

OWNERS MANUAL

Arrow Springs

Model ASC/3 Temperature Controller F/C

The Model ASC/3 is a relatively easy to use, full feature, digital temperature controller. You can choose from one of several preinstalled programs, or create your own. The display reads in Fahrenheit or Celsius and can control temperatures to 2500 degrees.

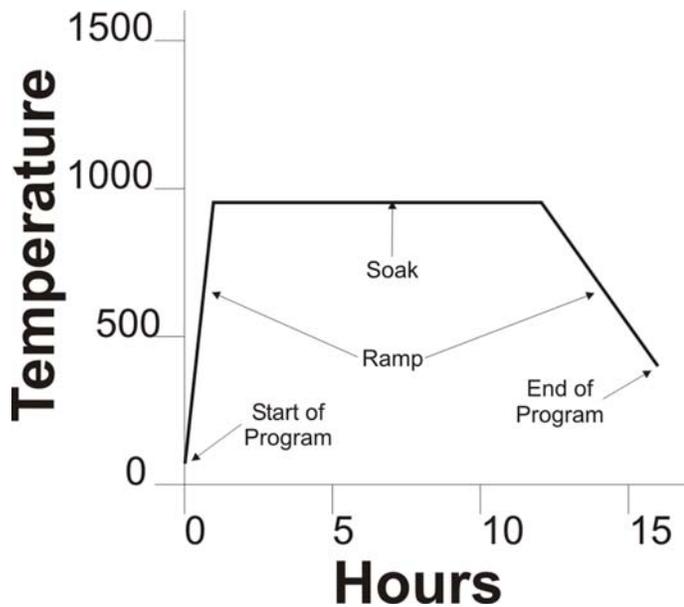
Setup

First, make sure the controller is turned off. This is done by placing the power switch, located on the panel to the right of the controller's face, in the down position. Next insert the thermocouple into the oven (kiln or annealer) as described by the oven manufacture. The thermocouple is the temperature sensor the controller uses to make its decisions whether to turn the oven on or off. It is the very tip of the thermocouple that senses the temperature and it is very important that the tip is well into the oven, not in the wall of the oven. If it is in the wall, the controller will be reading the wrong temperature and cause the oven to actually become hotter than the controller thinks it is. The ASC/3 uses a Type K thermocouple. If the controller has a mercury relay, it will be labeled so on the top of the controller. The controller must then be securely mounted to a wall or other stable surface so that the controller is always in its upright position. Controllers without a mercury relay are not position sensitive. Next, plug the controller into an appropriate electrical outlet, and then the oven into the controller. If the oven has an infinite control switch, turn it to high and always leave it there while operating the oven with the temperature controller.

How a temperature controller operates

A temperature controller is a device that controls the operation an oven, connected to it, through the use of a program. The ASC/3 temperature controller has been designed to be able to run any one of several preprogrammed programs as well as any programs you may add. A program is a set of instructions that the temperature controller uses for this operation. These instructions include information of what temperature to go to, how fast to heat up or cool down to that temperature (called a Ramp), whether or not to hold a steady temperature over a period of time (called a Soak), whether or not to repeat any of these instructions and how to vary them, and finally, to terminate the program.

If you were to study how a program is displayed in a typical firing graph, you will see that there are lines to represent what the program has the controller do for the operation of the oven. These lines are called Segments. If a segment is angled, either up or down from horizontal, it is called a Ramp segment. A horizontal segment is called a Soak. The bottom horizontal scale of the graph shows time passing from left to right, and on the left vertical scale, temperature is shown to increase from bottom to top. So, a Ramp that is angled like this, /, is a heating segment. The temperature inside the oven increases as time passes. A Ramp angled like this, \, is a cooling Ramp. The temperature inside the oven decreases as time passes. A horizontal segment like this, —, is a Soak segment. The temperature inside the oven remains the same as time passes. The ASC/3 temperature controller considers a Soak segment as the last part of the preceding Ramp segment and therefore does not count it as a separate and independent segment.



When you start the controller in a segment, the controller will either have a delayed start and then start operating the controller with the next segment or start operating the oven with that segment, depending how the program was written. When the controller has made the oven perform what you programmed that segment to do, for instance, ramp up or down to a temperature, at the rate set, and hold it there, for the amount of time set, it will then go to the next segment for further instructions. The controller carries on in this manner until it reaches a segment that has an Event set to END, at which time it ends the program, turns off power to the oven and does not go to any other segment.



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The layout of the controller

Side panels

While facing the controller, you will find on the right side, a fuse holder, power switch, and power cord, which plugs into a wall receptacle. On the opposite side, you will find a thermocouple, which the controller uses to read temperatures inside the oven, and a receptacle, which the oven's power cord plugs into. The fuse used can range from 1 to 2 amps. The power switch only turns on or off the power to the controller. It is not intended for starting or terminating a program.

The front panel

The display

Centered near the top of the controller's front panel is a digital display. It can show one of several different things at a time. When the controller is first power up, the display will momentarily show random characters, followed by EEEE for another moment, then settle on showing the temperature the thermocouple senses. By factory default, the controller is set to display the temperature in Fahrenheit for the United States and Celsius for most of the rest of the world. This can be changed from one to the other, and is discussed later. The temperature displayed may wander a few degrees, for several minutes, as it goes through self calibration. The display can show up to four characters at a time. When displaying the temperature, it will show temperatures up to 999 followed by an F for Fahrenheit or a C for Celsius. When the temperature is 1000 or higher, the F or C is dropped to allow the temperature to be properly displayed. The display can show a temperature of up to 2500 degrees, Fahrenheit or Celsius. However, the type of thermocouple that the controller uses, Type K, loses reliability after about 2000° F / 1100° C, and will wear quickly.

The LED layout

Located below the display, and to the left, are four LED lights grouped vertically. To the left of the lights are two columns of boxes with words in them. When a single light is lit, the information in one of the two boxes to its left will refer to what state or function the controller is in. If one of the lights is blinking slowly, it will refer to the box on the far left. If the light is continuously on, it will refer to the closer box. A single blinking light means that you are in Programming Mode and the information in the box to the far left of the light is what step in the programming you are working on. A single continuously lit light means you are in Run Mode and the information in the box to the immediate left of the light is what state the controller is in. When the controller is powered on, but is not running a program, and it is in Run Mode, you will see the fourth light continuously lit. The light will refer to the box immediately to the left of the light. Written in the box is OFF. Even though no program is running, the controller is in Run Mode and is on standby, waiting for you to start a program.

If all four lights are slowly blinking together, a segment number is displayed. The controller will also be in Pause Mode, if it is running a program. In addition, the segment number displayed can now be modified for use in a program. Or, if that segment is already part of a program, the controller can be started with that segment number. These features are discussed later. If one or two lights are blinking very fast, you have entered one of the two menus that allow you to modify the factory defaults that control how the controller operates. Usually the factory defaults are appropriate for what you are using the controller for and should be left at what they are already set to.

Below the group of four LED lights is a single LED labeled Heat. When this light is lit, the controller is sending power to the oven. This light will only light up when a program is running.

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The six button layout

The specifics of how to use the buttons are discussed throughout this manual. You may find it helpful to periodically refer back to these descriptions.

The center top **Up Arrow** button and the center bottom **Down Arrow** button are used to change the values shown in the display. They have no affect unless first the Select button or the Seg/PS button is first pressed. If held down, the speed of change accelerates. If tapped, the speed stays the same. If left released for a brief time, the speed decelerates.

In the upper right corner is the **Start** button. When pushed, this button will always start the controller in segment 1 (S-1), if the controller is powered on and not already running a program. If the controller is running a program, regardless of the segment it is running in, it will terminate the program and return the controller to a ready state. Note the icon to the right of the Start button, labeled **Run/Stop**. This button acts as a toggle.

In the lower right corner is the **Seg/PS** button. This button also acts as a toggle. If the display shows the temperature, and this button is pushed, the display will change to show the segment the controller is in. For example, S-1 or S-34. Note: the S look like a number 5. However, if this S/5 character is followed by a – (dash), interpret the character as an S. If there is no – after the character, interpret the character as a 5. If you press this button, and the display shows anything other than the temperature or time remaining in a soak, the controller will exit whatever function the display refers to and display the temperature. If a segment is displayed, you only need to press the button once to display the temperature. Other times you may need to press it twice. This button also places any running program in Pause Mode (discussed later).

The **Enter** button is located in the lower left corner. It has three functions. The function of this button is determined by which state or mode the controller is in when it is pushed. First function: If a segment number is displayed, pushing this button starts a program that contains that segment, with that segment. Second function: If you are in Program Mode, pressing this button stores any changes made to the program. You must press this button while the change is still showing in the display. If the Enter button is not pressed, and the value displayed was changed, the new value will not be stored into the controller's memory, even if the UP and DOWN buttons have been pressed. Third function: If the controller is operating in a Delay portion of a running program (indicated by the top light being continuously lit) or is in a Soak portion of a running program (indicated by the third light being continuously lit), and the temperature is displayed, pressing the Enter button changes the display to show the hours and minutes left before the delayed start begins or the soak time remaining is up. Pressing the Enter button again changes the display back to showing the temperature. For this third function only, this button acts as a toggle and does not affect the operation of the controller.

In the upper right corner is the **Select** button. This button is used when reviewing, creating or modifying a program. Pressing it scrolls through the attributes of a segment; the Event, the Ramp Rate, the Soak Time and the Temperature.

Programming Segments

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For the controller to run through the segments of a program, it must know four things about each segment, the Event, the Ramp Rate, the Soak Time and the Temperature, in that order.

Events

The **Event** tells the controller what type of segment it is. You will know that you are either reviewing or programming the Event of a segment, because the top light is blinking slowly. The blinking light will refer to the information written in the box to the far left of the light. The four Event choices are as follows: **dly**, for delaying the start of the program. **conr**, for giving priority to time over temperature while running a program. **cont**, for giving priority to temperature over time while running a program. **END** to end the program. To change from one type of Event to a different one, use the Up and Down Arrow buttons. When the type of Event you want is showing in the display, press the Enter button to store it into the controllers nonvolatile memory.

Types of Events

The dly Event

A segment with an Event set to **dly** means that when the temperature controller is started in that segment, the controller will actually start with the next segment after the amount of time set for the delay has passed. The amount of time for the delayed start is set by the time entered for the Soak of that segment. This type of Event is rarely used.

The conr Event

A segment with an Event set to **conr** means that that segment gives priority to the time that that segment should reach the temperature programmed for that segment instead of the actual temperature. A scenario would be when you set a Ramp Rate so fast that the oven cannot possibly reach the set temperature at that rate. For instance, let's say that you have programmed the controller to ramp down at the rate of 600 degrees per hour to 400 degrees after a soak that was at 960 degrees, then turn off. The controller counts on the fact that when no power is being sent to the oven, it will lose heat. Typically, an oven will lose heat fast enough that when power to it is off, the temperature inside the oven will rapidly drop. To keep the temperature from dropping at a rate faster than the Ramp Rate is set for, the controller will need to occasionally turn on and off the power to the oven. However, the rate of heat loss slows as the temperature inside the oven approaches the temperature on the outside of the oven. The controller has calculated the time it should have taken the ramp to have reached the temperature. The Event of **conr**, which means continue regardless, tells the controller that if the amount of time it should have taken for the ramp to reach the set temperature, for that segment, is up, that the controller should then disregard the fact that the temperature was not reached and proceed on to the next segment. In this scenario, the next segment is a segment with an Event set to **END**. Therefore, the program ends, even though the final temperature was not reached.

Generally, the **conr** type of Event is usually used only on a segment preceding an **END** type of Event segment. This prevents the controller from possibly trying to run a program long after it was not necessary. This is extremely important for ovens with exposed heating elements. Should you have set the segments temperature, as in the scenario described above, so low, that before the set temperature is reached, the temperature inside the oven is cool enough to touch, you may get electrocuted. This can happen, because when you open the lid to an oven, the fast inrush of air can chill the thermocouple (temperature sensor). Even though this sudden chill is a temperature

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that the ramp should have reached by then, the controller will send power to the oven to prevent cooling faster than the set Ramp Rate.

The cont Event

A segment with an Event set to **cont**, which means continue, works opposite of the **conr** type of Event. The **cont** type of Event tells the controller that that segment gives priority to the set Temperature over the set Ramp Rate. What this means is, that if you have programmed a Ramp Rate to be faster than the oven is capable of performing, that the controller will instruct the oven to continue on to reach the set temperature before continuing on to the soak portion of that segment, or on to the next segment, even if the time is up, as was calculated for the ramp rate. Generally, the **cont** type of Event is used on all segments except the one preceding an **END** type of Event segment.

The END Event

The **End** Event does just that. It ends the program and turns off power to the oven until a program is once again started.

Segment 0:

Segment 0 normally has the Event set as **End**. When the controller is turned on, it will go to segment 0. If the Event setting is set to other than **End**, the controller will begin running immediately. If this is desired, it is recommended to set segment 0 with a 1 minute delay (set Event to **dly** and **Soak/Dly** to 1). This will allow the controller to properly start up. A useful application for this would be where a mechanical 7-day timer is used to apply power to the controller and it should begin a program automatically without requiring you to manually start it. If segment 0 is used, the **START** button will have limited function. For most applications, leave segment 0 as an **End** Event.

Ramp Rate

The Ramp Rate of a segment tells the controller how fast to make the rate of change in temperature during heat up or cool down of that segment. You will know that you are either reviewing or programming the Ramp Rate of a segment, because the second of the four lights is blinking slowly. The blinking light will refer to the information written in the box to the far left of the light. Ramp Rate is expressed in degrees per hour. The Ramp Rate can be set to anything from 1 to 4000 degrees per hour. The total time for the ramp to take place must not exceed 40 hours per segment.

If the ramp rate is set below 1, the display will show **FULL**. This means that the full available heat will be used (no controlled ramping), just like a simple temperature control. In this situation, when ramping up to a temperature, the heat will continuously stay on during the ramp. When ramping down to a temperature, the heat will continuously stay off during the ramp. This is strictly true when operating the controller in **ON/OFF** mode (discussed later). However, when the controller is operated in the factory default **PID** mode (discussed later), the heat will actually be applied in short intermittent bursts during the very end of the ramp to prevent the ramp from overshooting its target temperature.

If **FULL** is entered as the ramp rate, the Event should not be set to **conr**, or the ramp portion of the segment will skip entirely to the soak portion of that segment. This means that the soak timer will

begin counting down, even though the set temperature has not been reached. In this situation, use cont for the Event.

Soak

The Soak tells the temperature controller how long the soak time is for that segment. You will know that you are either reviewing or programming the Soak time of a segment, because the third of the four lights is blinking slowly. The blinking light will refer to the information written in the box to the far left of the light. The soak only starts after the temperature, for that segment, is reached, when the Event is set to cont, or after the calculated time to reach the programmed temperature has elapsed, when the Event is set to contr. A soak time of 0 would not show up on a graph. Maximum soak time is 50 hours per segment.

Temperature

The Temperature tells the controller to what temperature the oven will go to for that segment. You will know that you are either reviewing or programming the Temperature of a segment, because the fourth, or bottom, of the four lights is blinking slowly. The blinking light will refer to the information written in the box to the far left of the light. The maximum temperature you can set is 2500 degrees.

Programming the controller

Understanding how a program works

The controller has 55 segments. Each segment has an attached Soak. This means that each segment is capable of soaking for a period of time after it has reached temperature when the Event is set to cont, or when the calculated ending time of the Ramp is up when the Event is set to contr. A Soak time can be set to 0. A program is simply a continuous set of segments, with the last segment having its Event set to END. You start a program by going to the first segment of the program and starting it. The program accomplishes what the first segment's instructions command it to do, and then continues on to the next segment, and so on, until finally it reaches a segment whose Event is set to End, at which time the program ends. The next segment is available for use in another program.

A program can be started in any of its segments, except the last segment, because it has its Event set to END.

Creating a program

To run through the steps to create a program, we will go through the steps that were used to create the third program the controller was preprogrammed with. This program, as with all of the preprogrammed programs the controller already has loaded, can be deleted or modified at any time. This program starts with segment 9.

When the controller is first turned on, it boots up and then settles on showing the temperature the thermocouple senses. It is also in stand-by mode, halted in segment 0, providing the Event of segment 0 is set to END. Press the Seg/PS button. The display will read S-0 to represent segment 0, the segment the controller is currently operating in. As stated before, segment 0 should have its Event set to END to make that segment not be part of a running program. Press the Up Arrow button until the display shows S-9. Of course, if the display does not show S-0 when pushed, you

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can still get to S-9 using the Up and Down Arrow buttons as is necessary. Notice that the stack of four LED lights are slowly blinking. Remember, the S character looks like the 5 character. You can always tell if the character is an S, because it is always followed by a – (dash).

Once the desired segment is displayed, it can be programmed with all of its necessary attributes. To do this, press the Select button. While the Select button is being pushed, the display will show which segment you are currently programming. This will come in handy later, when after programming the first entry, the display would not otherwise inform you of which segment you are currently programming. Also, when you pressed the Select button, the top light, of four, will be the only light slowly blinking. This lets you know that you will be programming the Event for that segment. While in programming mode, the blinking light makes reference to what is written in the box located to the far left of it. Using the Up and Down Arrow buttons, make the display show cont, if it doesn't already. There are only four choices available, so cont is not hard to find. Press the Enter button to store any change you may have made. If the Event was already set to cont, you do not need to press Enter, as it was already there and stored in memory. If you made a change and do not press the Enter button, the change will not take effect.

Next, to set the Ramp Rate, press the Select button. While it is being pressed, the display will show S-9 as a reminder. The second light will now be blinking slowly to let you know that you are programming the Ramp Rate of that segment. After letting go of the button, the light continues to blink and you are now ready to enter the Ramp Rate for segment 9. As before, the blinking light makes reference to what is written in the box located to the far left of it. Use the Up and Down Arrow buttons to set the Ramp rate to full. The value of FULL is located where you would expect to find 0. Press the Enter button to store any change you may have made in the Ramp Rate. If the Ramp Rate was already set to FULL, you do not need to press Enter, as it was already there and stored in memory. If you made a change and do not press the Enter button, the change will not take effect.

Now we set the Soak time. By now you should have a grasp of what you are seeing happen. Press the Select button again. The third light is now blinking. Use the Up and Down Arrow buttons to make the display show 1200 to represent 12 hours and no minutes. You need to use a little imagination to insert an imaginary : (colon) between the 12 and the 00 as in 12:00. Press Enter to store into memory.

Finally, press the Select button a fourth time to program the Temperature. The fourth light will be blinking. Once again, use the Up and Down buttons to make the display show the value you want to set. Enter a temperature of 960. Press Enter to store into memory.

Now, all of the instructions for segment 9 have been entered and stored. To continue on and program the next segment, simply press the Select button again. While you hold the button in, you will see that the display will now show S-10, indicating that you have advanced to the next segment and are programming segment 10. The top light is now blinking. Release the button, and program segment 10, as described above. Continue on to program segment 11. When you reach segment 12, all you need to program is the Event. Because the Event is set to END, the Ramp Rate, Soak time and Temperature will have no meaning.

All of the program information for all of the preinstalled programs can be found on page 17 of this manual.

Running a program

To run any program, display that program's first segment. This is done by first pressing the Seg/PS button. This will make the display show what segment the controller is currently in. Second, use the Up and Down Arrow buttons to change to the desired segment. Let's start the program that we discussed above. It starts with segment 9. So, make the display show S-9. This time, when segment 9 is displayed, we will not press the Select button. The Select button would take us into Program Mode. Instead, press the Enter button to start the controller in the segment that is showing in the display, namely S-9. After pressing the Enter button, press the Seg/PS button to show the temperature. Not pressing the Seg/PS button would leave the controller in Pause mode. Pause mode is described next.

The Seg/PS button

As described above, the Seg/PS button has two functions when pressed. The first function allows you to either program a segment, the one displayed, or to start a program with the segment displayed. Pressing the Seg/PS button and displaying a segment number also puts the controller into Pause mode, when a program is running. When in Pause mode, the four grouped LED light will blink slowly. Pause mode can only be canceled by pressing the Seg/PS button a second time to make the display show the temperature. If a program is running and you want to modify it or some other program, you cannot do so without also entering the controller into Pause mode.

Pause mode stops the controller from counting down the time of the Soak. It does not affect the temperature. For instance, if you were to push the Seg/PS button while a program is ramping to a temperature that is to be followed by a soak, the temperature would continue to ramp to the temperature set for that segment, at the ramp rate set for that segment, but when that temperature is reached, the soak time will not count down. It is suspended and the temperature will remain constant, indefinitely. The Soak will begin to count down to the end of the soak only after the Seg/PS button is again pushed and the temperature is showing in the display. If you place the controller into Pause Mode during a Soak period, the soak count down stops where it currently is, and will resume only when canceled. Again, by pressing the Seg/PS button and displaying the temperature. If the segment has a soak set to 0, and if you want to pause that segment, you must press the Seg/PS button before the ramp reaches the set temperature. If you wait until the temperature is reached, you will have missed the opportunity to enter into Pause Mode for that segment, because as soon as the temperature is reached, the program will advance to the next segment.

Displaying time remaining in a soak

The Enter button has a third function. If a program is running and the temperature is displayed, pressing the Enter button will make the display show the time remaining, in hours and minutes. As before, you must use a little imagination when viewing the time remaining. You need to insert an imaginary : (colon) between the hours and minutes, as in 11:30 for 11 hours and 30 minutes. The display will show 1130. The Enter button works as a toggle in this function. Pressing it a second time will cancel it. If you press the Enter button while the temperature is displayed, and a program

is running, and the program is still in the ramp portion of the segment, the display will not show the time remaining until the Soak starts. This feature is self canceling when the Soak has ended and the next segment is started.

Up and Down Button Acceleration

When you hold down one of the Arrow buttons to change the value of the Ramp Rate, Soak time, Temperature, or segment number, it will first increment the numbers by one at a time. Then, after about one second, the numbers will begin to increment by tens. After about another second of continuously holding the button, the numbers will begin to advance by hundreds. When the numbers are advancing by ones, tens or hundreds, you can keep it at that level by letting go of the button and tapping either Arrow button. If you let go of the button, or do not push either button, for more than one half of a second, the advancing speed drops back down to the next level slower. In other words, advancing by hundreds becomes advancing by tens. Letting go for a full second would take you from hundreds to ones.

Quick Review of Important Points

Start button - If the controller is turned on, but no program is running, pressing the Start button will always start the controller in segment 1 (S-1). This is true whether the temperature is displayed or any one the 55 segments is displayed, such as S-1, S-22, S-50, and so on. If the controller is running a program, in any segment, pressing the Start button will terminate the program.

Enter button – The Enter button has three different functions, depending on which state the controller is in. 1) If a segment number is displayed, and the Enter button is pushed, the controller will start a program with that segment. 2) During programming, the Enter button is used to store changes made to the Event, Ramp, Soak or Temperature settings. 3) If a program is running, and it is in the Soak portion of a segment, pressing the Enter button will change the display from showing the temperature, to time remaining in the soak. Pressing it a second time will return the display to showing the temperature. If the Enter button is pressed while the controller is still in the Ramp proceeding the Soak, the display will not show the time remaining time until the temperature is reached and the soak has started. This feature is self canceling at the end of the soak, and must be preformed for each segment.

Seg/PS button – The Seg/PS button has two different functions. 1) If a temperature is displayed, pressing the Seg/PS button once will display a segment number. If anything other than the temperature is displayed, pressing the Seg/PS button once, or twice as needed, will display the temperature. 2) If a program is running, and the temperature is displayed, pressing the Seg/PS button for the purpose of restarting the controller in a different segment, or creating, modifying or reviewing any segment, also places the running program into Pause Mode. This suspends the Soak count down timer. Pressing the Seg/PS button, once, or twice as needed, and displaying the temperature, will cancel the Pause, and the Soak count down timer will resume.

Tuning the controller

The controller uses PID, (Proportional, Integral, Derivative) control to control how it operates. PID helps the controller to anticipate the power needs of the oven it is controlling. This makes for better accuracy. To access the PID constants, turn on the controller, press and hold the ENTER button until the top LED begins blinking rapidly and the display shows the P (Proportional) band in degrees. This take about 3 seconds. Release the button. This value can be set from 0 to 1000

degrees. If set to 0, the controller will use ON/OFF control algorithm with a deadband rather than PID control. After changing the value, press the Enter button to store the change into memory.

To change the value of the I (Integral) time constant, press the Select button. The second LED will blink rapidly. The I (integral) time constant can be set from 0 to 3600 seconds. If set to 0, the integral action is disabled. After changing the value, press the Enter button to store the change into memory. Note that integral action should not be set to 0 if ON/OFF control is not used, since there is no guarantee that the temperature will reach the set point using P or PD control and thus the "guarantee soak" feature may cause the program to halt at that point for this reason.

To change the D (derivative) constant, press the Select button. The third LED will blink rapidly. The D (derivative) constant may be set from 0 to 1000 seconds. Setting it to 0 disables the rate action. After changing the value, press the Enter button to store the change into memory.

Factory settings for PID control are 60 degrees Fahrenheit or 30 degrees Celsius for the P band, 180 seconds for the I band and 50 seconds for the D band. Performance can be improved in general by adjusting these constants to suit the system. To exit this menu, press the Seg/PS button twice. It is strongly recommended that you do not change these values unless you have a thorough understanding of their function, which is beyond the scope of this manual.

Changing from Fahrenheit to Celsius and overriding the 2 hour/100% Power Safety Feature

Hold down the SELECT button while turning the power on to the controller. The top and bottom LED's will begin flashing together at a medium rate and the display will show the configuration code for the relay switching rate when the button is released. To switch between Fahrenheit and Celsius, use the up and down arrows to change the number in the display, press ENTER to store it, and then Seg/PS to exit the configuration. Factory settings for controllers with solid state switching is 0 for Fahrenheit and 1 for Celsius. For controllers with small mechanical relays (also known as contactors) the factory setting is 10 for Fahrenheit and 11 for Celsius. For controllers with large mechanical relays the factory setting is 14 for Fahrenheit and 15 for Celsius. Note that changing from Fahrenheit to Celsius affects the P band in the PID equation and will require adjusting. See above, ***Tuning the Controller***.

The controller has Broken Heating Element Detection. The default setting is enabled. Should the controller determine that there might be a broken heating element, it will terminate the running program and show Err1 on the display. The program determines this when a programmed temperature is not reached at its scheduled time, and the heat continues at 100% for an additional two hours.

A false Err1 message can occur when a program is written so that it asks the oven to ramp up to a temperature faster than the oven is capable of. You may want to disable this feature if you find that your oven is very slow to heat up and cannot keep up with your programming. This false Err1 happens when a ramp is set to FULL and it takes longer than two hours to reach the segment's set temperature, or when a ramp is set so fast, that the temperature cannot be reached within two hours of when the controller has calculated that it should have.

To disable this feature, add 32 to the above listed configuration codes. In other words, 0 becomes 32, 1 becomes 33, 10 becomes 42, 11 becomes 43, 14 becomes 46 and 15 becomes 47. If you choose not to disable the broken heating element detection and an Err1 message is displayed, you can clear it and reset the controller by turning off the power to the controller and then turning it back on. You should then rewrite the program so that it does not ask of the oven something it is not capable of.

This menu also contains a second code, the deadband. It is accessed by pressing the Select button a second time. It is set to 256 and should be left set as is. The deadband value, is this number divided by 256. Therefore, the actual deadband value is 1. It is strongly recommended that you do not change this value unless you have a thorough understanding of its function, which is beyond the scope of this manual.

Diagnostics and Error Codes

The controller has built-in diagnostics that help to assure that the memory and microprocessor are working properly. A watchdog timer monitors the operation and will reset the microprocessor if system upset occurs. This will result in causing any running program to terminate. The nonvolatile memory is checked once per second and if invalid data is found, the error code Err2 is shown on the display and the program shuts down. The next section, ***How to Reset an Err2***, address an Err2 Code in detail.

To clear an Err1, turn off and then turn on the power to the controller. Err1 is discussed in detail, in the above section titled: **Changing from Fahrenheit to Celsius and overriding the 2 hour/100% Power Safety Feature.**

If the thermocouple or the connections to it are faulty (open circuit), the display will show EEEE. If the thermocouple is connected in reverse, the display will show temperatures lower than room temperature as the oven heats. When the temperature reaches about 100 degrees, the display will go from about -20 to EEEE.

How to Reset an Err2

If the controller displays an Err2 message, it will terminate the running program and cease function. The typical cause for an Err2 message is an electrical surge or noise, such as that caused by lightning, bad power lines or a bad relay . Note: The controller can have an Err2 issue and not show Err2 in the display. If the controller is acting oddly, try performing the Err2 Reset. Also, check the entire length of the thermocouple for damage, check to see that the infinite control switch is set to high, if the oven has one, and determine if the relay is past its lifespan. See ***Maintenance***, below.

To clear the Err2 message and restore proper function, you must change the information contained in two menus, reboot, put back in the factory default values or values that you assign, and reboot again. The first menu contains two values, the relay switching rate code and the deadband code. The second menu contains three values. One each for P, I and D control.

In the following instructions, you will be given values for a controller that uses a small mechanical relay (also known as a contactor), and is setup to read in Fahrenheit. If your controller is rated for

30 or 50 amps, and it has a large mechanical relay, substitute the value of 14 where 10 is listed. If your controller is equipped with solid state switching, substitute the value of 0 where 10 is listed. If your controller is setup to read in Celsius, add 1 to the values just listed. In other words, change 0 to 1, 10 to 11 and 14 to 15.

In addition, you will be given a value of 60 for the P value. This applies to controllers that are setup to read in Fahrenheit only. Change this number to 30 if your controller is setup to read in Celsius.

The value of 0 or 1 allows for very fast switching rates, something a solid state relay can take advantage of. The value of 14 or 15 causes the controller to have a slower switching rate for a larger relay. Larger relays are not as capable of operating at as fast a switching rate as smaller relays.

Err2 fix procedure:

Be sure to carefully read and understand the preceding five paragraphs first.

Turn off the power to the controller.

Press and hold the Select button, and while holding the button, turn on the power. After the display shows S-0, release the button.

Of the four panel lights located on the left side of the face of the controller, aligned directly one above the other, the top light and the fourth light will be blinking slowly.

Using the Arrow buttons, change the display to read a number, other than what it shows, or 10.

Press Enter to store the new number.

Press Select to display the second menu item.

The second and fourth light will be blinking slowly.

Using the Arrow buttons, change the display to read a number, other than what it shows, or 256.

Press Enter to store the new number.

Since there are only two items in this menu, pressing the Select button a third time will display the first menu item and pressing the Select button a fourth time will display the second menu item. If you find that while reviewing the two menu items, one or both are not what you set them to, more than likely you did not press the Enter button as described above. Redo the described procedure.

It is important that you exit this menu properly by pressing the Seg/Ps button twice. Doing so will make the display show the temperature. If the thermocouple is detecting a temperature of 999° or lower, the display will show the temperature with an F after the number to indicate Fahrenheit or C to indicate Celsius. If the temperature is not displayed, or there is a C when you expect F to be displayed, do not be concerned, as the full Err2 Reset procedure is not yet complete.

Now access the second menu by pressing the Enter button continuously until the display changes. This takes about three seconds. Release the button.

The top light will be blinking fast.

Using the Arrow buttons, change the display to read a number, other than what it shows, or 60, or 30.

Press Enter to store the new number.

Press Select to display the second menu item.

The second light will be blinking fast.

Using the Arrow buttons, change the display to read a number, other than what it shows, or 180.

Press Enter to store the new number.

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Press Select to display the third menu item.

The third light will be blinking fast.

Using the Arrow buttons, change the display to read a number, other than what it shows, or 50.

Press Enter to store the new number.

Since there are only three items in this menu, pressing the Select button a fourth time will display the first menu item, pressing the Select button a fifth time will display the second menu item and pressing the Select button a sixth time will display the third menu item. As before, if you find that while reviewing the three menu items, one, two or all three are not what you set them to, more than likely you did not press the Enter button as described above. Redo the described procedure.

Once again, it is important that you exit this menu properly by pressing the Seg/Ps button twice. Doing so will make the display show the temperature.

Turn off the power to the controller.

Wait five seconds.

Turn the power back on to the controller.

Wait five seconds.

Turn off the power once more.

Now you need to restore the factory default values or the values that you wish to assign, and reboot again. The procedure is similar to what was described above.

Turn off the power to the controller.

Press and hold the Select button, and while holding the button, turn on the power. After the display shows S-0, release the button.

Of the four panel lights located on the left side of the face of the controller, aligned directly one above the other, the top light and the fourth light will be blinking slowly.

Using the Arrow buttons, change the display to read 10.

Press Enter to store the new number.

Press Select to display the second menu item.

The second and fourth light will be blinking slowly.

Using the Arrow buttons, change the display to read 256.

Press Enter to store the new number.

Since there are only two items in this menu, pressing the Select button a third time will display the first menu item and pressing the Select button a fourth time will display the second menu item. As before, if you find that while reviewing the two menu items, one or both are not what you set them to, more than likely you did not press the Enter button as described above. Redo the described procedure.

As before, it is important that you exit this menu properly by pressing the Seg/Ps button twice. Doing so will make the display show the temperature.

Now access the second menu by pressing the Enter button continuously until the display changes. This takes about three seconds. Release the button.

The top light will be blinking fast.

Using the Arrow buttons, change the display to read 60 if the controller is setup for Fahrenheit, 30 for Celsius.

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Press Enter to store the new number.
Press Select to display the second menu item.
The second light will be blinking fast.
Using the Arrow buttons, change the display to read 180.
Press Enter to store the new number.
Press Select to display the third menu item.
The third light will be blinking fast.
Using the Arrow buttons, change the display to read 50.
Press Enter to store the new number.
Since there are only three items in this menu, pressing the Select button a fourth time will display the first menu item, pressing the Select button a fifth time will display the second menu item and pressing the Select button a sixth time will display the third menu item. If you find that while reviewing the three menu items, one, two or all three are not what you set them to, more than likely you did not press the Enter button as described above. Redo the described procedure.

Once again, it is important that you exit this menu properly by pressing the Seg/Ps button twice. Doing so will make the display show the temperature.

Turn off the power to the controller.
When next you turn the power on to the controller, it will be back to its original condition.

After completion of the Err2 Reset, you will need to review the program that was running when the Err2 developed. One or more of the values that were set for each segment may have become corrupt. You need to review the entire program, correct any anomalies, and press Enter for each value reviewed, whether or not it is changed. This is accomplished as follows: While the temperature is displayed, press the Seg/PS button. A segment number will be displayed. Using the Up and Down Arrow buttons, go to the first segment of the program that was running when the Err2 developed. Press the Select button to begin reviewing the program. If the correct value is displayed, press Enter. If however, the value is incorrect, change it to the proper value, using the Up and Down Arrow buttons, and press the Enter button to store it to memory. Continue to repeat this process through the entire program. When completed, press the Seg/PS button twice to exit. The display should now show the temperature and the temperature controller should now work properly.

Maintenance

You should regularly inspect the thermocouple for wear and damage. A damaged thermocouple can give the controller false information that the controller may not be able to detect. This can lead to overheating and subsequent damage to the oven and its contents. Replace it as necessary.

A mechanical relay is the only moving part on the controller. A controller that has a solid state relay has no moving parts. A typical mechanical relay should be replaced as routine maintenance after about three years of service, where the total use time is equal to about four or five full days of use per week. A mechanical mercury relay can last several times this, as can a solid state relay. A mechanical relay that is worn out past its useful life can cause several problems. It can stick closed, causing the oven to overheat, even if a program is not running. It can create intense electrical noise that can cause an Err2. It can also be so corroded that it may impede electrical flow to the oven, causing a failure to heat.

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A solid state relay tends to have a long and reliable life, but will typically fuse closed when it fails. This causes the oven to overheat, even if a program is not running. Also, a solid state relay always “leaks” a few volts through itself to the oven, even if a program is not running.

Glossary

DEADBAND - The amount in degrees on either side of the set point temperature that the controller turns off power to the oven.

DELAY - Refers to the amount of time before the controller will start running a program.

EVENT - Refers to how a segment is controlled. It can be either a delayed start, a continue regardless, a continue or an ending segment.

LED - Light Emitting Diode. The lights on the controllers front panel.

ON/OFF CONTROL - Refers to the controller in the way it handles ramping and soaking. It does not use PID controls.

OVEN - Any heating chamber. Includes kilns, annealers and furnaces.

PAUSE - An interruption in the running of a program that suspends the controllers clock and holds the temperature at the programmed set point temperature indefinitely.

PID - Refers to a functioning of the controller in the way it handles ramping and soaking. P is for proportional. I is for integral. D is for derivative. By using different values for each of the three functions, you can change how the controller interprets the way it ramps and soaks. Note: Understanding PID control is very difficult and its values should not be changed except by someone with a thorough knowledge of how it works.

PROGRAM - The starting, all of the temperature set points, all of the ramp rates, all of the soak times and then turning off of the controller as it affects the oven. An example is when the controller starts the oven and ramps it to a temperature of 960° F (515° C) at the rate of 1000° F (535° C) per hour, then holds that temperature for 30 minutes, then ramps the temperature down to 500° F (260° C) at the rate of 300° F (150° C) per hour and then finally turns off. All of this takes only 3 segments, leaving you 52 more segments available to other programs.

RAMP - It is the continual increase or decrease in temperature.

RAMP RATE - It is the rate of increase or decrease in temperature over a given amount of time.

SEGMENT - It is the time and any temperature change between two temperature set points and those points.

Although a soak is technically an independent segment, the ASC/3 temperature controller considers a soak as the continuation of the proceeding ramp, and does not count is as a separate segment.

SET POINT - The temperature at which you have the controller go to.

SOAK - The portion of a running program when the set temperature is held steady for a determined period of time.

SQUEEZE - The lowering in temperature of the glass in a crucible to about 1800° F (980° C) which causes the small bubbles to be absorbed into the glass

SUSPEND - A condition in which the controller halts the advance in time in a running program to allow the oven to catch up to the temperature at that point in the program of where it should be. An example of this is when you ask the controller to heat up the oven faster than it is capable of doing. Another example is when you ask the controller to ramp down the oven faster than the oven can loose heat.

THERMOCOUPLE - The temperature sensor or probe used by a temperature controller of pyrometer.

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5 Programs have already been entered into the controller as outlined in the following table. Any of these can be overwritten at any time if desired. To start program 1 when the controller is off, press **START**. To start any other program press the **SEG/PS** key, use the up and down arrow keys until the display reads **S-x** where **x** is the segment number of the desired program's starting segment. For instance, **Program 2** starts with **Segment 5**. So the display should read **S-5**. Then press the **ENTER** key followed by the **SEG/PS** key to start the controller in **Program 2**. The controller can be running in one program and can be restarted in another program or another segment of the currently running program without first turning off the currently running program. For instance, while the controller is running in **Segment 1**, you may find that the 12 hour soak is too long. You can restart the controller in **Segment 2** by pressing the **SEG/PS** key, press the up arrow to change the display to read **S-2**, press the **ENTER** key to restart the controller in **Segment 2** and then press the **SEG/PS** key to display the temperature and cancel pause mode.

PROGRAM 1 - ANNEALING

Ramp up – Fast to 960° F; Soak - 12 Hours/30 Min; Ramp down 10° F/Min.; Off at 400° F

Segment 1	
Event:	Cont
Ramp rate:	FULL
Soak time:	12 hours
Temperature:	960° F / 515° C
Segment 2	
Event:	Cont
Ramp rate:	FULL
Soak time:	30 minutes
Temperature:	960° F / 515° C
Segment 3	
Event:	Conr
Ramp rate:	600° F / 335° C
Soak time:	0 minutes
Temperature:	400° F / 200° C
Segment 4	
Event:	End
Ramp rate:	Not applicable
Soak time:	Not applicable
Temperature:	Not applicable

PROGRAM 2 - ANNEALING

Ramp up - 1 Hour to 960° F; Soak - 12 Hours/30 Min; Ramp down 10° F/Min.; Off at 400° F

Segment 5	
Event:	Cont
Ramp rate:	850° F / 470° C
Soak time:	12 hours
Temperature:	960° F / 515° C
Segment 6	
Event:	Cont
Ramp rate:	FULL
Soak time:	30 minutes
Temperature:	960° F / 515° C
Segment 7	
Event:	Conr
Ramp rate:	600 / 335° C
Soak time:	0 minutes
Temperature:	400° F / 200° C
Segment 8	
Event:	End
Ramp rate:	Not applicable
Soak time:	Not applicable
Temperature:	Not applicable

PROGRAM 3 - ANNEALING

Ramp up - Fast to 960° F; Soak - 12 Hours/1Hour; Ramp down 5° F/Min.; Off at 400° F

Segment 9	
Event:	Cont
Ramp rate:	FULL
Soak time:	12 hours
Temperature:	960° F / 515° C
Segment 10	
Event:	Cont
Ramp rate:	FULL
Soak time:	1 hour
Temperature:	960° F / 515° C

Segment 11	
Event:	Conr
Ramp rate:	300° F / 165° C
Soak time:	0 minutes
Temperature:	400° F / 200° C
Segment 12	
Event:	End
Ramp rate:	Not applicable
Soak time:	Not applicable
Temperature:	Not applicable

PROGRAM 4 - ANNEALING

Ramp up - 2 Hour to 960° F; Soak - 12 Hours/1 Hour; Ramp down 5° F/Min.; Off at 400° F

Segment 13	
Event:	Cont
Ramp rate:	425° F / 235° C
Soak time:	12 hours
Temperature:	960° F / 515° C
Segment 14	
Event:	Cont
Ramp rate:	FULL
Soak time:	1 hour
Temperature:	960° F / 515° C
Segment 15	
Event:	Conr
Ramp rate:	300° F / 165° C
Soak time:	0 minutes
Temperature:	400° F / 200° C
Segment 16	
Event:	End
Ramp rate:	Not applicable
Soak time:	Not applicable
Temperature:	Not applicable

PROGRAM 5 - FUSING

Ramp up to 1000° F in 55 Min.; Ramp up to 1550° F Fast; Soak - 30 Min.; Ramp down Fast to 960° F; Soak 30 Min; Ramp down 7° F/Min.; Off at 400° F

Segment 17	
Event:	Cont
Ramp rate:	1000° F / 555° C
Soak time:	0 minutes
Temperature:	1000° F / 535° C
Segment 18	
Event:	Cont
Ramp rate:	FULL
Soak time:	30 minutes
Temperature:	1550° F / 840° C
Segment 19	
Event:	Cont
Ramp rate:	FULL
Soak time:	30 minutes
Temperature:	960° F / 515° C
Segment 20	
Event:	Conr
Ramp rate:	400° F / 220° C
Soak time:	0 minutes
Temperature:	400° F / 200° C
Segment 21	
Event:	END
Ramp rate:	Not applicable
Soak time:	Not applicable
Temperature:	Not applicable

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APPENDIX

Program 1 is designed to heat up your annealer at full speed, then hold a temperature of 960° F (515° C) for 12 hours, then again hold the temperature for 30 minutes, then ramp down at the rate of 600° F (335° C) degrees per hour (10° F / 5.25° C per minute) to 400° F (200° C) and then stop. Use this program to heat up an empty annealer. This program allows you to make beads or sculpture during the 12 hour soak (hold) time and place them in the annealer. At the end of the 12 hour time the controller holds the temperature for an additional 30 minutes then ramps down to 400° F (200° C) at the rate of 600° F (335° C) per hour (10° F / 5.25° C per minute) and then turns off. If you find that having the annealer hold for 12 hours is not enough time, simply press the **SEG/PS** key. The display will change from showing the temperature to showing the segment that the controller is currently running in and the four LED lights on the left will be blinking indicating that the controller is in pause mode. This means that the controller will hold the annealer at the programmed temperature that the segment it is currently running in indefinitely. If the **SEG/PS** key is pressed while the program is ramping up, the ramp will continue. When the programmed temperature is reached then the program will indefinitely hold that temperature. Press the **SEG/PS** key again to cancel the pause. The display will return to showing the temperature and the four LED lights on the left will stop blinking.

The more likely scenario is that 12 hours is too long as was intended in the programs design. Generally, after you have made your last glass item, placed it into the annealer and closed the annealer, you will want to heat soak the annealer's contents before slowly ramping down the temperature. This is done as follows. Press the **SEG/PS** key. This is not done because you want to pause the program as described above, but to display the segment that the controller is currently running in. While the display shows the current segment, which should be **S-1**, press the up arrow once. The display will advance to the next segment, **S-2**. Press the **ENTER** key to restart the controller in segment 2. Then press the **SEG/PS** key again so the display shows the temperature. If the **SEG/PS** key is not pressed, the controller will be in pause mode and it will hold the temperature in the annealer indefinitely at 960° F (515° C). Segment 2 is the segment that actually starts the annealing process. The controller holds the annealer for 30 minutes then ramps the temperature down to 400° F (200° C) at the rate of 600° F (335° C) per hour (10° F / 5.25° C per minute) and then turns off.

If you press the **ENTER** key while the controller is ramping, nothing will happen. If you press the **ENTER** key while the controller is in soak mode (the third LED light down from the top is lit), the display will show the remaining time of the soak and count it down until it reaches the next segment at which time the display reverts back to showing the temperature. Press **ENTER** again to cancel the soak count down. If the **ENTER** key is pressed while the display shows a segment (for example **S-9**), the controller starts in that segment, even if the displayed segment is the segment the controller is currently running in.

Program 2 is similar to program 1 except it is designed for the instance where there is cold glass placed in the annealer to be annealed. This requires the annealer to come up to annealing temperature slowly in order to avoid thermal shock.

Program 3 is similar to program 1 except it features a longer soak time and a slower ramp down for annealing larger works.

Program 4 is similar to program 2 except it features a longer soak time and a slower ramp down for annealing larger works.

The annealing schedules for the first four programs are very conservative. If your work breaks after using one of them, check the compatibility of the glass used and be sure that you are using proper flame annealing techniques.

Program 5 is for fusing. To start it press the **SEG/PS** key. Use the up and down arrows to make the display show the first segment of program 5 (**S-17**). Press the **ENTER** key to start the controller in segment 17 and then press the **SEG/PS** key to return the display to showing temperature. If you don't press the **SEG/PS** key, the controller will be in pause mode and the annealers temperature will only go to segment 17's programmed temperature (1000° F / 535° C) and stay there indefinitely.

Program 5 will ramp the temperature up to 1000° F (535° C) at the rate of 1000° F (555° C) per hour (about 55 minutes). It is important to heat up the glass slowly to prevent thermal shock and resulting breakage. Once the glass has past the strain point, the point at which the glass no longer expands, it can be heated up as quickly as the oven can go. The strain point for most art glass used in fusing is around 850° F (450° C). After the temperature is reached in segment 17, the controller advances to the next segment, **S-18**. Segment 18 ramps up to 1550° F (840° C) at the full capability of the oven and holds that temperature for 30 minutes. The controller then advances to the next segment, **S-19**. Segment 19 ramps down to 960° F (515° C) as quick as possible and holds that temperature for 30 minutes. The controller then advances to segment 20 which ramps the temperature down to 400° F (200° C) at the rate of 400° F (220° C) per hour (7° F / 3.3° C per minute) and then turns off.

In fusing, you usually need to look at the glass as it nears the fusing temperature to see its progress. If the glass fuses too far, there is nothing you can do about it. If it hasn't fused enough you can give it more time until the desired look is achieved. While the program is running in segment 18 and the temperature is near the fusing point, look at the glass. Be sure to use all the proper precautions so not to burn your hands, face and eyes. When you are satisfied with the look of the fusing press the **SEG/PS** key. While the display shows the current segment, which should be **S-18**, press the up arrow once. The display will advance to the next segment, **S-19**. Press the **ENTER** key to restart the controller in segment 19. Then press the **SEG/PS** key again so the display shows the temperature. If the **SEG/PS** key is not pressed, the controller will be in pause mode and it will hold the temperature indefinitely at 960° F (515° C). To prevent the glass from devitrifying (turning dull on the surface), as segment 19 quickly ramps down to 960° F (515° C), vent the oven by opening the lid slightly. As before, use caution to prevent injury. When the temperature reaches 1000° F (535° C) close the lid. The temperature will go up slightly. This is not a problem. The temperature will not rise into the divitrification range. Segment 19 is the segment that actually starts the annealing process. The temperature will ramp down to the programmed temperature of segment 19 (960° F / 515° C) and then hold for 30 minutes. The controller then advances to segment 20, **S-20**, ramps the temperature down to 400° F (200° C) at the rate of 400° F (220° C) per hour (7° F / 3.3° C per minute) and then turns off.

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PROGRAM #

Segment #

Event:

Ramp rate:

Soak time:

Temperature:

PROGRAM #

Segment #

Event:

Ramp rate:

Soak time:

Temperature:

PROGRAM #

Segment #

Event:

Ramp rate:

Soak time:

Temperature:

PROGRAM #

Segment #

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Ramp rate:

Soak time:

Temperature:

PROGRAM #

Segment #

Event:

Ramp rate:

Soak time:

Temperature:

PROGRAM #

Segment #

Event:

Ramp rate:

Soak time:

Temperature:

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