configuration	Allows the user to view (but not edit) configuration settings.

Authorized users can set the access level using a special password. Once the current password is entered, the authorized user can also select a new password.

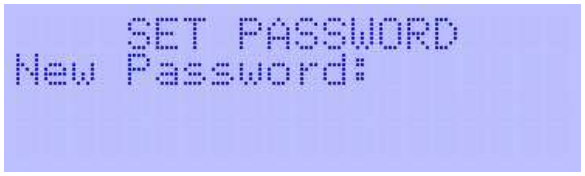
1. From the main screen, select **4. Setup**, then select **5. Access**.
2. The password screen will appear:
   - If no password has been set, press the right arrow key.
   - If a password has been set, use the alphanumeric keys to enter the password, then press **ENT** and the right arrow key.



3. If the password has been entered correctly, this screen will appear:

4. To change the access level, select **1. Access Level**. Press **ENT** key until the desired access level is displayed.
5. Press **ESC** to save the new access level and exit.

6. To change the password, select **2. New Password**. This screen will appear:
7. Enter the new password. The password may consist of up to 15 keystrokes.
8. Press **ENT** to accept new password.
9. Press **ESC** to exit.



Viewing computer interface settings

1. From the main screen, select **4. Setup**, then select **4. Computer I/O**. The computer interface screen will appear.
2. To see the current settings, select **2. Setup**, then press the up and down arrows to cycle through the settings.
3. For information on computer interface setup and diagnostics, refer to the *3200 Programmer/ Controller Computer Interface Manual*.

Configuring system events

System events monitor variables, such as temperature or throttle, and turn digital outputs on or off based on the state of the monitored variables. System events 1 through 4 are available for your use.

Each system event must be configured with some or all of the parameters listed in this section. These parameters specify the control points for the selected logic. The following table explains the meaning of each of these relative to the logic type selected.

Logic type	Low/Off	High/On
Range (RNG)	The low value of the active range.	The high value of the active range.
Point (PNT)	The off point, which may provide hysteresis.	The on point.
Duty cycle output (DCY)	The time period. The total time from one on cycle to the next.	The duty cycle. The percent of the period during which the system event will be activated.
Repeat cycle timer (RCY)	The off time. The amount of time the system event will be deactivated.	The on time. The amount of time the system event will be activated.

NOTE: The low/off and high/on parameters are unitless. They assume the units of the variable selected, or minutes in the case of the timers.

System event parameters defined

1. Channel (**Source Chan** for control channels) identifies the channel associated with the system event. Control channels 1 through 8 and monitor channels 1 through 8 can be used to trigger system events. A system event will only be active when the channel associated with it is selected and running.
2. Variable (**PVar**) indicates which variable the 3200 will monitor for the selected channel. The available variable types are:
   - Process variable (**PVar**): The system event uses the selected channel's process variable to trigger the event. Any value within the range of the selected control channel can be used.
   - Set point (**SetPt**): The system event uses the selected channel's set point to trigger the event. Any value within the range of the selected control channel can be used.
   - Output throttle (**Throt**): The system event uses the selected channel's throttle to trigger the event. The range is -100% throttle to +100% throttle.
   - Control deviation (**Dev**): This variable is the process variable minus the set point. This variable uses the same unit of measurement as the process variable and set point.

3. **Logic** indicates the type of system event. This parameter determines when the 3200 will activate and deactivate the system event. The available logic types are:

   - **Range**: The system event output will be activated when the variable is within the selected range (between the low and high parameters, inclusive).
   - **Point**: The system event output will be activated when the variable is at the on point, and deactivated when the variable is at the off point. This provides some switching hysteresis when required. The relative values of the on point and the off point determine the logic as follows:

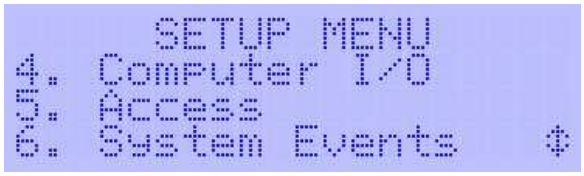
On point ≥ Off point		
Var ≤ Off	Off < Var < On	Var ≥ On
Deactivate	No change	Activate
On point < Off point		
Var ≤ On	On < Var < Off	Var ≥ Off
Activate	No change	Deactivate

   - **Duty Cycle** output: This type of system event will provide a pulse output based on the low and high settings. The low/off setting specifies the output's period in minutes, and the high/on setting specifies the output's duty cycle (percentage on). For example, a low/off setting of 1.0 with a high/on setting of 50.0 will provide a 50% duty cycle pulse with a period of one minute (the output will be activated for 30 seconds and deactivated for 30 seconds.)
   - **Repeat Cycle** timer: This type of system event will provide a variable pulse with an adjustable on/off time setting. This type of system event is very similar to the duty cycle type, except that the parameters are set differently. The low/off setting specifies the off time in minutes, and the high/on setting specifies the on time in minutes.

4. Low or off point (**Low/Off**)
5. High or on point (**High/On**)

Setting up system events

1. From the main screen, select **4. Setup**. Then select **6. System Events**.
2. Use the up and down arrow keys to cycle through the values and to select the system event you want to configure.
3. Before you change any system event parameters, you should record the original settings.



4. To change the source channel (**Source Chan**), variable (**Variable**), high or on point (**High/On**), low or off point (**Low/Off**), or **Logic** settings:

   a. Use the up and down arrow keys to highlight the desired field.

   b. Use the numeric keypad to enter a new value.

   c. Press **ESC** to exit.

5. Keep these values on record with the programmer/controller manual.

Viewing monitor channels readings

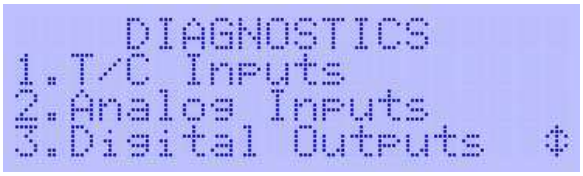
The monitor channels screen allows you to view the real-time environmental readings of the input channels configured as monitor-only channels. The 3200 can have up to eight monitor channels. Monitor channels read the same input types as control channels. For more information on your chamber's monitor channels, refer to your chamber manual.

1. From the main screen, select **5. Monitor Channels**. The monitor channel screen will appear:
2. To view any other monitor channels, press the up and down arrows.

Viewing diagnostic screens

Access to the diagnostic screens is provided to allow you to troubleshoot your chamber with the assistance of a Thermotron Technical Liaison.

1. From the main screen, select **8. Diagnostics**. The first diagnostics screen will appear:
2. Use the up and down arrows to cycle through the different options.



3. Please call the Thermotron Product Support group at (616) 392-6550 between 8:00 am and 4:30 pm Eastern Standard Time for assistance.

Section 3: Programming the 3200

The 3200 provides programmed control of the temperature and other process variable cycling operations for your chamber. This section provides a general description of programmed cycling and programming options, followed by step-by-step programming procedures.

Programmed cycling

The basic purpose of a chamber is to cycle products through a wide range of environmental conditions.

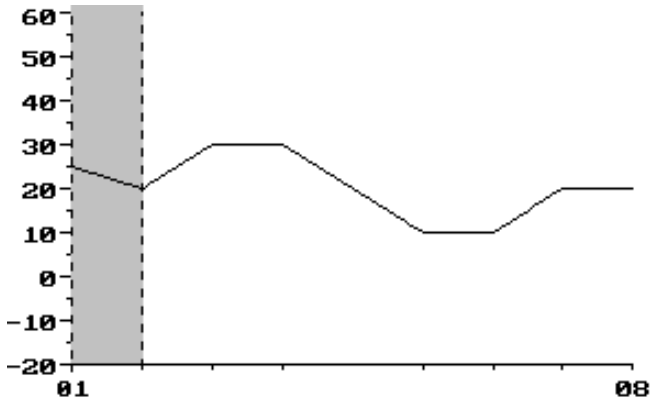
- During temperature or quality testing, temperatures and other process variables are changed at a specified rate to verify product performance.
- During stress screening, process variables are changed as quickly as possible to force any early life failures on each product.

In two-channel mode the 3200 is programmed to control humidity as well as temperature. **NOTE**: Other operations, such as electronic testing of the products, are not a function of the 3200.

To perform process variable cycling, programs are written to control the chamber. Each program is made up of intervals. Each interval runs the chamber from an initial value to a final value in a specified amount of time. An interval's time can vary up to 99 hours, 59 minutes, 59 seconds, and is limited only by the speed a chamber can reach a given parameter. Refer to your chamber's performance specifications to determine change rates.

Each basic interval is programmed with the following entries:

1. Initial value (**Init Val**) is the starting value of the set point for this program. Initial values can be edited only in interval 1. After the first interval, the initial value is always the final value of the previous interval.
2. Final value (**Final Val**) is the ending value of the set point for this interval.
3. **Deviation** controls how far you will allow the temperature or other process variable to be from set point. The deviations will be monitored and the deviation alarm will activate if the values are exceeded. **NOTE**: In an interval with guaranteed soak (**GSoak**) enabled, the program will wait in the interval until all deviations are satisfied before moving on to the next interval.
4. Auxiliary relays in auxiliary group 1 (**Aux Grp1**) and auxiliary group 2 (**Aux Grp2**) may be enabled or disabled by pressing the number corresponding to the desired auxiliary relay. For more information, refer to your chamber manual. **NOTE**: Auxiliaries are active only when the 3200 is running.
5. **Time** is the duration of the interval. This value controls how fast the set point is to be cycled from initial value to final value.



The image to the right illustrates a sample temperature program with seven intervals. Each interval represents an action or condition inside the chamber. The first interval ensures the chamber reaches a given starting temperature, in this case +20°C. The second interval increases ("ramps") to the next required temperature of +30°C. The third interval maintains that temperature for five minutes. The fourth interval lowers the temperature to +10°C. The fifth interval holds that temperature for five minutes. The sixth interval raises the temperature to +20°C, with the seventh interval holding that temperature for five minutes.

Along with raising, lowering, and holding the chamber temperature, each interval lasts a specified length of time. The time a temperature is held depends on the product being tested at that temperature. The total time of the sample temperature program shown above is 40 minutes.

The interval time has two methods of control:

a. If you enter a **Time** greater than zero, the 3200 performs a temperature ramp. This cycles the temperature evenly to the final temperature within the programmed time. If too short a time is programmed, the 3200 will transition to the next interval when the time runs out anyway.

b. If you enable guaranteed soak (**G-Soak**) and set one or more **Deviations**, the program will wait in the interval until all deviations are passed before going on to the next interval.

6. Sequential programming is selected by allowing the 3200 to move forward to the next sequential interval. Programmed looping is selected by using the **Loop To** and **Num Loops** values. **Loop To** indicates the interval to loop back to after completion of the current interval. **Num Loops** is the total number of times the programmed loop will be executed.

   The **Loop To** value is valid only if it is less than or equal to the number of the current interval, and if the **Num Loops** value is greater than 1. The interval will actually loop back to the target interval the **Num Loops** value minus 1. The following rules apply to looping:

   - The target interval may be the target of another loop, but must not cross into another loop. (When a loop is crossed, the target interval is between the beginning interval and the ending interval of the loop).
   - Nested looping is legal. In nested looping, one loop starts and finishes inside another loop. Both loops can have the same target interval.
   - The final value of the looping interval should be the same as the initial value of the target interval.
   - The maximum number of separate loop patterns per program is 32.

7. **PTC** enables or disables the product temperature control system. Product temperature control uses the load temperature (usually channel 3) to control the channel 1 air set point for faster load stabilization.

8. **Humidity** enables or disables the humidity system. The humidity system should be enabled only in the normal temperature range (0°C to +100°C).

Using the program entry steps listed above, a relatively complex program can be written. Repetitive tests can be looped and repeated rather than rewritten. Fast temperature cycles can be programmed using the guaranteed soak method. Controlled temperature cycles can be programmed using the ramp method.

During two-channel (such as temperature/humidity) operations, the program becomes more complex. Each channel's variable is programmed with an initial value and final value. During guaranteed soaks both channels can be programmed with a deviation. All deviations must be satisfied before the 3200 moves to the next interval.

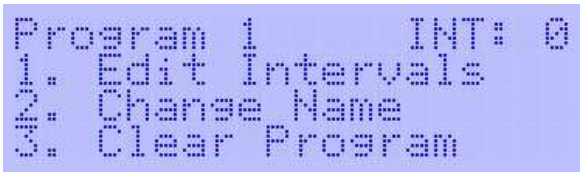
Creating or editing a new program

1. From the main screen, select **1. Edit Program**.

2. The edit program list screen will appear:
3. Select the program (1 through 9) you want to create the program in. Use the up and down arrows to cycle through the 9 program slots.

NOTE: To delete an existing program and empty its program slot, see "Deleting a program" later in this section.

4. When you have selected an empty program slot, select **1. Edit Intervals**.



5. Select **1. Air Only** or **2. Air/Humidity**.

6. You can use the up and down arrow keys to cycle through the options:
   - **Air Init**: Air initial value
   - **Air Final**: Air final value
   - **Air Dev**: Air deviation
   - **Hum Init**: Humidity initial value
   - **Hum Final**: Humidity final value
   - **Hum Dev**: Humidity deviation
   - **G-Soak**: Guaranteed soak
   - **Time**: Length of current interval
   - **Aux GRP1**: Auxiliary relays in group 1
   - **Aux GRP2**: Auxiliary relays in group 2
   - **Next Int**: Insert interval?
   - **# of Loops**: Number of loops
7. Use the numeric keypad to change a displayed value and press **ENT**.

8. The following list describes the editable program values:

   a. For initial value (**Air Init/Hum Init**) enter the starting value for each active channel's set point for this interval. **NOTE**: After interval 1 the initial value will always be the final value of the previous interval and cannot be edited.

   b. For final value (**Air Final/Hum Final**) enter the ending value for each active channel's set point for this interval.

   c. Deviations (**Air Dev/Hum Dev**) control how far you will allow the selected channel's process variable to be from set point. Enter a positive number only; the 3200 will monitor both plus and minus deviations and activate the deviation alarm if the values are exceeded. **NOTE**: In an interval with guaranteed soak (**G-Soak**) enabled, the program will wait in the interval until all deviations are satisfied before moving on to the next interval.

   d. Auxiliary relays in auxiliary group 1 (**Aux Grp1**) and auxiliary group 2 (**Aux Grp2**) may be enabled or disabled by pressing the number corresponding to the desired auxiliary relay. For more information, refer to your chamber manual. **NOTE**: Auxiliaries are active only when the 3200 is running.

   e. For **Time** enter the length of this interval. To do this, enter the number of hours, press the **·/:** key, enter the number of minutes, press the **·/:** key, and enter the number of seconds. The maximum interval time is 99 hours, 59 minutes, 59 seconds.

   f. For # **of Loops** enter the number of times you want the programmed loop to be executed. A loop can be repeated up to 300 times. Up to 32 separate loop patterns can be used per program. **NOTE**: The interval will actually loop back to the target interval the **Num Loops** value minus 1.

   g. **PTC** enables or disables the product temperature control system. PTC uses the load temperature (usually channel 3) to control the channel 1 air set point for faster load stabilization.

   h. **Humidity** enables or disables the humidity system. The humidity system should be enabled only in the normal temperature range (0°C to +100°C).

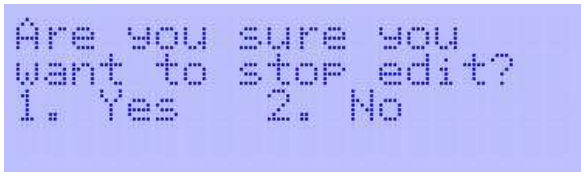
      NOTE: Enabling **Humidity** disables **PTC** and the PTC channel. Enabling **PTC** disables **Humidity** and the humidity channel. When **PTC** is enabled, only the values for the PTC channel can be edited.

   i. If you enable guaranteed soak (**G-Soak**) and set one or more deviations (**Air Dev**), the program will wait in the interval until all deviations are passed before going on to the next interval.

   j. To insert a new interval following the current interval, press right or left arrow key when **Next Int** appears. To confirm your decision, select **1. Yes** or **2. No**.

9. The maximum number of intervals is 300. **NOTE**: Once one or more intervals have been created, you can move back and forth between intervals by pressing the right and left arrow keys.

10. When all intervals have been entered, press **ESC** to exit programming mode. To confirm your decision, select **1. Yes**.



Editing a program name

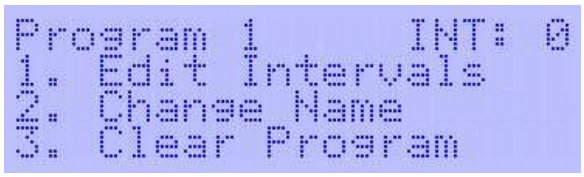
1. From the main screen, select **1. Edit Program**.

2. The edit program list screen will appear:

3. Select the program (1 through 9) you want to rename. Use the up and down arrows to cycle through the 9 program slots.

   NOTE: To delete an existing program and empty its program slot, see "Deleting a program" later in this section.

4. When you have selected an empty program slot, select **2. Change Name**.



   Use the keypad to enter a new program name. Program names can be up to 12 characters long.

   For example, to rename the program **LOAD 1**:

   a. Press the **4** on the alphanumeric keypad. The letters **J**, **K**, and **L** will appear on the display:

   b. Stop at **L**.

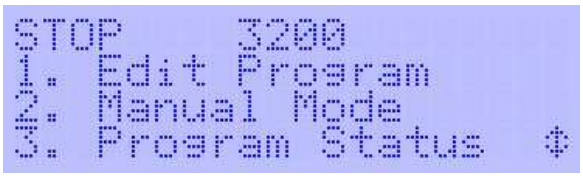
   c. Repeat this process for the rest of the new name:

      - For O, press **5** and stop at **O**.
      - For A, press **1** and stop at **A**.
      - For D, press **2**, and stop at **D**.
      - For the space, press the **9** key, and stop at **_ SPACE**.
      - For 1, press 1 and stop at **1**.

5. If you enter the wrong letter or number, press the left arrow key to delete your last entry.
6. To reject the new name and restore the original name, press **ESC**.
7. To accept the new name, press **ENT**.

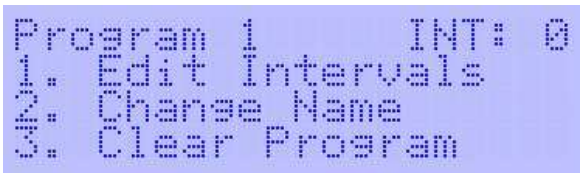
Deleting a program

1. From the main screen, select **1. Edit Program**.



2. The edit program list screen will appear:
3. Select the program (1 through 9) you want to delete. Use the up and down arrows to cycle through the 9 program slots.

4. When you have selected a program, select **3. Clear Program**.



5. To permanently delete the program, select **1. Yes**.

   NOTE: Deleting a program removes only the program's intervals. The program name is not removed from the program list. To rename a program, see "Editing a program name" earlier in this section.

Section 4: Therm-Alarm Functions

CAUTION: It is *your* responsibility to set Therm-Alarm limits appropriate for your product, and to properly place any Therm-Alarm thermocouples or analog sensors. When used properly, the Therm-Alarm is an effective product protection device; however, it is not a fail-safe device and will not guarantee the safety of your product. If you are testing expensive products, you should have an additional back-up product protection device. If you are testing products with live electrical loads, you should install additional power cutoffs. Please call Thermotron Industries if you have any questions on additional product protection.

The Therm-Alarm is a redundant protection system. Each Therm-Alarm has one temperature channel and may also have one linear analog channel. The Therm-Alarm can detect undesirable conditions at the products under test and alert you with audible and visible alarms. The Therm-Alarm can also disconnect power to the products being tested and to the chamber heating and cooling mechanisms.

The Therm-Alarm's temperature channel uses a thermocouple to monitor the temperature at the products under test. Likewise the Therm-Alarm's analog channel monitors the signal from an analog sensing device (humidity sensor, accelerometer, etc.). If the product temperature or the analog signal exceeds either the high or low limits, the Therm-Alarm disables the control circuit at the chamber circulators. This cuts off power to the control circuitry.

In the following instructions "input temperature" refers to the temperature of the product being tested (measured by the input thermocouple). "Limit temperature" refers to the adjustable high and low temperature settings. "Analog signal" refers to the analog channel's signal. "Analog limit" refers to the adjustable high and low analog channel limit settings. An alarm occurs if the input temperature reaches a limit temperature or the analog signal reaches an analog limit.

This section includes a description of the Therm-Alarm operating modes, instructions for setting up the Therm-Alarm, instructions for muting and resetting alarms, as well as calibration instructions.

- For calibration instructions, see "Calibrating a Therm-Alarm" later in the section.
- For Therm-Alarm hardware setup instructions, see the *CM2 Control Module Technical Manual*.
- For information on operating the Therm-Alarm from a host computer, see the *3200 Programmer/ Controller Computer Interface Manual*.

Therm-Alarm operating modes

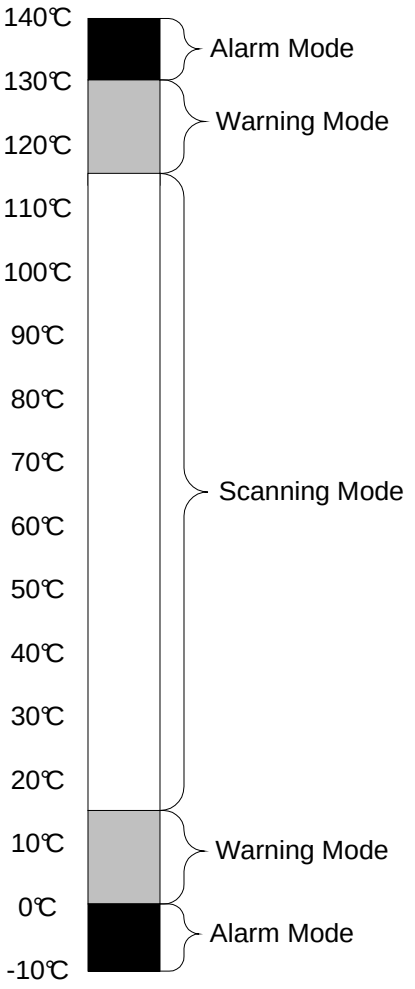
The Therm-Alarm stays in **scanning mode** as long as the input temperature and analog signal are within the acceptable range between the high and low warning settings.

Temperature warning mode occurs when the input temperature comes within the warning temperature band of a limit temperature or the analog signal comes within the warning band of an analog limit. (For information on setting the warning band, see "Changing the Therm-Alarm settings" later in this section.) The chamber heating and cooling systems continue to operate during this mode. In this mode the Therm-Alarm is automatically reset when the condition that caused the mode is removed.

The Therm-Alarm goes into **alarm mode** as soon as the input temperature or analog signal exceeds the high or low limits by more than five units. (For information on setting the temperature or analog limits, see "Changing the Therm-Alarm settings" later in this section.) This mode also occurs if the limit is exceeded by less than five units and the nuisance alarm timer has timed out. During alarm mode, the Therm-Alarm disconnects power to any circuit wired through its mechanical relay contacts. If the input temperature or analog signal causes an alarm and then returns to an acceptable level, the Therm-Alarm must be reset to exit from alarm mode. For information on resetting the instrument, see "Alarm mute and reset mode functions" later in this section.

Open thermocouple occurs when the input thermocouple is not connected or is opened. During this mode the Therm-Alarm disconnects power to any circuit wired through its mechanical relay contacts. In this mode the Therm-Alarm is automatically reset when the condition that caused the mode is removed.

Failure mode occurs if the Therm-Alarm detects a problem within its own circuitry. During this mode the Therm-Alarm disconnects power to any circuit wired through its mechanical relay contacts.



High limit: +130℃
Low limit: 0℃
Warning bandwidth: 15℃

Positioning the input thermocouple or analog sensor

A long wire connects the input thermocouple or analog sensing device to the Therm-Alarm. Because it is important to measure the conditions of the product itself, you must place the thermocouple or analog sensor directly on the product being tested, or as near to the product as possible.

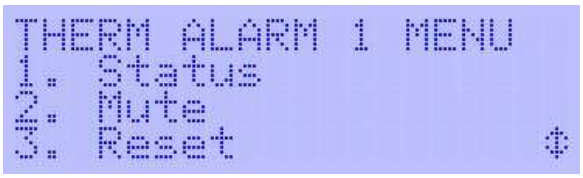
CAUTION: It is *your* responsibility to properly place any Therm-Alarm thermocouples or analog sensing devices. When used properly, the Therm-Alarm is an effective product protection device. However, it is not a fail-safe device and will not guarantee the safety of your product. If you are testing expensive products, you should have an additional back-up product protection device. If you are testing products with live electrical loads, you should install additional power cutoffs. Please call Thermotron Industries if you have any questions on additional product protection.

Viewing the Therm-Alarm status

1. From the main screen, select **6. Therm alarms**.

2. The **THERM ALARMS** screen will appear:
3. Select the Therm-Alarm you want to view.

4. From the **THERM ALARM** menu, select **1. Status**.



5. The Therm-Alarm status screen will appear:

   - **Temperature** is the current temperature at the product under test as measured by the input thermocouple. If your Therm-Alarm is configured for temperature and the additional analog channel you will see both the current temperature and the current analog signal.
   - **High** (high alarm limit) and **Low** (low alarm limit) indicate the temperature and analog limits that, if exceeded, will cause a Therm-Alarm trip. For information on editing these limits, see "Changing the Therm-Alarm settings" later in this section.
   - **Max Excursion** (maximum excursion) is the most extreme temperature or analog value experienced during the most recent alarm condition.

Changing the Therm-Alarm settings

1. From the **THERM ALARM** menu, use the up and down arrow keys to cycle through the options and select **4. Setup**.

2. The first Therm-Alarm configuration screen will appear.
   - Use the arrow and alphanumeric keys to select and edit the settings you are changing, then press **ENT**.

   - Press the up and down arrows to move back and forth between configuration screens.
3. For **High Limit** and **Low Limit**, enter the temperature or analog limit that you want to cause a Therm-Alarm trip if it is exceeded at the product under test.
4. For **Mute Time** enter the number of minutes you want an audible alarm to remain silent after it is muted. You can enter any number of minutes from 0 to 99. If an alarm is still active after the mute period, the audible alarm will resume sounding.
5. For **Warning Band** enter the number of degrees from the limit temperature you want the warning band to begin. The maximum setting is 15°. To disable the warning mode enter 0°.
6. For **Alarm Delay** enter the number of seconds you want the alarm mode to be delayed after the input temperature reaches a limit temperature. The maximum setting is 30. If you enter 0, the alarm mode will begin as soon as a limit temperature is reached. **NOTE**: If the limit temperature is exceeded by more than five degrees, the alarm delay will not occur.
7. The **Reset Mode** setting determines how the Therm-Alarm is reset when it is in alarm mode.
   - In **Manual** reset mode you must go to the Therm-Alarm status screen and press **RESET** to reset the Therm-Alarm.
   - In **Auto** reset mode the Therm-Alarm will reset itself after the input temperature or analog signal is two degrees from the limit temperature within the acceptable range.
8. To return to the main screen, press **ESC** repeatedly until it is displayed.

Alarm mute and reset mode functions

During warning, alarm, open thermocouple, and failure modes, the Therm-Alarm emits an audible alarm and the Therm-Alarm status screen will appear. From the status screen you can mute the alarm and reset the instrument.

In **warning mode** the Therm-Alarm resets itself after the input temperature or analog signal moves into the scanning mode (normal) range.

In **alarm mode** the Therm-Alarm is reset manually or automatically, depending on the reset mode.

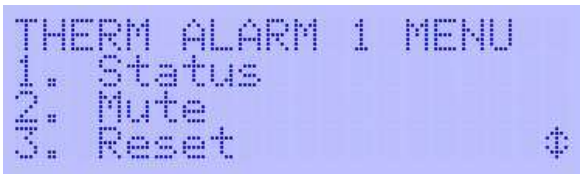
- If the reset mode has been set to **Manual** and the input temperature has returned to within the high and low limits, you must reset it to normal operating conditions from the Therm-Alarm status screen. (See the instructions below.)
- If the reset mode has been set to **Auto**, the Therm-Alarm resets itself when the input temperature is two degrees from the limit temperature within the acceptable range. **NOTE**: If the temperature is still inside the warning mode temperature band, the Therm-Alarm drops from alarm mode to warning mode.

In **open thermocouple mode** the Therm-Alarm resets itself once the thermocouple is closed or repaired.

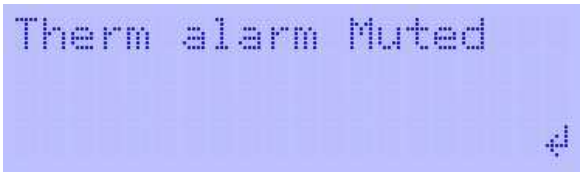
In **failure mode** you must remove power from the Therm-Alarm and then apply power again to reset it.

Muting or resetting the Therm-Alarm

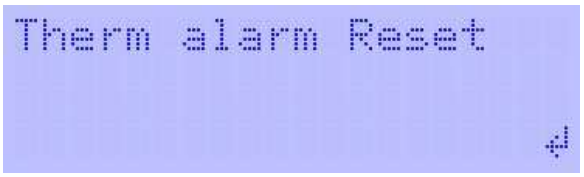
1. During temperature warning, alarm, open thermocouple, and failure modes, the Therm-Alarm will emit an audible alarm and the Therm-Alarm status screen will appear.
2. To mute an audible alarm for the number of minutes set in the Therm-Alarm setup screen, select **2. Mute** from the menu.



   If an alarm is still active after the mute period, the audible alarm will resume sounding.



3. To reset the Therm-Alarm to normal operating conditions, select **3. Reset** from the Therm-Alarm menu.



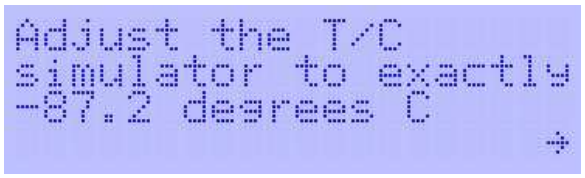
Initializing the Therm-Alarm data

CAUTION: Restoring the Therm-Alarm's factory default settings should be done only with the assistance of a Thermotron Technical Liaison Advisor. Please call the Thermotron Product Support group at (616) 392-6550 between 8:00 am and 4:30 pm Eastern Standard Time for assistance.

Calibrating a Therm-Alarm

NOTE: This calibration procedure requires a type T thermocouple simulator. Make sure the controller's temperature scale is set to Celsius before beginning any calibration procedure.

1. From the **THERM ALARM** menu, use the up and down arrow keys to cycle through the options and select **5. Calibrate**.
2. The first Therm-Alarm calibration screen will appear. Follow the directions on the screen and then press the right arrow key.
3. Connect a thermocouple simulator to the Therm-Alarm and then press the right arrow key.
4. Follow the directions on the screen and then press the right arrow key.
5. Once the calibration is complete press **ENT** to return to the **THERM ALARM** menu.



Section 5: CM2 Calibration

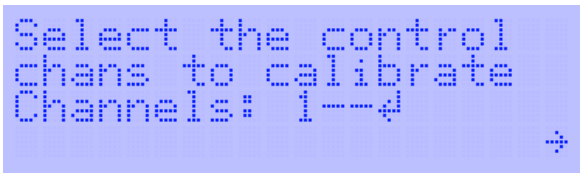
This section describes how to calibrate a CM2 control module's control channels, monitor channels, and analog outputs. **CAUTION**: This section is not a substitute for adequate technical training. Improper calibration could damage your chamber, controller, refrigeration system, or products under test.

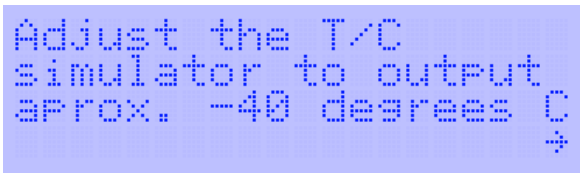
Calibration Menu

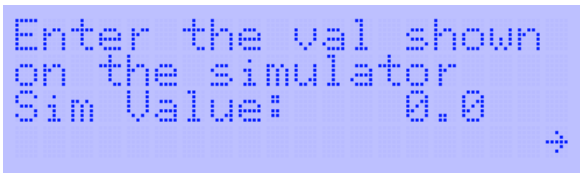
NOTE: This calibration procedure requires a type T thermocouple simulator.

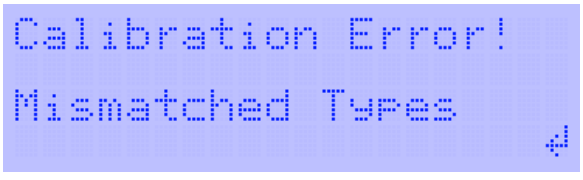
To enter the calibration menu from the **MAIN MENU** screen, select option 7 **Calibration**. The screen to the right will be displayed.

1. Select an option and follow the directions on the screen and then press the right arrow key.
2. Select the control channel to calibration and press **ENT**. Then press the right arrow key to continue.
3. Connect a thermocouple simulator to the selected channels and press the right arrow key.
4. Adjust the thermocouple simulator then press the right arrow key.
5. Enter the value shown on the simulator and press the right arrow key.
6. Wait 30 seconds for further instructions.
7. Follow the on-screen instructions, pressing the right arrow key when you are ready.
8. Once the calibration is complete press **ENT** to return to the **CALIBRATION MENU**.
9. To calibrate the monitor channels, select option 2. **Monitor Chans** and follow the directions on the subsequent screens.
10. To calibrate the analog outputs, select option 2. **Analog Outputs** and follow the directions on the subsequent screens.









NOTE: If more than one channel is selected and the channels are mixed between the thermocouple channels, and the analog input channels. A warning message will appear.

Appendix A: Glossary

access level: A function that allows you to select from seven levels of access to the 3200 programmer/ controller functions.

alarm band: The maximum amount beyond the current set point that the process variable (actual test space or product condition) can deviate. If the process variable drifts outside the alarm band, the 3200 enables its alarm functions.

alarm delay: The number of seconds the Therm-Alarm alarm mode will be delayed after the input temperature reaches a limit temperature. If the limit temperature is exceeded by more than five degrees, the alarm delay will not occur.

auxiliary cooling: An optional, non-mechanical refrigeration system that uses liquid nitrogen (LN_2) or carbon dioxide (CO_2) to provide cooling.

auxiliary cooling duty cycle; auxiliary cooling time frame: Settings that control an auxiliary cooling system. When the mechanical refrigeration system is operating at full cooling throttle, the auxiliary cooling system can be operated for a programmed percentage or duty cycle (such as 50%) of a selected time frame (such as six seconds).

auxiliary group: One of two groups of eight auxiliary outputs available with the 3200 programmer/ controller.

auxiliary output: A programmable TTL-compatible signal generated by the 3200 that provides on/off control to a system or circuit.

auxiliary relay: A solid-state relay operated by an auxiliary output that uses the TTL output to switch a line voltage. Auxiliary relays operate additional systems or circuits. You can turn these outputs on or off during programmed intervals, or you can operate them in manual mode. There are two auxiliary groups of eight outputs each available with the 3200.

calibration: The process of checking or adjusting an instrument by comparing it with a standard.

computer interface: A hardware component, such as an RS-232 or IEEE-488, that connects two or more other components for the purpose of passing information from one to the other.

control channels (process variable channels): Channels that receive analog inputs from thermocouples and other sensing devices used to monitor the environmental conditions inside the chamber's test space. The 3200 operates the chamber control systems based on the process variable readings and the demands of the test.

control module: The 3200 programmer/controller assembly that includes the microprocessor used to perform the chamber interface operations and distribute power to the display module.

control parameter: Settings that adjust the performance of the chamber around set point. As the chamber nears set point, the programmer/controller adjusts the chamber throttles to provide a smooth ramp to set point. To prevent overshooting and oscillation around the final set point, the refrigeration, heating, and other systems must be damped as they approach the set point. To maximize chamber performance, lag times must also be compensated for.

control sensor: A device (or group of devices) that monitors the environmental conditions in the chamber's test space for the programmer/controller.

controlled ramp: The process of changing the test space temperature, humidity, or other variable from an initial set point to a higher or lower set point at a linear rate.

cooling ramp: The process of decreasing the test space temperature from an initial set point to a lower temperature set point at a linear rate.

deviation: The difference between the process variable (actual test space or product condition) and the set point (assigned test space or product condition).

deviation alarm: A 3200 programmer/controller function that can be programmed to activate an alarm if the chamber temperature, humidity, or other process variable is outside the channel's +/- deviation alarm band. A deviation alarm band programs how far the temperature or humidity can be from set point. For example, a deviation alarm band of 5°C activates the alarm output if the chamber temperature is more than 5°C above or below set point.

display module: The 3200 programmer/controller assembly that includes the screen and keyboard, as well as the primary microprocessor, firmware, and memory.

droop: An effect that prevents a process variable from reaching the final set point. For example, natural heat loss through the chamber walls can prevent the test space temperature from reaching the final set point.

dry bulb: A thermocouple that monitors the test space temperature.

dry bulb temperature: The actual test space air temperature.

early life failure: A defect in a product that causes it to fail during its infancy.

event relay: A relay programmed by a computer. When the relay is programmed on, the operation controlled by the relay is activated.

final value: The final temperature or other process variable the chamber is to reach during an interval.

guaranteed soak: In an interval with guaranteed soak enabled, the program will wait in the interval until all deviations are satisfied before moving on to the next interval.

heat-up: The process of the test space temperature going from one set point to a higher set point.

heating ramp: The process of increasing the test space temperature from an initial set point to a higher temperature set point at a linear rate.

high alarm limit: The upper temperature limit which, if exceeded, will cause a Therm-Alarm trip.

initial value: The starting temperature or other process variable of an interval. After the first interval of a program, the initial value is always the final value of the previous interval and cannot be edited.

input temperature: The temperature of the product being tested as measured by the input thermocouple.

input thermocouple: A dry bulb thermocouple the Therm-Alarm uses to monitor the temperature at the products under test.

integral time: A control parameter that determines how quickly the throttle will be adjusted to compensate for droop. Droop is an effect, such as natural heat loss through the test space walls, that prevents the process variable from reaching the final set point. The integral time parameter adjusts the throttle to take the droop out of the proportional band settings and allow the chamber to reach set point.

interval: A programmed period during which the chamber operates under a specified set of conditions.

interval time: A setting that controls how fast the temperature, humidity, or other process variable is to be cycled from the initial value to the final value.

key beep: An audible beep that is sounded each time a 3200 programmer/controller key is pressed, unless this feature is disabled.

limit temperature: The Therm-Alarm adjustable high and low temperature settings. An alarm occurs if the input temperature reaches a limit temperature.

loop: A series of intervals programmed to be repeated.

low alarm limit: The lower temperature limit which, if exceeded, will cause a Therm-Alarm trip.

main screen: The base or home screen for the 3200 programmer/controller. From the main screen you can access all other screens and control all other functions. To return to the main screen from any other screen, press ***ESC*** repeatedly until the main screen is displayed.

manual mode: A function that allows you to operate the 3200 controller functions. Manual mode operates the chamber using set point and rate of change (ramp rate) settings. You can enter manual mode when the system is in stop mode. You also can enter manual mode from hold program mode if, while running a program, you want to perform a special operation in manual mode and then continue with the program.

maximum excursion: A Therm-Alarm function; the hottest or coldest temperature experienced during the most recent alarm condition.

monitor channel: A channel used by the 3200 for monitoring processes within the chamber. If the high or low limit is exceeded for any channel, the 3200 alarm outputs are activated.

offset: The amount the test space air temperature may exceed the final temperature set point during product temperature control operation.

option: One of the various options, such as humidity or product temperature control, that can be enabled or disabled for manual mode operation or for each programmed interval.

overshoot: A test condition where the process variable runs past final set point.

password: A string of up to 15 keystrokes that must be entered to set the 3200 programmer/controller access level. Once the current password is entered, the authorized user can also select a new password.

percent relative humidity (%RH): A measurement of the moisture content of air. See also relative humidity.

+/- deviation: How far you will allow the temperature, humidity, or other process variable to be from set point. If the value is exceeded, the deviation alarm is activated.

process alarm: A 3200 programmer/controller function that can be programmed to activate an alarm if the chamber temperature, humidity, or other process variable exceeds high or low limits you select. If the variable exceeds the high or low limit, the 3200 enters stop mode.

process variable: The actual sensed condition within the test space, such as temperature or humidity, that is controlled by the programmer/controller.

process variable channels: See control channels.

product: The device or equipment the chamber tests.

product temperature control (PTC): A heating and cooling process that controls the process variable from the product temperature rather than the test space air temperature. During normal temperature cycling, the chamber is cycled to the final set point in the specified time. However, the product temperature will approach final set point at an exponentially decreasing rate, lagging behind the chamber

air temperature. The PTC software is written to minimize the lag time. The software senses two thermocouple inputs: channel 1 from the chamber air and a second channel from the product under test. When PTC is enabled, the second channel senses the temperature at the product and causes channel 1 to operate the heating and cooling systems at a faster throttle and higher set point to make up for the temperature lag. When PTC is disabled, channel 1 controls and operates the chamber's heating and cooling systems.

program: A relationship between a test space condition and time.

proportional band: A control parameter that determines the point at which the control switches from 100% output to a proportional output. As the process variable nears set point, it enters the proportional band. Once inside the proportional band, the throttle is backed off in proportion to the difference between the set point and the current process variable.

PTC: See product temperature control.

pulldown: The process of the chamber going from one temperature set point to a lower temperature set point.

ramp: A controlled process where the process variable transitions from an initial value to a final value in a specified amount of time. During this time, the 3200's control parameters maintain a smooth transition.

ramp rate: The speed, measured in number of units (such as degrees Celsius) per minute, at which the controller cycles a process variable to a new set point.

relative humidity (RH): A percentage of the maximum amount of moisture that the air can hold at a given temperature and pressure.

reset mode: A setting that determines how the Therm-Alarm is reset when it is in alarm mode.

RH: See relative humidity.

set point: An assigned value for a test space condition. There are three types of set point:

- *Initial set point:* The value that the chamber is at in the beginning of an interval.
- *Final set point:* The final value the chamber is to reach within an interval.
- *Current set point:* One of the intermediate set points the programmer/controller sets when ramping from the initial set point to the final set point.

starting interval: The interval that a program begins with; typically a program begins with interval 1.

stress screening: Changing temperatures as quickly as possible to force any early life failures on each product.

system event: A control device that monitors certain variables, such as temperature or throttle, and turns its outputs on or off based on the monitored variables.

t/c: See thermocouple.

temperature program: The relationship between time and the test space temperature.

temperature scale: Celsius or Fahrenheit.

test space: The space within the test compartment where the product is tested.

Therm-Alarm: A product protection instrument that monitors the temperature or other analog signal at the product. If the product temperature or analog signal exceeds either the high or low limits you select, the Therm-Alarm disables the chamber control systems and alerts you with audible and visible alarms.

thermocouple (t/c): A device used to sense temperature as a function of current.

throttle: The percentage of output applied by a chamber's conditioning system to reach set point. Any positive throttle is a heating demand, and any negative throttle is a cooling demand. For example, to heat the test space as quickly as possible, the programmer/controller will operate the throttle at +100%. When the process variable (temperature) reaches the proportional band, the programmer/controller will begin reducing the throttle to control the process variable to equal the set point.

transition: The crossing point at which a value changes from one condition to another.

TTL: Transistor-transistor logic.

variable: An actual value of a test space condition. For example, if the temperature in the test space is +100°C, the temperature variable is +100°C.