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Precautions

The controller is used to control temperature; it is not a safety device.

Do not operate the controller in temperatures above 125 ^{O}F.

Never leave your kiln unattended at the end of a firing.

The controller contains electronic components that are sensitive to static electricity. Before handling the controller dissipate any static charge you may have by touching metal or a screw on the controller panel, the electrical box, the kiln lid, or some other grounded object.

Always check the position of the thermocouple probe before starting a firing. The current temperature displayed on the controller is measured at the end of the thermocouple.

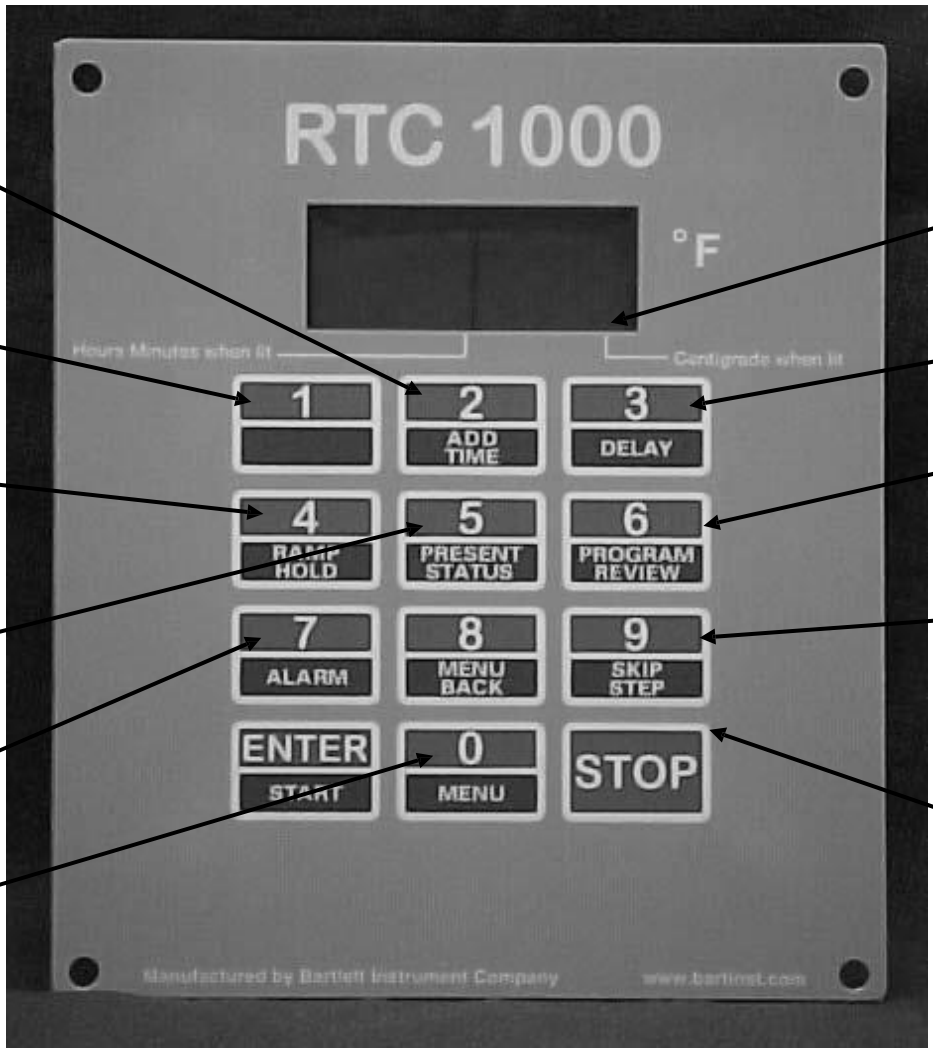
Always review the current program before firing to ensure the correct profile is programmed.

Overview of How the Controller Functions

You enter a program that tells the controller what temperature you want to fire to and at what rate you want the temperature to rise. The controller uses a thermocouple (t/c) to sense the temperature of the kiln. The temperature is measured at the tip of the t/c. When "start" is pressed, the controller reads the kiln temperature and uses that temperature as a starting point for a traveling set point. The controller then calculates how much power is needed to keep the temperature equal to the traveling set point and cycles the electricity to the elements so the correct amount of power is applied. As the firing progresses, the controller moves the traveling set point according to the programmed firing rate and recalculates how much power is needed to keep the temperature at the new traveling set point.

You can enter a program in two different ways. The cone fire method is the easiest and is designed for firing ceramics to ensure correct heat-work for each cone number and firing rate. With as few as six key presses, you can have a firing programmed and started. The ramp-hold method allows more complicated profiles and freedom in firing. Ramp-hold programs are used for firing such things as glass, jewelry, and crystalline glazes.

RTC 1000



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Cone #s (Cone Table) Page 7

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The Keypad

The controller is easy to master once you understand that the keys have two functions:

1. **Select and Operation**
   Press a key to start the operation shown in the top half of the key. Most operations begin by pressing **START** from **IdLE** display. Some operations begin during firing.
2. **Type Numbers**

After beginning an operation, press keys to enter numbers, such as time and temperature.

Getting Started

Do NOT fire your kiln or furnace until you have read this section and "Cone-Fire Basics" or "Ramp-Hold Basics". To use your controller to its fullest capacity, read the advanced sections and "Additional Features".

Testing and Recording

You will learn much by testing. How slowly should clay be heated through quartz inversion? How slowly must you cool glass through the annealing range? Find out for yourself by testing. The RTC 1000 can precisely control every stage of firing, so you can easily experiment and test.

Keep a notebook of firing records. When you fire similar projects weeks later, after you have forgotten the details of your previous firing, you will be grateful for your records.

Room Temperature and Humidity

It is okay to store the RTC 1000 at subzero temperatures. But before operating, raise the room temperature to at least 0°F/-18°C.

The circuit board is rated for 155°F/68°C maximum operating temperature. However, maximum temperature for rated accuracy is 125°F/52°C. If the board gets hotter, open windows and exhaust hot air from the room. (See page 11 for instructions on checking circuit board temperatures.)

High humidity will not adversely affect the RTC 1000 unless water condenses on the circuit board. If this happens, do not fire the kiln until the moisture has evaporated from the board.

IdLE and CPL Messages

The controller displays **WAIT** when you first apply power. After a few seconds, **IdLE** and the temperature will appear. Operations begin from **IdLE**.

If the display shows **FAIL** instead of **IdLE**, the thermocouple is either disconnected or burned out.

CPL means "completed". The controller may display **CPL**, after certain programming actions.

Which Instructions to Use

The RTC 1000 fires in two modes

1. **Ceramic Cone-Fire,** based on pyrometric cones
2. **Ramp-Hold,** based on firing rates and target temperatures.

Ceramic kilns, usually top-loading, use both Cone-Fire and Ramp-Hold. Heat-treating, glass fusing, and enameling furnaces and kilns usually come with ramp-hold only.

How to Tell if You Have Cone-Fire

1. From **IdLE** display, press **ENTER** then **1.** If **CONE** appears, you have Cone-Fire mode. If **---** appears, you have Ramp-Hold mode only.
2. Bring the controller back to **IdLE** display:
   - **a)** From **---**, press **STOP**. **IdLE** will appear.
   - **b)** From **CONE**, press **ENTER** 3 times slowly. **IdLE** will appear.

If you have Cone-Fire, this entire manual applies to your controller. If you have Ramp-Hold only, you may skip to page 8.

Care of the Thermocouple

The small metal rod protruding into the firing chamber is the temperature sensor, or thermocouple. Do not let shelves, posts, or ware touch the thermocouple; this could affect the temperature reading.

Bumping the thermocouple during loading can damage it or push it out of the firing chamber. It should protrude into the firing chamber about 1-$^1/_2$". Check the kiln manufacturer's placement instructions.

Avoid firing clay with high sulfur content. The sulfur erodes the thermocouple making it brittle and easy to break.

Display Dots

Single Center Dot: Time

A lower center dot appears during time display. It separates hours from minutes (i.e. 1 hour, 30 minutes displays as 1.30). During temperature display, the dot disappears.

Single Right-Hand Dot: °C

When a temperature is displayed in °C, a lighted dot appears in the lower right. In °F it disappears.

Three Dot Display: Power Monitoring

To adjust temperature, the RTC 1000 sends power to the relay(s) intermittently. The relays, in turn, power the heating elements. To monitor when the relays are turned on, press **8** during firing. When three dots appear along the bottom of the display, the relays are receiving power.

To turn off Power Monitoring, press **8** again. This feature is used mostly for diagnostics.

Correcting Entries

If you enter the wrong temperature, cone, time, etc., while programming, enter 0000. Then enter the correct numbers before pressing **ENTER**.

The Stop Key

You can stop a firing at any time by pressing the **STOP** button.

If you inadvertently enter Ramp-Hold, you do not have to go through all the prompts to get back out. Press **STOP** when USER appears. That will take you back to IdLE.

If you inadvertently enter Cone-Fire, **STOP** will take you back to IdLE.

If you inadvertently press **MENU**, you can get back to IdLE by pressing **STOP.**

Cool-Down Temperature Display

When the firing is finished CPLT will display alternating with the current temperature in the kiln and the total firing time in hours and minutes. To view the current kiln temperature as the kiln cools, press **ENTER**. CPLT will disappear. Then temperature will display.

Repeat Firings

To repeat the previous firing, press **ENTER** twice from IdLE. The kiln will begin firing. This works in both Cone-Fire and Ramp-Hold. But first, make sure you are repeating the correct firing by using "Program Review" below.

Program Review

When a Cone-Fire or Ramp-Hold profile is programmed it will be saved to memory. This profile is then ready to fire. "Program Review" shows you the values for that program.

To start "Program Review" from IdLE, press **ENTER**, then **6**. Values for the program selected for firing will display one after the other. You can also use Program Review during firing simply by pressing **6**.

TIP: *In Program Review, values for a program display about one per second. You can speed up this display by pressing **1** repeatedly. If you hold down the key, the values will speed by. This works from both* IdLE *and during firing.*

Pyrometric Witness Cones in Ceramic Firings

Though the RTC 1000 fires electronically, every ceramic firing should include shelf or witness cones. They measure heat work accurately and give a history of the firing.

If you fire the same sized load and type of ware regularly, the shelf cones let you compare one firing to the next and alert you when something is wrong. For example, if the shelf cone bends farther and farther with each consecutive firing, this may indicate thermocouple temperature drift.

Keep cones 3" from the peephole to avoid cool air drafts. Wear firing safety glasses when viewing the cones at high temperature. Your dealer can tell you which cone number to use for each clay and glaze.

When Kiln Shuts Off Too Soon

If the kiln shuts off below maturity, you can turn it back on and keep firing. Simply program a higher temperature or hotter cone. Then from IdLE, press **START** twice. The kiln will begin firing, taking up where it left off.

Ceramic firings: if the kiln shuts off within 100^{O}F/50^{O}C of maturity, and the temperature drops 50^{O}F/28^{O}C or more after the kiln shuts off, do not depend on the pyrometric witness cones in the kiln. Once the cones cool 50^{O}F/28^{O}C after they have been heated within 100^{O}F/50^{O}C of maturity they will not bend properly. This is due to the formation of a hard shell.

Ceramic Cone-Fire

Cone-Fire mode is based on pyrometric cones. It is not designed for heat-treating, glass fusing and enameling. For these firings, see "Ramp Hold", page 8. Use Ramp-Hold to fire ceramic pieces that require a custom firing schedule, such as some types of stoneware sculpture or crystalline glaze. To fire faster than Cone-Fire Fast speed, use Ramp-Hold.

Cone-Fire Basics

Firing Speeds

Cone-Fire operates in Fast, Medium, or Slow speed. The instructions that follow will show you how to select speed.

To view the firing segment of a cone-fire, press **5** during firing (See "Present Status", page 11). The segment number will appear (see left column in the following charts), informing you of how far the firing has progressed.

Fast (1)

Consider Fast for overglazes, decals, china paint, or small, thin-walled ceramic greenware.

Cone-Fire Fast Firing Schedule

Segment in "Present Status"	Actual Segment	Rate of Firing Schedule
5	-	Pre-Heat (if any)
6	1	570^{O}F/hour until the last 250^{O} F
7	2	200^{O} F/hour during the last 250^{O} F

Medium (2)

Use Medium for larger slip-cast pieces or more tightly loaded kilns.

Cone-Fire Medium Firing Schedule

Segment in "Present Status"	Actual Segment	Rate of Firing Schedule
4	-	Pre-Heat (if any)
5	1	110^{O} F/hour until 250^{O} F
6	2	400^{O} F/hour until the last 250^{O} F
7	3	120^{O} F/hour during the last 250^{O} F

Slow (3)

Use Slow for hand-thrown or heavily cast pieces, stoneware, and porcelain.

Cone-Fire Slow Firing Schedule

Segment in "Present Status"	Actual Segment	Rate of Firing Per Hour
2	-	Pre-Heat (if any)
3	1	80^{O} F/hour to 250^{O} F
4	2	250^{O} F/hour until temperature reaches 950^{O} F
5	3	110^{O} F/hour until temperature reaches 1100 ^{O}F
6	4	225^{O} F/hour until the last 250^{O} F
7	5	90^{O} F/hour during the last 250^{O} F
8	6	150^{O} F/hour, cooling down to 1000^{O} F

Hold

Cone-Fire "Hold" heat-soaks the ware at the end of the firing. Without Hold time, the kiln shuts off after it reaches the cone temperature. With Hold time, the kiln maintains the cone temperature for the period you specify. Hold time helps even out the temperature throughout the kiln. It also helps the heat to penetrate completely into the clay. Rapid firing is like cooking: the turkey will be done on the outside but not on the inside. Hold helps glaze absorb china paint. It helps to heal glaze defects such as bubbles. A little hold time can yield dramatic results.

CAUTION: *Too much hold time can overfire your ware and burn out colors.*

One way to add Hold time without over-firing is to fire to one cone cooler than needed. Then add enough hold time to bend the next hotter cone. Hold time needed will vary. As a rule of thumb, one hour of hold = one cone of heat work.

Example: to fire to cone 05½, program Cone-Fire for 05 and add 30 minutes of hold time.
Watch the pyrometric shelf cones through the peephole. Press **STOP** when the correct shelf cone bends, noting how much Hold time was needed. Program that much Hold time the next time you fire the same type of ware loaded to the same capacity. You can hold for up to 99 hours and 99 minutes.

You will learn by experiment with ceramics. Hold is one more tool to experiment with.

Cone-Fire Programming

Use these instructions for your first firings. Later you may prefer "Cone-Fire Quick Reference".

As the RTC 1000 prompts for cone, speed, etc., values entered for the last firing will appear. To use these values again, press **ENTER**.

To fire without Delay or Alarm: Follow steps 1-6 below. Then from IdLE press **START** twice.

1. Apply power to the kiln.

2. WAIT will appear, then IdLE.

3. Press **ENTER** then **1**. CONE will appear. Enter cone number. (If ---- appears instead of CONE, your controller uses Ramp-Hold only.)

4. Press **ENTER**. SPd will appear. Enter speed: Fast (**1**), Medium (**2**), Slow (**3**).

5. Press **ENTER**. HOLd will appear. Enter hold time, if any, in hours and minutes (i.e. 12 hours and 30 minutes = 12.30).

6. Press **ENTER**. IdLE will appear.

7.To set alarm, press **ENTER** then **7.** ALRM will appear. Enter alarm temperature. (Enter **9999** to turn alarm off.) Then press **ENTER**.

8. To set delay fire, press **ENTER** then **3.** dELA will appear. Enter delay time in hours and minutes (i.e. 12 hours and 30 minutes = 12.30). Press **ENTER**. (Delay zeroes out after each firing.)

9. To start program, press **ENTER** twice. -ON- will appear, then time remaining until start. To stop the program during fire, press **STOP**.

Pre-Heating the Ware

Moist greenware can explode during firing. This happens when the moisture in the clay turns to steam rapidly and cannot easily escape. The RTC 1000 "Pre-Heat" feature dries the ware at low temperature before the moisture can turn to steam.

Pre-Heat is necessary when firing thick greenware, such as stoneware. It may also be necessary in humid weather, which inhibits drying. If possible, however, avoid using Pre-Heat to dry greenware. If the greenware feels damp or cool when you touch it to your cheek, dry it longer before firing. Use a dehumidifier in humid weather. Drying greenware in the kiln tends to rust the kiln.

> ***TIP:*** *During Pre-Heat, vent the lid. Otherwise the firebricks will absorb moisture, leading to rust behind the stainless steel case. Moisture in the firebrick will also slow the kiln to a crawl when firing begins.*
>
> *Venting the lid during Pre-Heat is so important that some ceramists use the extended vent position or even leave the lid open. If you do this, you must be near your kiln at the end of Pre-Heat to lower the lid.*

Pre-Heat raises the temperature 60^{O}F/33^{O}C per hour to 200^{O}F/93^{O}C. Then it holds at 200^{O}F/93^{O}C for the time you specify. Pre-Heat works in Cone-Fire only. After Pre-Heat is finished, the kiln will automatically begin firing to the cone you have selected. Pre-Heat zeroes out after each firing.

After entering the cone number, speed, etc., in the Cone-Fire program, activate Pre-Heat as follows. Then begin firing.

1. Press **ENTER**
2. Press **0** repeatedly until **PRHT** appears.
3. Press **ENTER**. **HLd** alternating with **00.00** appears.
4. Enter Pre-Heat hold time in hours and minutes (i.e. 1 hour 30 minutes = 01.30).
5. Press **ENTER**. Display returns to **IdLE**.

AOP

The optional "AOP" (Auxiliary Output) is an extra output on the controller. The AOP can be used to power a relay to control a kiln vent or other appliance. If your kiln is equipped with AOP, **AOP** will appear in Cone-Fire after **HOLd**. (If **AOP** does not appear in the display, your kiln is not equipped with AOP.)

When set to OFF, the AOP receives power during the Cone-Fire firing. At the end of the firing, the AOP shuts off.

When set to ON, the AOP remains powered during both Cone-Fire firing and cooling. It shuts off after the kiln cools to 150^{O}F/66^{O}C.

TIP: *For slow cooling in Cone-Fire, select AOP OFF.*

Adjusting AOP in Cone-Fire

1. After programming Cone, Speed, and Hold, **AOP** will appear, alternating with **ON** or **OFF**.
2. To Change the setting, press **1**, then **ENTER**. Display will return to **IdLE**.

Advanced Cone-Fire

Built-in Cone Table

For your convenience, the controller can look up a pyrometric cone temperature. Do not be concerned if your kiln's cone shut-off temperature differs from the cone table temperature. The shut-off temperature varies with the firing speed.

1. From **IdLE**, touch **ENTER** then **9.** **CONE** will appear, then the cone currently programmed in Cone-Fire Mode.
2. Enter the pyrometric cone number you are looking up. Then touch **ENTER**. The display will show the cone temperature. If you enter a non-existent cone number, the display will show **CONE**, ready for you to enter a different cone number.

Cone temperatures displayed are for self-supporting cones fired at a rate of 108^{O}F during the last hour.

Firing History in Cone-Fire

When the kiln fires to completion, **CPLT** will flash, alternating with total firing time in hours and minutes. To view the final temperature the kiln reached, press **ENTER**. **IdLE** will appear. Press **ENTER** then **6** (Program Review). Final firing temperature will display along with the cone, speed, and hold.

Fine-Tuning Shelf Cones With Cone Offset (CNOS)

Sometimes the pyrometric cone programmed in Cone-Fire does not match the bending of the cone on the kiln shelf. Using "Cone Offset" you can adjust to fire hotter or cooler.

IMPORTANT: Cone Offset adjusts the firing temperature individually for each pyrometric cone number. Adjusting one cone has no effect on the other cones. To adjust all the cones equally, use "Thermocouple Offsets", page 11.

For instance, the controller fires shelf cone 018 to a perfect six o'clock bend. But at cone 6, the shelf cone over-fires. Using Cone Offset, you could lower cone 6 firing temperatures without affecting the perfect results you are getting at cone 018.

> ***TIP:*** *Before using Cone Offset, check that the thermocouple is protruding into the firing chamber by at least 1-$^{1}/_{2}$" to 2". Sometimes bumping a shelf against a thermocouple pushes it out of the firing chamber, thereby preventing accurate temperature readings.*

How to Use Cone Offset

1. From IdLE, press **ENTER**.
2. Press **0** until CNOS appears.
3. Press **ENTER**. CONE will appear, alternating with last cone number entered in Cone-Fire. Enter the new cone number.
4. Press **ENTER**. °FOS (or °COS for Celsius) will appear, alternating with 9000 or an adjustment number.
5. Enter adjustment number (see chart). Then press **ENTER**. Temperature and IdLE will display.

You can raise or lower firing chamber temperature for each cone from 1-50°F/1-28°C. Place 00 in front of the number to make the kiln fire hotter. Place 90 in front to make it fire cooler.

The following chart contains seven examples of Cone Offsets. Program any temperature in the 01-50°F/1-28°C range, hotter or cooler, using these examples as a guide.

Cone Offset Examples,°F

0001	Kiln will fire 1°F Hotter
0030	Kiln will fire 30°F Hotter
0049	Kiln will fire 49°F Hotter
0000 or 9000	No Adjustment
9005	Kiln will fire 5°F Cooler
9040	Kiln will fire 40°F Cooler
9049	Kiln will fire 49°F Cooler

* Cone Offset works in °C the same as in °F. In the above examples, replace °F with equivalent °C.

Once you enter a Cone Offset number, Cone-Fire will remain adjusted to that number for that cone until you change it again. Keep a written record of Cone Offset Adjustments.

Ramp-Hold

Ramp-Hold fires in segments. Each segment has an end temperature, a degrees per hour rate to reach that temperature, and a hold time.

Ramp-Hold Basics

User Programs

When you enter Ramp-Hold mode, the first prompt to appear is USER, meaning, "Select a User Program". A user program is a firing schedule stored in memory.

It includes:

1. Number of segments needed
2. Rate (how fast temperature changes in degrees per hour) for each segment
3. Target temperature for each segment
4. Hold, if any, for each segment
5. Alarm temperature, if any

The controller can retain six user programs in memory even when power to the kiln is turned off.

If using Ramp-Hold for the first time, press **1** when USER appears. Your first firing will be stored as User Program #1.

Each time you store another program, select the next available number, such as 2, at the USER prompt. Write down the firing profiles of your User Command.

When you use a stored program, select the program number at the USER prompt. Press **ENTER**. If there are no changes to the program, press **STOP**. STOP will appear, then IdLE. The controller is ready to fire your selected program.

Segments

A "Segment" fires to a target temperature. It includes a rate and, if needed, a hold. Every time you need to change firing speed or hold a temperature, add another segment. You have up to eight segments available in a User Program. You don't have to use all eight segments – only the number needed per firing. Often one segment is all you will need.

For complex firings, Ramp-Hold can be fired in 16 segments instead of the standard eight.

Rate

Each segment must include a rate, programmed as degrees of temperature change per hour. One way to figure rate is to divide firing temperature by number of hours needed to fire. Maximum rate is 9999. When you enter 9999, the controller will heat as fast as your furnace or kiln is capable.

If you are not sure about how fast to fire, remember the old firing adage: "When in doubt, slow it down."

Hold

"Hold" in Ramp-Hold maintains the target temperature of a segment for the time you specify. Hold gives the temperature time to become more even throughout the kiln. Hold can be used in either heating up or cooling down segments.

Wearing firing safety glasses, watch the pyrometric cones on the shelf near the end of the firing. When the shelf cone bends, note the hold time. The next time you fire the same type of ware loaded to the same capacity, program that amount of hold time.

Ramp-Hold Programming

Use these instructions for your first firings. Later you may prefer "Ramp-Hold Quick Reference"

As the program prompts for segments, rate, temperature, etc., you will see values from the last firing. To use these again, press **ENTER**. To control cooling, set the segment to a lower temperature than that of the preceding segment.

To fire without a timed Delay: Follow steps 1 through 8, then press **START** twice.

1. Apply power to the kiln. If ERRP or PF appears, press **ENTER.** IdLE and kiln temperature will appear.
2. Press **ENTER** then **4**. USER will appear. Enter a number from 1-6 for the stored program desired.
3. Press **ENTER.** SEGS will appear. Enter number of segments needed.
4. Press **ENTER**. RA 1 will appear. Enter firing rate for segment 1 (temperature change per hour: from 1^{O} - 9999^{O}).
5. Press **ENTER**. °F 1 (or °C 1) will appear. Enter the target temperature of segment 1.
6. Press **ENTER**. HLd1 will appear. Enter segment 1 hold time in hours/minutes (i.e. 12 hours and 30 minutes = 12.30). No hold = 00.00.
7. Press **ENTER**. Continue entering values for all segments.
8. Press **ENTER**. ALRM will appear. Enter alarm temperature. (Enter **9999** to turn alarm off.) Then press **ENTER**. Display returns to IdLE.
9. To set Delay Fire, press **ENTER** then **3**. dELA will appear. Enter delay time in hours/minutes (i.e. 12 hours and 30 minutes = 12.30). Then press **ENTER**. (Delay zeroes out after each completed firing). Display returns to IdLE.
10. To start program, press **ENTER** twice. -ON- will appear, then kiln temperature. If delay was programmed, -ON- will appear then time remaining until start.

To stop the firing, press **STOP**. When program fires to completion CPLT will appear. Press **STOP**. IdLE will appear, alternating with cool-down temperature. To shut off the alarm when it sounds during a firing press **ENTER**.

AOP

The optional "AOP" (Auxiliary Output) is an extra output on the controller. The AOP can be used to power a relay to control a kiln vent or other appliance. If your kiln is equipped with AOP, AOP will appear in Ramp-Hold after SEG. (If AOP does not appear in the display, your kiln is not equipped with AOP.) In Ramp-Hold, AOP can be turned on or off for each segment.

Adjusting AOP in Ramp-Hold

1. After selecting the User Program and number of segments**,** AOP1, alternating with ON or OFF, will appear.
2. To change the setting, press **1**, then **ENTER**. Continue entering rate, temperature, hold, etc. for segment 1. As you continue programming, turn AOP on or off in each segment.

Advanced Ramp-Hold

Segments for Controlled Cooling

For controlled cooling, program a segment to a lower temperature than that of the preceding segment.

Skip Step

You may need to skip a segment in Ramp-Hold. For instance, you are firing to cone 05 for the first time. You program the last segment to soak for 30 minutes at 1850^{O}F. (This is a few degrees below cone 05.) You are not sure at what temperature the cone will bend during this firing.

At 1850^{O}F, the alarm beeps, alerting you to check the witness cone on the shelf. You look into peephole every few minutes to check the cone. After a 10-minute hold, the shelf cone 05 bends to maturity. Using "Skip Step", the controller begins a cool-down segment. Skip Step stops the current segment and starts the next segment.

Skip Step works only during firing and only in Ramp-Hold, not Cone-Fire. To skip a segment, press **9**. SKIP will appear. If you change your mind and don't want to skip that segment, do nothing and the firing will continue as it was. If you still want to skip the segment, press **ENTER**. RA will appear along with the segment number you just skipped to.

*Press **5** ("Present Status") if you are not sure which segment the firing has reached. Then skip the segment.*

16 Segment Firing (16-S)

Sixteen segment firing combines Ramp-Hold user programs 5 and 6 into one continuous firing. You can use all 16 segments, or only a few segments from each program. Program 5 will fire first, then program six.

1. Press **ENTER**, then **4**. USER will appear, alternating with the last user program entered.

2. Press **5** (user program 5), then **ENTER**. Using Ramp-Hold instructions, enter the values for all segments needed in program 5.
3. IdLE and temperature will display after program 5 is entered. From IdLE, press **ENTER**, then **4**.
4. USER will appear, alternating with 5. Press **6** (user program 6), then press **ENTER.** As before with program 5, enter the values for all segments needed in program 6.
5. IdLE will appear after program 6 is entered. Press **ENTER**, then **PROGRAM REVIEW**. Make sure all values for user program 6 are correct. After reviewing the program, IdLE will appear.
6. From IdLE, press **ENTER**, then **4**. USER will appear, alternating with 6. Press **5**, then **ENTER**.
7. Press **STOP**. IdLE will appear. Program 5 is now selected in Ramp-Hold.
8. From IdLE, press **ENTER**, then **0** repeatedly until 16-S appears. Press **ENTER.**
9. OFF or ON will appear. Press **1** to change OFF to ON. ON will appear. Press **ENTER**. IdLE will appear.
10. Begin firing by pressing **ENTER** twice.

*16-S appears under **MENU** only after user program 5 or a Cone Fire Program has been selected.*

When you use Program Review for a 16 segment firing, user program 5 will appear. Then 16-S, ON, to confirm that your program is the 16 segment. However, the values for user program 6 will not appear in Program Review.

Additional Features

Selecting °F or °C (CHG°)

The controller operates in your choice of °F or °C temperature. In °C display, a lighted dot appears in the lower right. In °F, it disappears. To switch from °F to °C or vice versa:

1. From IdLE, press **ENTER**.
2. Press **0** repeatedly until CHG° appears.
3. Press **ENTER**. °F or °C will appear.
4. To change, press **1**.
5. Press **ENTER**. Display returns to IdLE.

°F/ °C Temperature Conversion Formula

Below are formulas for converting temperature between °F and °C. Converting a firing rate requires a different formula than firing temperature:

Firing Temperature

(i.e. "Fire to 1600°F." 1600°F = 871°C)

(°C x 1.8) + 32 = °F

(°F – 32) ÷1.8 = °C

Firing Rate and Temperature Change

(i.e. "Fire at 200°F per hour" or "Fire 200°F hotter"

200°F per hour = 111°C per hour)

°C per hour x 1.8 = °F per hour

°F per hour ÷ 1.8 = °C per hour

Delay Fire

The Delay Fire programs the kiln to begin firing later. Use it to adjust the firing to suit your schedule or to take advantage of lower electric rates at night.

It zeroes out after each completed firing. To set the Delay, follow earlier instructions for entering the Cone-Fire or Ramp-Hold firing program. Then press **ENTER**, then **3.** Enter the delay time in hours/minutes. (i.e. 12 hours and 30 minutes = 12.30). To begin firing, press **ENTER** twice.

***WARNING:** Never leave your kiln unattended near the end of a firing. We cannot guarantee your kiln against overfiring even though the controller is automatic. The operator assumes full responsibility for shutting the kiln off at the proper time.*

Temperature Alarm

The alarm beeps when a preset temperature is reached. Use the alarm to alert you to:

1. Lower the lid from venting position.
2. Check the witness cone near shut-off time.
3. Check the fusing or slumping of glass.
4. Remove the knife blade from the furnace at the end of heat treating.

You can enter only one alarm temperature at a time. However, after the alarm beeps, you can set the alarm for another temperature as many times as you want during the firing. You can enter a higher or lower temperature than the current temperature.

Setting the Alarm From Idle

1. From IdLE , press **ENTER** then **7.** ALRM will appear alternating with the last alarm temperature entered.
2. Enter desired alarm temperature. Then touch **ENTER**. IdLE will appear. (Enter **9999** to turn alarm off.)

When the alarm sounds, shut it off by **ENTER**. (Do not press **STOP** to turn off the alarm.) If the alarm sounds as soon as the furnace or kiln begins firing, it is because the alarm was set to **0000**, or any temperature below room temperature.

Setting Alarm During Firing

1. The alarm beeps while the kiln is firing. Press **7.**
2. Enter the new alarm temperature.
3. Press **ENTER**. The kiln will continue firing.

Add Time

Pressing the "ADD TIME" key during a hold period adds 5 extra minutes to the hold period. To add time, press "ADD TIME", TIME will be displayed, then the temperature alternating with the new hold time.

Present Status: Current Segment and Circuit Board Temperature

"Present Status" displays the current segment of a firing and temperature of the circuit board.

Knowing which segment you are in is especially useful for firings with both heating-up and cooling-down segments. Present Status works with both Cone-Fire and Ramp-Hold. (See Cone-Fire firing schedules, page 6)

To use present Status, press **5** during a firing. The following information will display momentarily. Then normal temperature display will return:

1. Ramp (RA) or Hold (HLd) followed by segment number.
2. Travelling Set Point, the temperature the controller is trying to reach to maintain the correct rate of rise.
3. Circuit Board Temperature

High temperatures in the switch box can damage the controller circuit board. The circuit board is rated for 155^{O}F/68^{O}C maximum operating temperature. Maximum temperature for rated accuracy is 125^{O}F/52^{O}C. The circuit board can operate safely at 155^{O}F/68^{O}C, although a temperature less than 125^{O}F/52^{O}C is preferable. If necessary, exhaust hot air from the room to lower board temperature. When firing several kilns, position them at least three feet apart to allow adequate air circulation.

Checking Circuit Board Temperature from IdLE

1. Press **ENTER**.
2. Press **0** repeatedly until bd T (board temperature) appears.
3. Press **ENTER**. The board temperature will appear, followed by the firing chamber temperature.

Power Failures

The RTC 1000 handles a power failure in two ways:

1. An ERRP message, alternating with the firing temperature, means power was interrupted by a brief power outage. The firing will continue. Press **ENTER**, and normal temperature display will return.

2. PF display indicates that power was lost during a firing and the kiln temperature was below 140^{O}F (60^{O}C) or power was lost and the kiln temperature dropped more than 250^{O}F during the power outage.

To resume firing, press **ENTER** twice. The kiln will begin firing again from its present temperature. For example, the kiln reached 1000^{O}F/538^{O}C before power failed. When you turn the kiln back on, the temperature is 700^{O}F/371^{O}C. Firing will resume from 700^{O}F/371^{O}C. You do not need to cool the kiln to room temperature before starting over unless you use witness cones (See next section).

When you resume firing by pressing **ENTER** twice, the controller begins firing again from segment one. If the temperature is already higher than that of segment one, the controller skips to the next segment. When it finds a segment with a higher target temperature, it begins firing in that segment. For this reason, a power failure during a ramping down (cooling) segment can confuse the controller. When you resume firing, the controller will begin firing from a ramping up (heating) segment rather than the ramping down segment.

Firing Ceramics After an Extended Power Failure

1. The firing was interrupted below 100^{O}F/56^{O}C of maturity: Fire the ware again. It is okay to use the same partially fired witness cones, even if they cooled back down to room temperature. As long as the cones did not reach within 100^{O}F/56^{O}C of maturity.
2. The ware fired within 100^{O}F/56^{O}C of maturity: Fire the ware again but do not use same witness cones. Use new ones.

Thermocouple Offset (TCOS)

The thermocouple is the rod protruding into the firing chamber. It measures temperature. Thermocouples can "drift" as they age, causing inaccurate temperature readings. (This may be so slight that you won't notice it.) To calibrate the controller to compensate for drift, use "Thermocouple Offset".

***TIP:** Before using Thermocouple Offset, check that the thermocouple is protruding into the firing chamber by at least 1-$^{1}/_{2}$" to 2". Sometimes bumping a shelf against a thermocouple pushes it out of the firing chamber, thereby preventing accurate temperature readings.*

Thermocouple Offset for Ceramic Firings

In ceramics, Cone Offset (see page 7) adjusts each pyrometric cone without affecting the other cones. Thermocouple Offset, on the other hand, affects all cones equally, and all Ramp-Hold firings. A 5^{O}F hotter setting in Thermocouple Offset fires everything 5^{O}F hotter.

If you find that all of your cones are consistently under- or over-firing, adjust Thermocouple Offset. If you need to adjust only a particular cone, use Cone Offset.

Calibrating Thermocouple Offset with a Thermocouple Standard or Pyrometer.

A thermocouple standard is a device that calibrates pyrometers and controllers. If you do not have a thermocouple standard, you can calibrate Thermocouple Offset using a calibrated digital pyrometer. One way to calibrate your digital pyrometer is to take it to a heat treater or other location that has a calibrated controller you can trust. Take a reading with your pyrometer. Either zero it out to match the other heat source, or write down the temperature difference between your pyrometer and the reliable source. Store your pyrometer. Use it only for calibrating controllers. Thus, it remains a reliable calibration standard.

Adjust Thermocouple Offset to compensate for any temperature difference between the controller and the calibrated pyrometer or thermocouple standard.

Setting Thermocouple Offset

You can raise or lower the thermocouple offset from 1-50^{O}F/1-28^{O}C. If the kiln is firing too hot, place 00 before 01-50^{O}F/1-28^{O}C. If the kiln is too cool, place 90 before 01-50^{O}F/1-28^{O}C.

The following chart contains seven examples of Thermocouple Offsets. Program any temperature in the 01-50^{O}F/1-28^{O}C range, hotter or cooler, using these examples as a guide.

Thermocouple Offset Examples, ^{O}F

0001	Kiln will fire 1^{O}F Cooler
0030	Kiln will fire 30^{O}F Cooler
0049	Kiln will fire 49^{O}F Cooler
0000 or 9000	No Adjustment
9005	Kiln will fire 5^{O}F Hotter
9040	Kiln will fire 40^{O}F Hotter
9049	Kiln will fire 49^{O}F Hotter

* Thermocouple Offset works in ^{O}C the same as in ^{O}F. In the above examples, replace ^{O}F with equivalent ^{O}C.

Directions for Thermocouple Offsets:

1. From **IdLE**, press **ENTER**.
2. Press **0** repeatedly until **TCOS** appears.
3. Press **ENTER**. **^{O}FOS** (or **^{O}COS**) will appear, alternating with the current thermocouple offset. (Factory setting is 0000)
4. Enter the new offset (i.e. 9005). Press **ENTER**. **IdLE** will appear.

   *To reset Thermocouple Offset back to 0000, press **ENTER** then **0** until **RSET** appears, then press **ENTER**.*

Turning Off Error Codes (ERCd)

The RTC 1000 uses error codes to alert you to firing problems. In certain applications, it may be desirable to turn off some of the error codes.

For instance, error code **E-1** appears when temperature rises slower than 12^{O}F/12^{O}C per hour. (In Ramp-Hold, the temperature is also below the programmed temperature.) **E-1** may interfere when the door of the kiln is opened to remove certain materials, such as enameled pieces or heat-treated steel.

"Error Codes" **ERCd**, when set to OFF, turns off all error codes except **E-6**, **E-8**, **E-P**, and those dealing with hardware errors.

*During the last 250^{O}F/139^{O}C of a Cone-Fire program, the **E-1** code will become active again even when **ERCd** is turned off.*

Setting Error Codes ON or OFF

1. Press **ENTER** from **IdLE**.
2. Press **0** repeatedly until **ERCd** appears.
3. Press **ENTER**. **ON** or **OFF** will appear. Press **1** to change the setting.
4. Press **ENTER**. The display will show temperature and **IdLE**.

   ***RSET** (from MENU key) can turn on error codes*

Cost of Firing

The RTC 1000 is able to track the cost of firing based on the cost of electricity and the wattage rating of the kiln. Both of these numbers need to be entered into the RTC 1000 kiln controller. The cost of firing can be viewed at any time by pressing the Program Review key. If the Program Review key is pressed while the controller is in idle the controller will display the total cost of the last firing. If the Program Review button is pressed while a firing is in progress the controller will display the cost of the current firing up to that point in time. The cost of firing will be displayed immediately after the message **COST**.

1. Press **ENTER** key one time. The message **----** will be displayed.
2. Press **MENU** (0) key. The message **RECL** will be displayed.
3. Repeatedly press **MENU (0)** key until the message **COST** is displayed.

Press **ENTER** key. The display will alternate between **COST** and a four-digit number. Enter the price per kilowatt-hour of electricity in your area.

EXAMPLE: If price per kilowatt-hour is $0.071, enter 0071 into the controller.

Press **ENTER** key. The display will alternate between WATT and a four-digit number. Enter the wattage rating of your kiln divided by 10.

> **EXAMPLE:** If the rating of your kiln is 11650 Watts, enter 1165. If the rating of your kiln is 1450, enter 145.

Press **ENTER** key. The controller will return to idle.

FIRING COUNTER – The firing counter will help the user keep track of the number of firings on their kiln and help plan routine kiln maintenance. It is incremented five minutes into each firing. The number of firings can be viewed during a program review after the word FIRE.

Menu Quick Reference List

Pressing 8 (menu back) moves you backwards through this list.

1. RECL – Used to recall a stored user program.
2. RSET Sets the Thermocouple Offset to 0 and turns error codes on; page 9.
3. CHG° changes temperature read-out between °C and °F; page 7
4. ERCd Error codes: Turns errors off. Designed for applications where the furnace door is opened at high temperatures, such as heat-treating; page 9.
5. TCOS Thermocouple Offset: calibrates the thermocouple read-out; page 8.
6. bd T Board temperature: shows the temperature of the circuit board; page 8.
7. CNOS Used in Cone-Fire only: Cone offset; changes the temperature shut-off of individual cones; page 4.
8. PRHT Used in Cone-Fire only; Pre-Heat; page 4.
9. Id Identifies the kiln for interface with a personal computer. Used for K.I.S.S. (Kiln Interface Software System)
10. 16-S Used to set a 16 segment firing or add User 6 program to a conefire program for cool down. See page 9
11. COST Used to set electricity cost and watts.

RTC 1000 Cone-Fire Quick Reference

After you press the key(s) in the left column, the message to the right will appear. If after pressing **ENTER**, then **1**, only four horizontal lines appear, your controller does not have Cone-Fire.

THIS FIRING HAS NO DELAY FIRE AND NO ALARM SET. If the alarm sounds during firing, press ENTER.

KEYS TO PRESS	DISPLAY
Apply power to kiln	**WAIT then IdLE**
ENTER	**----**
1	**CONE**
Cone # of Choice	**05 Displays cone #**
ENTER	**SPd**
1 (Fast), 2 (Med.), or 3 (Slow)	**FAST, MEd, or SLOW**
ENTER	**HOLd**
Hold time	**00.00 Displays hold time (if any)**
ENTER	**IdLE and flashing temp.**
ENTER	**----**
ENTER	**-ON-**

RTC 1000 Ramp-Hold Quick Reference

After you press the key(s) in the left column, the message to the right will appear. If alarm sounds during a firing, press **ENTER**.

KEYS TO PRESS	DISPLAY
Apply power to kiln	**WAIT then IdLE**
ENTER	**----**
4	**USER / 1 etc.**
Select program 1-6	**1 etc. Displays # entered**
ENTER	**SEGS**
Number of segments needed	**1 etc. Displays # entered**
ENTER	**RA 1**
Temp. change per hour	**0200 etc. Displays temp.**
ENTER	**°F 1**
Final temperature, seg. 1	**2000**
ENTER	**HLd1**
Hold time (if any)	**00.00 (or hold time)**
ENTER	**RA 2 or ALRM**
Repeat for number of segments desired	
ENTER	**ALRM (Alarm temp.)**
Alarm temp (OFF= 9999)	**2000 etc. Displays temp**
ENTER	**IdLE and flashing temp.**
ENTER, ENTER	**-ON-**
Kiln is now firing.	

SELECT AND FIRE A STORED USER PROGRAM; NO DELAY FIRE

Apply power to kiln	**WAIT then IdLE**
ENTER	**----**
0	**RECL**
ENTER	**USER / 1 etc. (select program)**
1 through 6	**1 etc. Displays selected program**
ENTER	**IdLE**
ENTER, ENTER	**-ON-**

Kiln is now firing. (See separate program review instructions.)

Appendix A: Edit-on-the-Fly

Programming "on the fly" is the ability to make changes to the program while the kiln is firing. Programming on the fly allows great flexibility but there are precautions that must be taken into consideration, see Programming Cautions on next page.

Programming

Programming on the fly allows for changes to be made only to the current segment being fired. You can change the rate of rise, the soak temperature, the hold time, or any combination of these three. To check the current segment, press the "5" key, "PRESENT STATUS". If you are firing the segment you want to change, then press the "4" key, RAMP HOLD. rA followed by the current segment number will be displayed alternating with the current rate of rise. Make changes if desired and press ENTER or just press ENTER to proceed to the soak temperature. The soak temperature and the hold time can be changed similarly if desired.

After pressing ENTER for the hold length the controller will save the changes and return to firing. **These changes are permanent and they will be part of the program for all subsequent firings.**

If there is no key press for forty seconds after entering programming on the fly, the controller will return to the current firing without any changes.

Either after the final ENTER key press or if there is no key press, the controller returns to the ramp of the current segment. If you were in a hold, the controller will ramp to the hold again and rerun the entire hold period.

Following is a brief example of utilizing programming on the fly.

The RTC 1000 controller is currently in segment two that has the following data:

Rate of rise	500°F/hr
Soak temperature	1250°F
Hold time	10 minutes

The controller has not yet entered the hold for this segment but it is nearing the 1250°F soak temperature. The operator wishes to increase the soak temperature by 15° to 1265°F.

Pressing the RAMP HOLD key (4) brings up programming on the fly. Since the rate of rise is not going to be changed the ENTER key is pressed to skip to the soak temperature. The controller is now alternating between °F 2 and 1250. Key in 1265 and press ENTER. Press ENTER again since no change in the hold time is desired. These changes affect this firing and the changes are stored to the program for future firings.

KEYPRESS	DISPLAY	NOTES
RAMP HOLD	rA 2/0500	Begins the programming on the fly operation.
ENTER	°F 2/1250	No change made to rate of rise.
1	0001	Making changes to the soak temperature.
2	0012	
6	0126	
5	1265	
ENTER	HLd2/00.10	Soak temperature updated to 1265°F.
ENTER	Current temperature	No changes made to hold length and programming on the fly complete.

Edit-on-the-Fly Programming Cautions

This appendix lists situations that could arise from utilizing the programming on the fly feature. There are certain instances where programming on the fly could cause undesired effects or error codes. If you are unsure of how a change will affect the firing it is safer to not make any changes.

Continuous operation of the elements

If the kiln elements are heating when you enter programming on the fly they will remain on during the entire programming procedure. This means that the kiln will be heating at full power during the time you program. If no key is pressed and the kiln will heat at full power until the 40 second timeout period is complete.

Changing direction of ramping

It is possible to have the kiln go from an up ramp to a down ramp with the proper changes in the program. Although this could be the desired effect it is included as a programming caution to warn of the potential for its occurrence.

Error D (E-d) due to changing soak temperature

It is possible to alter the soak temperature and cause the controller to display E-d. E-d occurs whenever the kiln temperature is more than 100°F above the traveling set point. If the controller soak temperature is decreased to a value more than 100^{O} below the current kiln temperature, E-d may occur.

Error 2 (E-2) or Error 3 (E-3) from changing soak temperature

Either E-2 or E-3 may occur if after altering the soak temperature, the kiln temperature deviates from the travelling set point by more than 50^{O}F.

Appendix B: Hot keys during Firing

These keys can be pressed at any time during the firing:

#3 Key will run the amperage diagnostic routine displaying the amperage rating for each section of the kiln. If the kiln is not equipped with the optional current sensor all amperage readings will be zero.

#4 Key is used to change the parameters of the segment you are presently firing. See Appendix A.

#5 Key (PRESENT STATUS) displays the segment you are firing, the traveling set-point, and the board temperature.

#6 Key reviews the current program being fired.

#7 Key will allow the reprogramming of the alarm to either a low or high temperature alarm.

#8 Key turns on the decimal points so they work as pilot lights for the outputs. See “Three Dot Display: Power Monitoring” on page 4.

#9 Key allows you to skip to the next segment of the firing. See “Skip Segment” on page 9.

#0 Key displays the time that has elapsed since the start of the firing.

Appendix C: Error Codes

The error codes are displayed as an "E" followed by a "-" then a number or letter. For example "E-1" stands for error one.

NOTE: If you get an error code it is important to note the error letter or number. It will help in diagnosing any problem with the kiln.

The list of error codes follows:

THESE ERRORS WILL ONLY BE DETECTED IF ERROR CODES (ERCD) ARE ON:

Error Code	Description	Possible Causes
E-1	Kiln temperature increasing slower than 12°F per hour when ramping up	This is a kiln heating problem, not a controller problem. Do the Full Power Test to check elements and relays. Low or dropping voltage to the kiln could also be the cause. A thermocouple reading incorrectly or improperly placed may also be the cause.
E-2	Kiln temperature 50°F above hold temperature	A relay latched in the "on" position may cause this error. Another possible cause is if the kiln lid is opened for rapid cooling, then closed, such as for glass firings.
E-3	Kiln temperature 50°F below hold temperature	Relay failure.
E-4	Kiln temperature 50°F above previous hold when ramping down	Same causes as for **E-2**.
E-5	Kiln temperature 50°F below traveling set point when ramping down.	Relay failure.
E-d	Kiln temperature 50°F above traveling set point	Stuck relay or stuck output. If using zone control, then the outputs or t/c's may be in the wrong zones.

THE ERROR CODE SETTING DOES NOT AFFECT THESE ERRORS:

Error Code	Description	Possible Causes and/or Corrections
E-0	Software error	Check the selected program and reprogram, if necessary. If error persists or program does not hold in memory, controller may need to be returned to factory for service.
E-6	Problem with thermocouple leads	This generally indicates the thermocouple is connected incorrectly, possibly reversed. Ensure the thermocouple extension wires are connected correctly to the controller and at all connection blocks back to the thermocouple.
E-8	In cone fire mode, temperature decreasing in last segment	If the kiln has a kiln-sitter, it may have turned the kiln off before the controller did. Other possible causes are broken element or relay failure.
E-9	Software thermocouple selection does not match the hardware thermocouple jumper selection	The jumper on the circuit board and the setting for thermocouple TYPE in the software do not match.

E-22 or **E-26**	Error in readings.	Check for reversed thermocouple leads. If leads are correct, then the analog to digital converter on the circuit board may not be functioning and the controller may need to be returned to the factory for service.
E--	Power loss during EEprom write	Turn the controller off and back on. Recheck the selected program and reprogram, if necessary.
E-A	Invalid program variable	Reprogram all eight segments of the program being fired. If error persists, controller may need to be returned to factory for service.
E-bd	Board temperature too high	The control box temperature may be too hot or the limit temperature may need to be reset. If the room temperature is very hot, aiming a fan at the control box may decrease the temperature.
E-E	Hardware error	Controller will need to be returned to the factory for service.
E-R	Microprocessor memory does not match program storage memory (EEprom)	Reprogram and try to fire again. If error persists, controller may need to be returned to factory for service.
E-U	Invalid 16-segment firing attempted.	Reprogram and restart firing.
FAIL	Steady **FAIL** indicates all t/c's have failed. If **FAIL** alternately flashes with **TC 1**, then t/c one (top section) has failed. If **FAIL** alternately flashes with **TC 2**, then t/c two (middle section) has failed. If **FAIL** alternately flashes with **TC 3**, then t/c three (bottom section) has failed.	Check the board temperature in the Menu. If board temp displayed with bd T is approximately room temperature, then the t/c is defective. If bd T display shows a high temperature or **FAIL** without showing room temperature, circuit board is defective.
P-F	Power failure. Firing has stopped.	Power was lost during a firing and the kiln temperature was below 140°F or the kiln temperature dropped more than 250 degrees during the power outage.
STUC	Key was held too long or is stuck.	If problem persists after releasing key, controller may need to be returned to the factory for keypad replacement.

Full Power Test

The full power test is used to check the relays and elements of the kiln. Program a 1-segment Ramp-Hold program to go up as fast as possible to 1000°F with no hold (1 segment, RA1 9999, °F1 1000, HLd1 0000) or program a Fast Glaze program to cone 04. Leave the lid of the kiln open and start the firing. Visually inspect the elements after the kiln has fired for 10 to 20 minutes. Observe each element from where it comes into the kiln all the way around to see that it is equally bright throughout.

The following observations are possible:

One section of the kiln is dark and not going on. This indicates a defective relay since there is usually one relay per section.

One element is not glowing at all. This indicates a broken element.

There are darker (cool) spots along the elements. This indicates worn elements.

The top and bottom elements appear brighter. This is normal for many kilns that have hotter elements in the top and bottom.

After you have made your observations, turn off the kiln.

APPENDIX D - Firing Program Blank

Keep this page as a Master and photocopy as needed

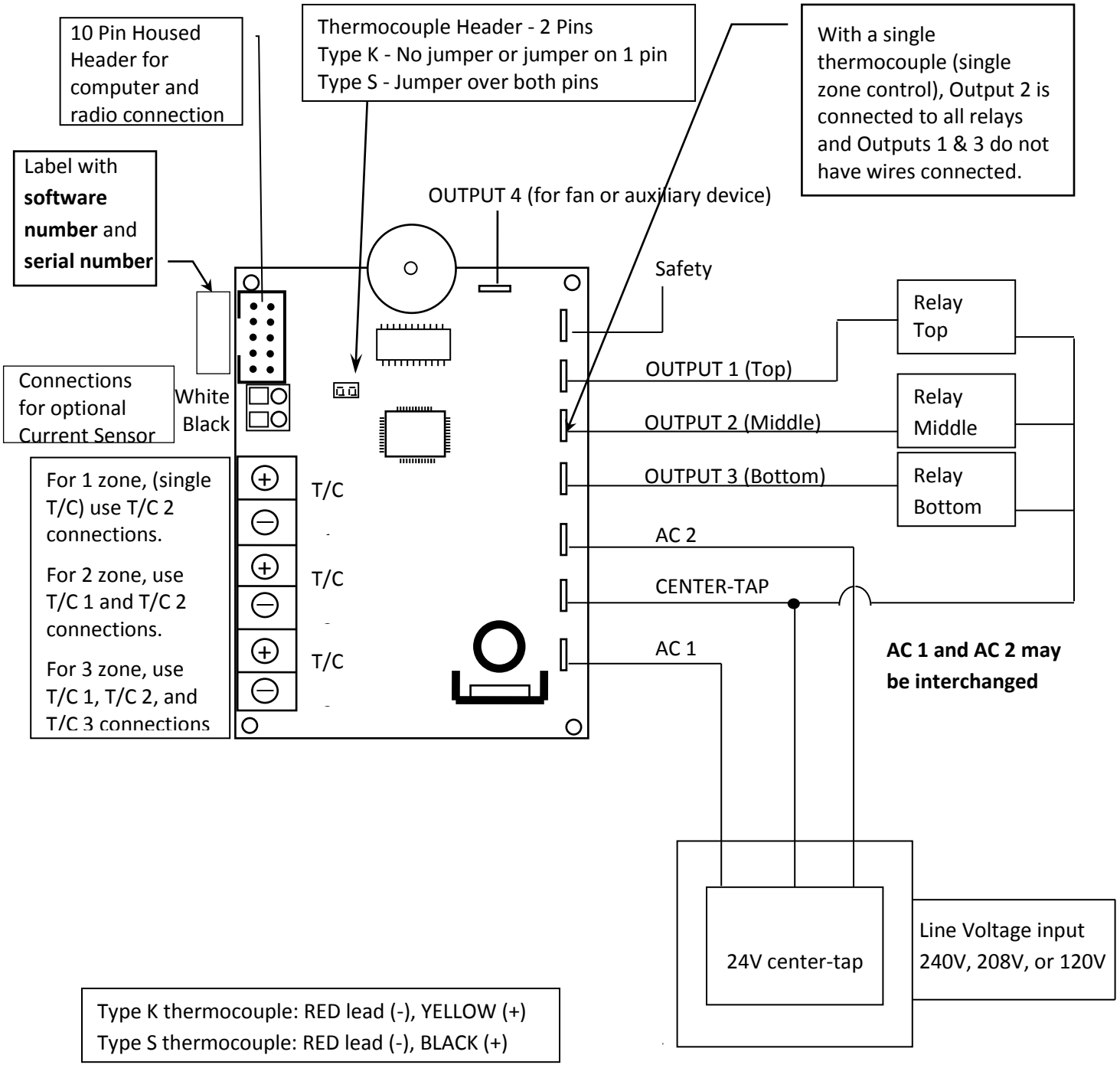
Firing Program Number: _____

Segment	Rate per Hour	Temperature	Hold
1			
2			
3			
4			
5			
6			
7			
8			

Firing Program Number: _____

Segment	Rate per Hour	Temperature	Hold
1			
2			
3			
4			
5			
6			
7			
8			

Connection Diagram - Series 700



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