Lindbergh Vacuum Tube Furnace (20 – 1100° C, <10^{-7} Torr base pressure)

You may use this furnace only after training from facility staff. Due to modifications, proper use may deviate slightly from below. Reserve the furnace in CCMR Coral and be sure to enable and disable when you start and finish.

Maximum temperature can be 1100° C with little/no hold time. Ramp rates >50° C/min may overshoot your setpoint temperature so lower ramp rates may be desired.   Control is achieved using the furnace air temperature; note that due to absorption of radiation sample temperature may be up to 50° hotter than the furnace temperature during heating.

Anything that will go inside the furnace should only be touched while wearing gloves.

Finger tighten flange bolts and not wrench-tighten more than 1/8 turn (45°). Wrench-tightening more than this can damage the tube and the turbo pump.

To load/unload samples (parts labeled on system with line numbers below):

1) Turn Ion Gauge off if necessary (MENU, IG OFF, ENTER).
2) Close turbo gate valve (2) by cranking handle, about 10 turns. Make sure it closes fully and CLICKS into place.
3) Close the turbo foreline valve (3).
4) SLOWLY open the vent valve (4), ~1 turn. Opening too quickly can cause the baffles to move.
5) When the tube is vented:
    a. Close the vent valve.
    b. Unscrew the 4 nuts holding flange at the right end of the tube and remove flange.
    c. Remove the right baffle from tube.
    d. Remove or load samples into the hot zone of the tube.
    e. Re-insert baffle.
6) Put door flange back on and only ***finger tighten*** the four nuts.
7) To pump out tube:
    a. SLOWLY open roughing valve (7), ~2-3 turns only.
    b. Wait for pressure to go < 1 torr (yellow/black capacitance gauge; note range change at 1 torr).
    c. Close the roughing valve (7).
    d. Open foreline valve (3), ~ 2 or 3 turns only.
    e. Crank open turbo pump gate valve (2).
    f. ***Finger-tighten*** nuts on flange door again.
    g. Use wrench to tighten nuts, no more than 1/8 turn (~45°)
    h. Turn on ion gauge (MENU, IG ON, ENTER).
8) Close the furnace lid. Put up sign stating furnace is in use.
9) Pump for an appropriate time before heating. Overnight pump-down should enable < 10^{-7} torr pressures. Make sure the fans are cooling both ends of the tube before heating.
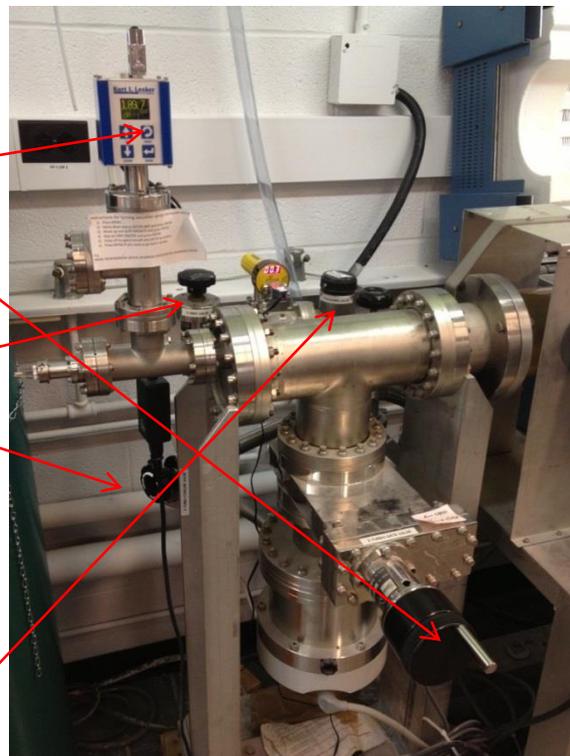
**Furnace programming instructions on separate sheet**

To program the furnace and run:

The manuals for the 3200 series controllers and iTools are each provided on the computer desktop. The top line on the controller indicates the current temperature (see note at top of first page) and the bottom line indicates the working setpoint, as well as (when applicable) the current control status.
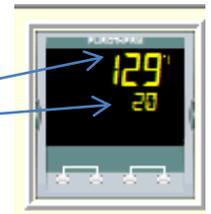
Timer operation (most commonly used) to set up and run a timer program with up to 4 ramp/soak steps. **If iTools is running skip to step 4 or 5.**

1) Open iTools Engineering Studio.
2) Click **Scan** and then **OK** to scan the default communication address range (the controller is at address 1). This will establish communication with the 3204, and an image of its front panel will appear at the bottom of the window.
3) Click the **Device Panel** icon. The panel view in the software now mimics all manual functions of the physical controller buttons and duplicates the controller indicators. The physical buttons may still be used if desired.
4) Right-click the **TIMER** folder in the **Browse** tab and select **Parameter Explorer** to open the window at right. This mode is analogous to the program mode on the previous controller.
5) A timer program may consist of up to 4 ramp/soak steps. Each STEP (1-4, indicated by "#") consists of:
   o a setpoint (**TimerSP#**), in °C
   o a ramp rate (**TimerRamp#**), in °C/min
   o a dwell time (**TimerDwell#**), enter in hours, minutes, seconds
   o To edit a parameter, double-click its value (or click the icon to its right to expand options) and type the new parameter value. To step rather than use a controlled ramp, enter 0 for the ramp value.
6) After the last desired step, set the following step to a setpoint of 20 or less, and a ramp of **OFF (0)**.
7) Pressing the △▽ buttons simultaneously on controller (or equivalent icon on computer) does the following:
   a. First press RUNS the timer.
   b. Second press HOLDS the run at the current SP, pressing again continues running.
   c. Holding down for >1 second cancels the run and goes to the preset setpoint.
   d. You will see the STATUS line (address 23) update from **RES(0)** to **HOLD(2)** to **RUN (1)** and you can change the status line instead of pressing the arrow buttons.
8) Note that a dwell timer begins when the working setpoint (not the measured temperature) reaches the TimerSP# value. This threshold may be changed; consult the 3200 series manual for details.
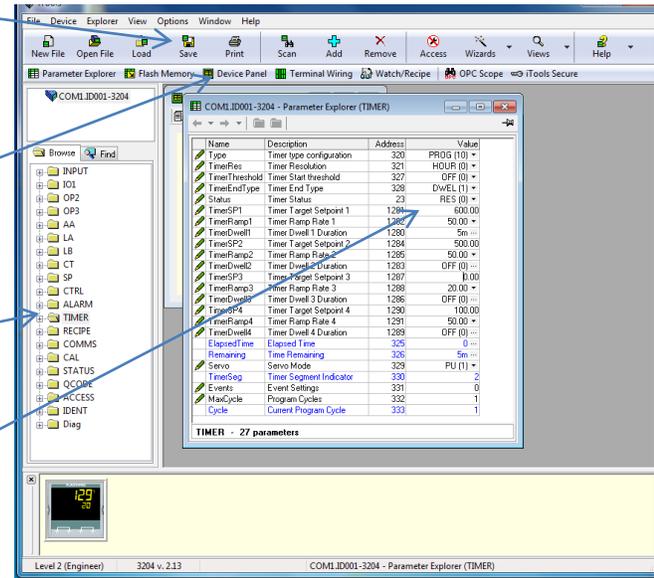
Data logging and real-time graphical view:

The OPC Scope module of iTools allows any controller parameter(s) to be fed into a real-time graphical display and/or a .csv data file. To open OPC Scope, click the **OPC Scope** icon in iTools. On the left side of the window, expand **COM1** and then **ID001-3204**. The resulting folder tree matches the **Browse** tab of iTools and gives access to the same parameters.

- Double-clicking a parameter adds it to the List and Chart (alternate tabs) on the right.
- Useful parameters for logging include:
   o the current thermocouple reading (**INPUT - PVInValue**)
   o working setpoint (**SP - WorkingSP**).

- o target setpoint (**SP** - **TargetSP**)
- Right-click on the chart and click **Show Chart Control Panel** to change the chart view parameters. Click **Save…** or **Copy Chart** to capture the chart as an image. When **Enable Review of Historical Data** (icon with 4 arrows) is on, you can zoom in on data by clicking and dragging.
- Click the watch icon ("Set update interval for all items") in the toolbar to adjust the data update rate.
- To save numerical data, click the tape icon ("Start data logger") to initialize a new data file. This will be a comma-separated text file with one column for time (in date/time of day format) and one column for each active parameter in the list/graph. Note that all data will save while logging is active, regardless of the time window in the real-time graph. Click the icon again to stop logging.

Setpoint operation:

- To simply go to a setpoint at full output (note – this may cause significant overshoot), you can adjust the setpoint by clicking (or clicking and holding) the up or down arrow button.
- Alternately, you can use the **Browse** tab on the left edge of iTools, expand the **SP** functions folder, and double-click **SP1**. Type in the desired setpoint and click **OK**.

(See reverse for how to log temperatures for verification purposes)

Recipes:

Up to 5 recipes can be stored in the controller memory. A recipe is simply a saved set of operating parameters, so we will use these to save timer programs. When creating or changing a recipe, please record the parameters used in the "Recipe Parameters" spreadsheet on the desktop, and record your name and date of most recent use. If no open slots are available, please over-write the recipe which has been used least recently. There are only two parameters for recipes, each of which are accessed via the **RECIPE** folder in the **Browse** tab.

- To save an active timer as a recipe, double-click **RecipeSave** and choose a slot to assign the program.
- To access a saved recipe, double-click **RecipeNumber** and choose the slot of the desired program. Note that if the recipe was saved while in **RUN (1)** status, opening it will cause it to immediately run.

Remote access:

The computer may be accessed remotely via TeamViewer. This can be useful for controlling and/or monitoring a process in progress or for transferring data files. To access the computer, start TeamViewer 7 and note "Your ID" (always 143 109 082) and the password (regenerates with each computer restart). Then, using TeamViewer7 (available for free download) on your computer, use the "Control Remote Computer" function and enter the access info.