

THERMOLYNE PROGRAMMABLE FURNACE

STANDARD OPERATING PROCEDURE

Purpose of this Instrument: anneal samples up to 1200 °C in air or nitrogen atmosphere via nitrogen purging.

Location: Engineering Science Building (ESB) Room G-75B

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The Shared Research Facilities are operated for the benefit of all researchers. If you encounter any problems with this piece of equipment, please contact the staff member listed above immediately. There is never a penalty for asking questions. If the equipment is not behaving exactly the way it should, contact a Shared Research Facilities staff member.

START UP

1. Sign in on the FOM. Write down your name and the process information on the log sheet.
2. Turn on the unit by pressing the red Power button (Figure 1) if it is not already on.
3. Check the chamber temperature reading (large display) on the 2404 controller (Figure 1). **If the chamber temperature is above room temperature, wait until it cools down to room temperature before loading the sample.**
4. Load your specimen into the process chamber. Close the chamber door.



Chamber
temperature
display

Figure 1: Furnace power button and the 2404 control unit

SINGLE SET POINT OPERATION (AUTOMATIC MODE)

NOTE: This process allows you to set the furnace to a set point temperature in automatic mode. You cannot define or modify the heating parameters. If you want to define heating/cooling process parameters, follow the Set Point Programming procedure in the next section.

1. Push the “Up” or “Down” button on the 2404 furnace controller to adjust the set point temperature (the lower readout value, Figure 2) to the desired value. Then release the button.
2. Select the Automatic Mode of operation by pressing the “AUTO/MAN” button to have AUTO light on.
3. The furnace will begin to heat if the new set point temperature is higher than the current chamber temperature (the upper readout value, Figure 2).
4. When finished using the furnace for the desired heating duration at set temperature, turn down the furnace by adjusting the set point temperature to 20 °C.

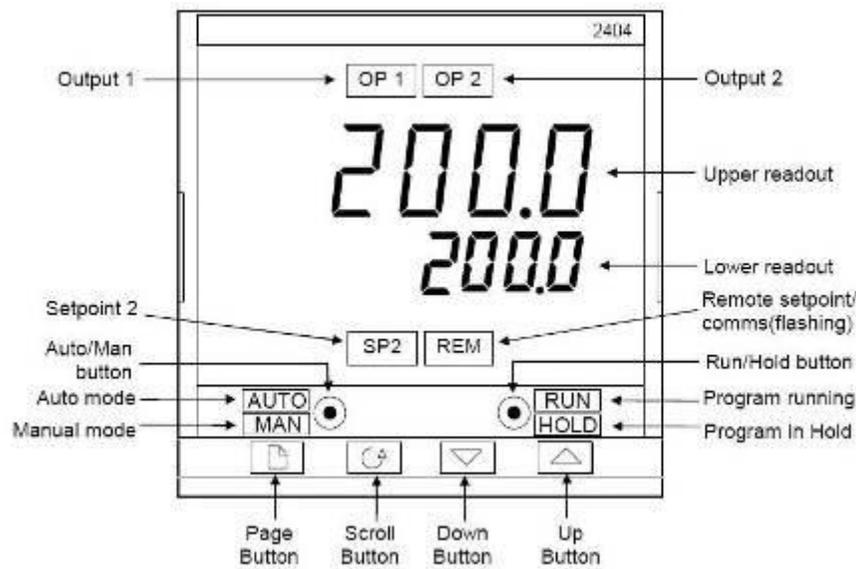


Figure 2: Furnace controller front panel layout

SET POINT PROGRAMMING (MANUAL MODE)

Note: Use the set point programming if you want to control the heating, dwell and cooling processes. A sample program is shown on page 5. You can set up to 8 segments for the process with the following five types of segment:

- Ramp:** the setpoint ramps linearly from current value to a new value either at a set rate (ramp-rate-programming) or in a set time (time-to-target programming)
- Dwell:** the setpoint remains constant for a specified period
- Step:** the setpoint steps instantaneously from its current value to a new value
- Call:** the main program calls another program as a subroutine
- End:** the program either ends in this segment or repeats

1. From the home display, press the “Page” button until you see the “ProG List” shown.

2. Press the “Scroll” button to set the Program Number (Pro.n). Use “Up” or “Down” button to select the program number that you want to modify (from 1–4).
3. Press the “Scroll” button to set the Holdback Type (Hb) (options: OFF, Lo, Hi, bAnd).
4. Press the “Scroll” button to set the Holdback Value (Hb U).
5. Press the “Scroll” button to select Ramp Units (rmP.U). Use “Up” or “Down” button to select Sec, min or Hour.
6. Press the “Scroll” button to select Dwell Units (dwL.U). Use “Up” or “Down” button to select Sec, min or Hour.
7. Press the “Scroll” button to set the Number of Program Cycles. Use “Up” or “Down” button to set the number of program cycles from 1 to 999, or ‘conT” for continuous cycling.
8. Press the “Scroll” button to the Segment Number (SEG.n) page. Use “Up” or “Down” button to select the segment number 1.
9. Press the “Scroll” button to the Segment Type (TYPE) page. Use “Up” or “Down” button to select the segment type.
 - rmPr: Ramp to a new setpoint at a set rate
 - rmPt: Ramp to a new setpoint in a set time
 - dwEl: Dwell for a set time
 - StEP: Step to a new setpoint
 - End: Make this segment the end of the program.
10. Press the “Scroll” button to select Holdback Type (TYPE); (only appears when Holdback per segment has been selected).
11. Press the “Scroll” button to select Target Setpoint (tGt) for ‘rmP.r’, ‘rmP.t or “StEP” segments. Set the target setpoint using the “Up” or “Down” buttons.
12. Press the “Scroll” button to select Ramp Rate (rAtE) for ‘rmP.r’ segment. Use “Up” or “Down” button to set a value for the ramp rate from 0.0 to 999.9. The unit is the ramp units (rmP.U) previously set in step 5.
13. Press the “Scroll” button to set Duration Time for a ‘dwEl’ segment or time to target for an ‘rmP.t’ segment. Set the time using “Up” or “Down” button. The unit is the Dwell Units (dwL.U) or the Ramp Unit (rmP.U) previously set in steps 5 and 6.
14. Press the “Scroll” button to the Segment Number (SEG.n) page. Use “Up” or “Down” button to select the segment number 2.
15. Repeat steps 9-14 to define additional heating/cooling/dwell segments. You can set up to 8 segments for the process.
16. Press the “Scroll” button to go to the End Segment (End.t) page. Use “Up” or “Down” button to select:
 - dwEl: an indefinite dwell
 - rSEt: reset
 - SOP: end segment output power level.

17. Press the “Scroll” button to the Power Value [End segment] page. Use “Up” or “Down” button to set the power value in the range of $\pm 100.0\%$.
18. Press the “Scroll” button to return to the ProG-List header.

START THE PROGRAM

1. Press “Page” button to select the Run List (run List).
2. Press “Scroll” button to select Program Number (Pro.n). Use “Up” or “Down” button to select the program to run.
3. Press “RUN/HOLD” button once to start the program. The RUN light will be on.
4. You can hold a program by pressing the “RUN/HOLD” button again (HOLD light on). Press the button again to cancel hold and continue running.
5. Press “RUN/HOLD” button and hold in for two seconds to reset the program (RUN and HOLD lights off).
6. At the end of the program, the RUN light will flash.

SHUT DOWN

1. Set the furnace temperature setpoint to 20 °C when finished. The system should be left at this temperature when idle.
2. Wait until the chamber cools down to room temperature before removing the specimen.
3. Unload the specimen from the chamber. Close the chamber door.
4. Log off your session on the FOM.
5. Sign out on the log sheet. Report any problem in the comment section and fill out the Service Request Form.
6. Clean up the working area before leaving the room.

EXAMPLE OF HEATING/COOLING PROGRAM

In this program, the program #1 is modified to perform the following heating/cooling processes:

- (1) heat up to 100 °C in 10 min;
 - (2) hold at 100 °C for 30 minutes;
 - (3) ramp to 400 °C at a rate of 10 °C/min;
 - (4) hold at 400 °C for 60 min;
 - (5) ramp down to 50 °C in 60 min.
1. Press “Page” button to reach “ProG LiSt” header.
 2. Set PrG.n to 1 % modify program number 1
 3. Set Hb to OFF % No hold back

 4. Set rmP.U to “min” % ramp unit min
 5. Set dwL.U to “min” % dwell unit min
 6. Set CYC.n to 1 % one cycle

- 7. Set SEG.n to 1 % program segment #1: ramp up to 100 °C in 10 min
- 8. Set tYPE to rmP.T % ramp to set point in a set time
- 9. Set tGt to 100 % target temperature 100 °C

- 10. Set dur to 10 % time to target 10 min
- 11. Set SEG.n to 2 % program segment #2: dwell at 100 °C for 30 min
- 12. Set tYPE to dwEll % set type to dwell

- 13. Set dur to 30 % 30 min dwell time
- 14. Set SEG.n to 3 % program segment #3: ramp up to 400 °C at 10 °C/min
- 15. Set tYPE to rmP.r % ramp up to set point at a set rate

- 16. Set tGt to 400 % target temperature 400 °C
- 17. Set rAtE to 10 % ramp up rate 10 °C/min
- 18. Set SEG.n to 4 % program segment #4: dwell at 400 °C for 60 min

- 19. Set tYPE to dwEll % set type to dwell
- 20. Set dur to 60 % 60 min dwell time
- 21. Set SEG.n to 5 % program segment #5: cooling down to 50 °C in 60 min

- 22. Set tYPE to rmP.t % ramp down to set point in a set time
- 23. Set tGt to 50 % target temperature 50 °C
- 24. Set dur to 60 % time to target 60 min

- 25. Set SEG.n to 6 % program segment #6: end the program
- 26. Set End.t to SOP
- 27. Set Pwr to 0.0 (or End.P)

EMERGENCY PROCEDURES

If no one is available and the machine is not acting as expected, the user should do the following:

- Turn **OFF** the power, switch located on control panel.
- Send an email describing details of the issue

Do not leave the machine running in an abnormal state. If the machine cannot be placed in **STANDBY MODE**, immediately contact:

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If it becomes necessary to leave the instrument then the user should leave a large, legible note on the **Programmable Furnace Tool** stating the tool is **DOWN**.

If a dangerous situation is evident (smoke, fire, sparks, etc.), the user should turn off the system, ONLY if it is safe to do so. The user should notify all other clean room persons within the clean room to evacuate and leave the clean room immediately. The user should then contact proper emergency personnel from a safe place. The contact numbers can also be found posted outside of the clean room.