MFD Thermal Process Controller Manual

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Draw a picture of the part or assembly that will be baked and illustrate each thermocouple and heater tape location. Number the heater tape and thermocouple connections for reference. This will be the master wiring diagram for programming and diagnoses of the bake. (Disregard heater tape if oven is used).

1) READ through Steps 2 through 4 at least once before hooking anything up.

Preparation:
For a well-controlled bake out you must:

a) Use multiple heater tapes for multiple thermal masses.

b) Use at least two TC's per heater tape. (This will help keep the bake running in the event that a thermocouple fails, falls off, or the heat distribution is uneven.)

c) When the TC's are properly connected, the temperature fluctuation of an individual channel should be less than 1.0°C. In order to avoid excessive (i.e. >3-5°C) electrical noise and ground loops, the thermocouples must be electrically insulated from the system. The tips must be covered with Kapton tape. (Noise will filter back through any TC that is left grounded to the system.)

d) Do <u>not</u> place any TC directly under a heater tape. This can have a detrimental effect on the control system feedback and will definitely contribute to the aforementioned electrical noise.

e) Test TC's prior to use.

f) For an oven Bake out - Check each heater elements power connection at both ends of the heater rod. Heating and cooling of the rod may cause the rod to shift and short to ground.

2) PLAN A Heater Tape Bake out (pre-bake out set up).

Sketch <u>desired</u> system setup **before** attaching any thermocouples (TC's) or heater tapes (HT). Include location(s) of at least one interlock TC.

PLAN B Oven bake out

a) Plug in gray oven control cable into Thermal Process Control Patch Panel power relay 24vdc channel 1-6, and the other end to relay controller. (Located on the side of the oven).

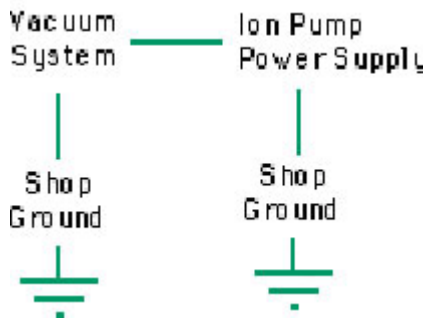
b) Plug in fan to 110V AC outlet on top of oven lid.

c) Attach a minimum of two TC's plus over-temp TC to object to be baked. Sketch a diagram showing location of thermocouples. (Extra TC's are always a plus due to noise and failure).

d) Verify oven box controller is switched to the following positions:
   a. Disable vacuum mode (up position).
   b. LabView mode (up position).
   c. There should not be anything plugged into the vacuum over pressure connector.

e) Set high temperature trip on oven box. **Note: the Omega readout is in degrees Fahrenheit**.

3) CHECK SYSTEM GROUNDING and VERIFY ION PUMP OPERATION



4) CONNECT THERMOCOUPLES TO CONTROLLER

a) Use Type K thermocouples only (yellow +, red -).

b) Make sure the TC's are electrically insulated from the system.
   Use Kapton or fiberglass tape on the tips.

c) Check entire thermocouple for wear and shorted wires.

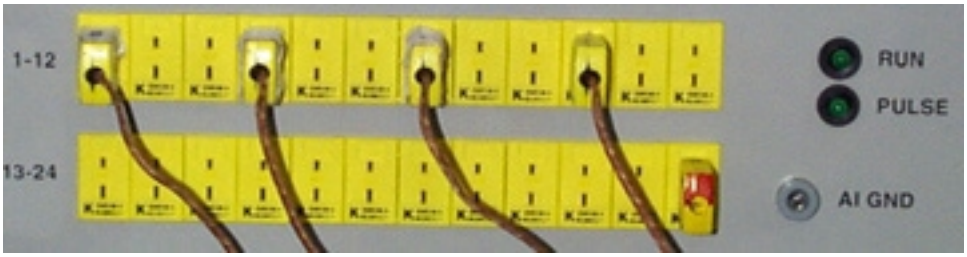
d) Connect over temperature TC to interlock chassis.

e) Plug in TC's starting with Slot #1. Don't leave any open slots between TC's. When finished, insert one dummy (shorted) TC immediately following the last "real" TC.

RIGHT

EXAMPLES OF <u>INCORRECT</u> THERMOCOUPLE CONNECTIONS

WRONG



WRONG

WRONG

5) CONNECT HEATER TAPES TO CONTROLLER (OVEN BAKE PROCEED TO STEP 6)

a) Check <u>each</u> heater tape circuit for continuity. Circuit resistances measuring less than 18 Ohms will probably blow a fuse.

b) Circuits are designed for 8A. (Use 8A fuses, SLAC stores 59-315-121-11).

c) **Wait** to install fiberglass or thermal blankets until the controller has been programmed and tested.

6) TURN ON CONTROLLER RACK POWER IN THE FOLLOWING ORDER

a) Verify 110v power cord is plugged in.

b) Power strip.

c) UPS (uninterruptible power supply).

d) Thermal Process Control Controller Interlock Chassis.

e) SCXI.

f) If you plan on printing over the network or monitoring the bake out remotely, check that the Ethernet cable is connected. If the rack has been moved to a new location, the printer selection in NT might need to be changed. For help, contact the network administrator. (Ethernet cable is normally white but can be Blue, Pink or yellow depending on location of connection. It has an 8 conductor modular connector).

g) Computer.

7) INTERLOCK SYSTEM

Check that all components of the interlock system are functioning properly and will trip the interlock chassis when faulted.

a) Turn off filament on gauge controller. (interlock chassis should fault).

b) Turn on gauge filament and reset interlock chassis by pressing the reset button.

c) Unplug TC from interlock chassis. (interlock chassis should fault).

d) Plug TC back in and reset Omega by pressing reset button.

e) Reset interlock chassis by pressing the reset button.

f) If using the oven set its Omega to 50^0F to verify it trips, return to original setting and reset.

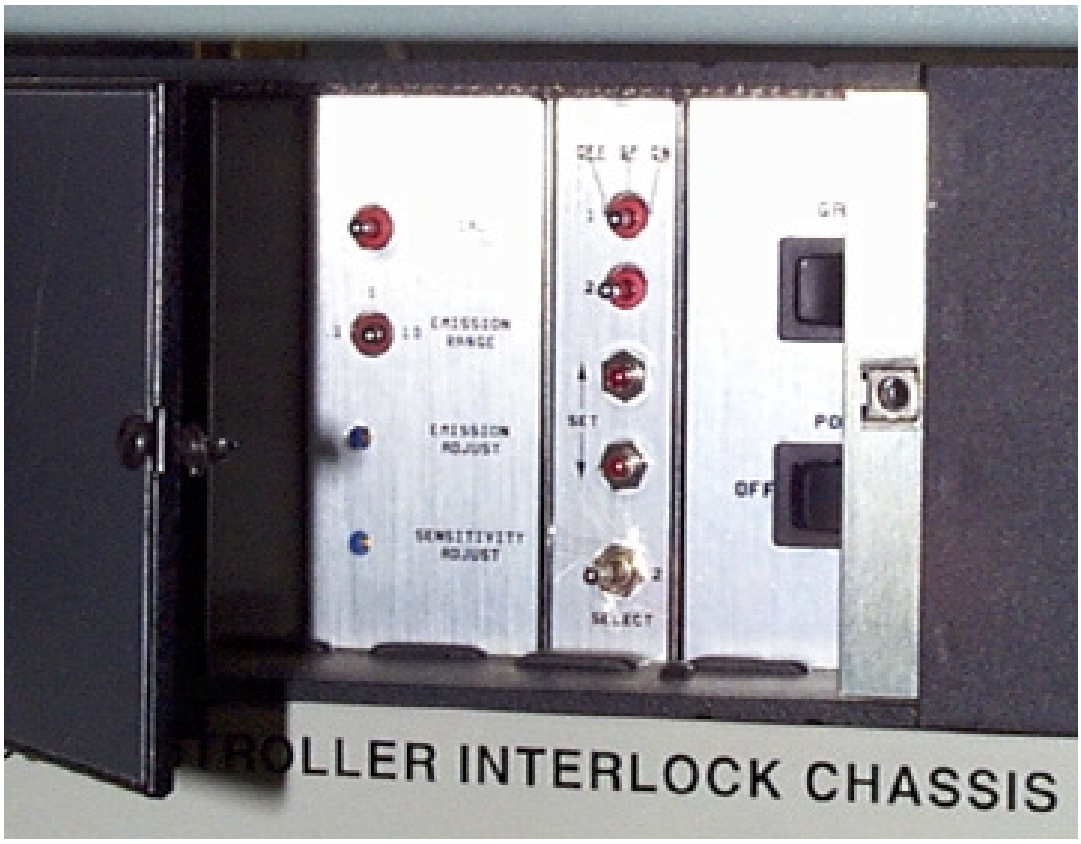
g) Set interlock trip temperature 20-30 degrees higher than the software limits on the Omega CN375-KC controller on the Thermal Process Control Interlock Chassis.

h) GP330 Ion gauge controller

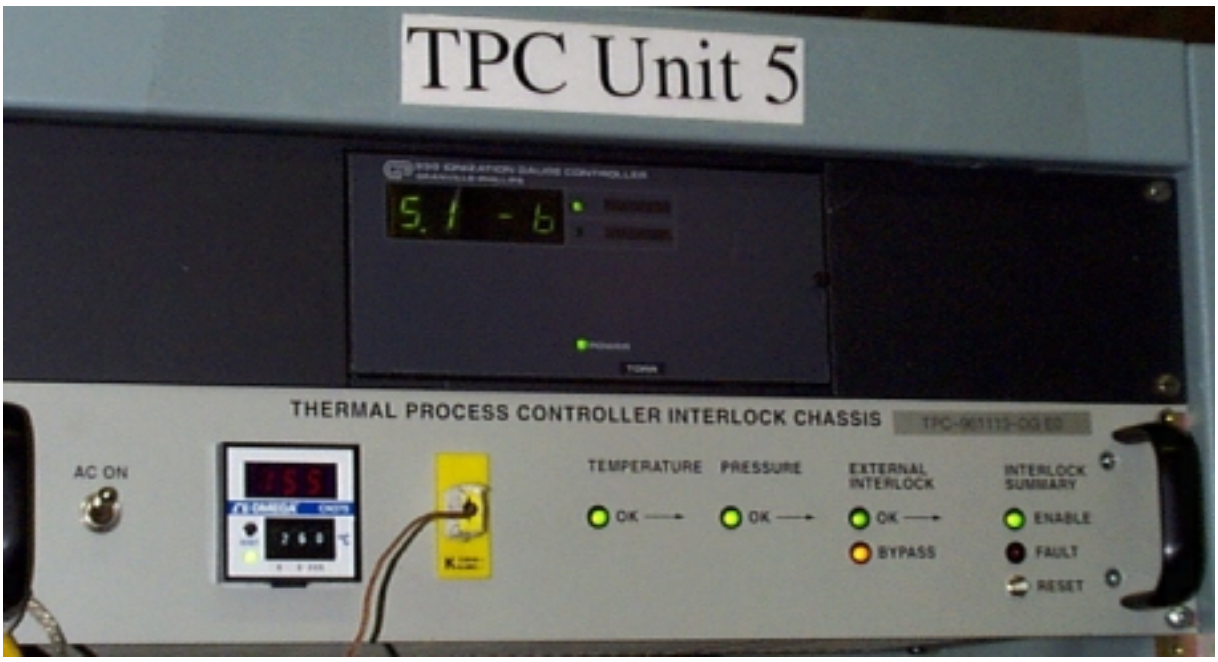
i) Check trip level on GP330 select channel one and two. (Default should be 1.0e-05 Torr) press either the *SET* up or down button to display the trip level.

ii) Verify the positioning of the following toggle switches.
   a) Cal in center position.
   b) Emission range in right position.
   c) 1 (one) in center position (SP).
   d) 2 (two) in center position (SP).
   e) Select in the right position (two).

Refer to the 330020 Ion Gauge Controller Instruction Manual for further details.



When testing of the GP330 and the Omega 375 controller is complete, verify green ENABLE on front of interlock chassis.

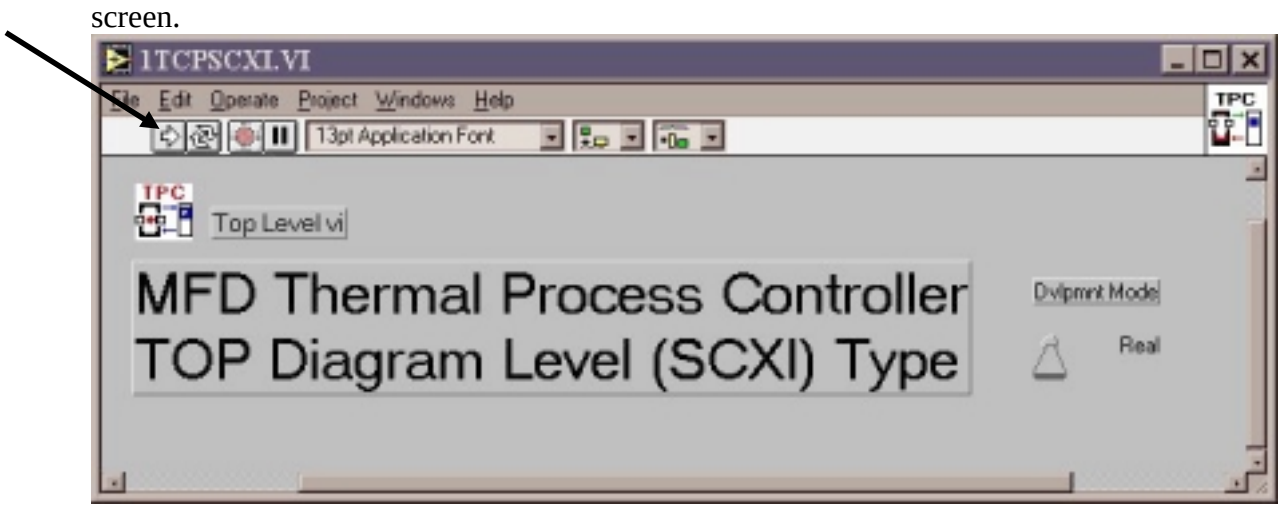


8) START TPC PROGRAM

a) Once Windows NT is loaded, double-click on the TPC icon or find it on the “START” Menu (lower left-hand corner).

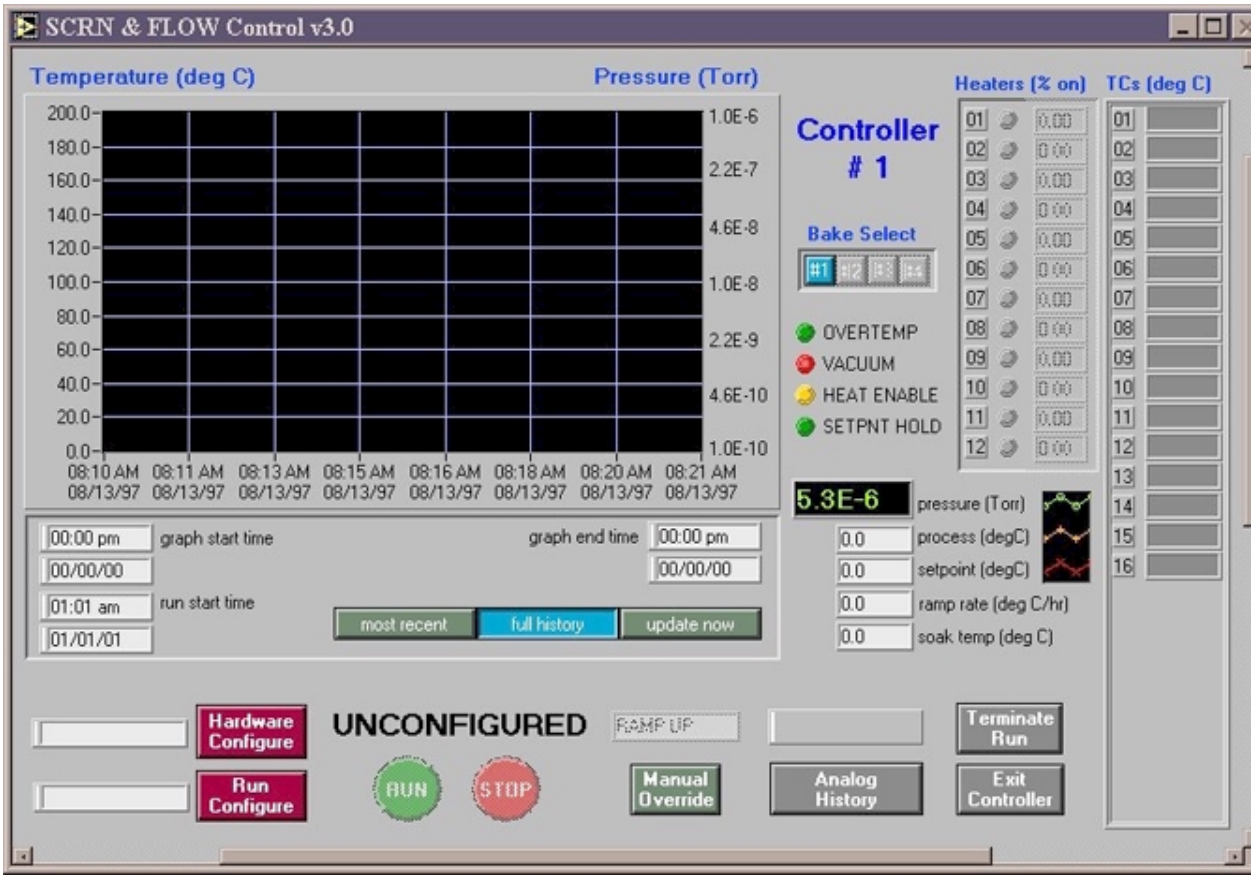
b) Wait for Lab View to load.

c) If the TPC program loads, but does not start automatically, press the arrow in the upper left-hand corner of the top-level LabView screen.



9) PROGRAM LOADED SUCCESSFULLY

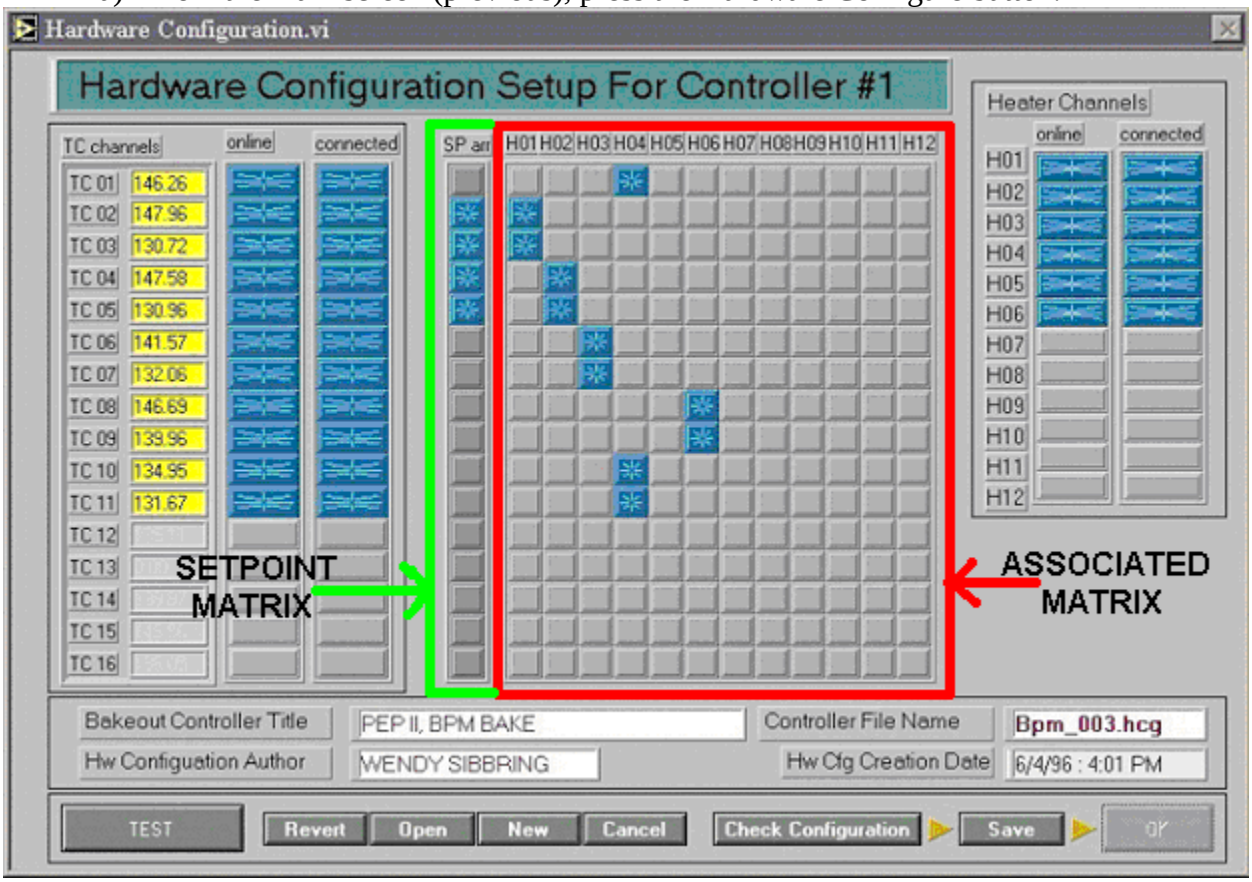
a) The controller program should now be on the screen (UNCONFIGURED).



b) Check that GP330 analog agrees (+- 0.5) with reading on computer screen. If you get a non-real number, make sure that the SCXI chassis is turned on; it's the box-shaped unit under the keyboard.

10) HARDWARE CONFIGURATION.

a) From the main screen (previous), press the Hardware Configure button.



b) Press the TEST button to make sure all of your TC's are reading properly. If you get non-real numbers, make sure that the SCXI chassis is turned on; it's the box-shaped unit under the keyboard. **It is a good idea to try and heat (or cool) each TC and observe a response**.

c) Press TEST again when complete.

d) Click boxes of the connected, and click the boxes of the online TC's.
   Connected: TC's that are physically plugged into the thermal process control patch panel.
   Online: allows the computer to track and readout on graph of TC.

e) Fill in associated matrix, clicking H01, H02 in relation to which TC's they control. Click heater channels that are being used online and connected.
   Connected: Heaters that are physically plugged into the heater tape relay chassis.
   Online: allows the computer to track and readout on graph of heater.

When using the oven, heater one will control oven and should be online and connected. Fill in associated matrix using heater one only.

f) Determine the set point (SP) matrix. The bake <u>will not run</u> if this matrix is left empty. Check the SP box for those TC's that will best represent the average temperature of the system to be baked. Unless the system contains components with very similar thermal masses and temperature limit requirements, it is not smart to click SP for all of the TC's. (Note: the orange PROCESS temperature displayed on the main screen is the average of all TC's with SP selected).

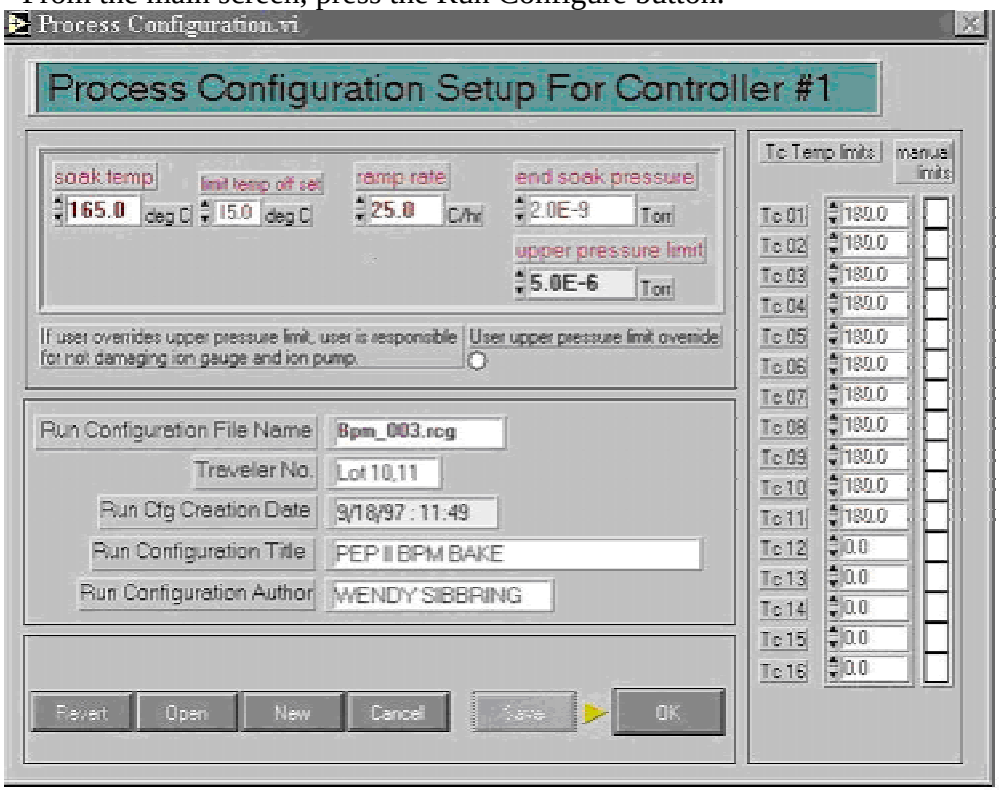
g) Fill in the following text fields and change the filenames.
   1. Bake out Controller Title.
   2. Hw Configuration author.
   3. Controller file name (note: this must be renamed every bake or it will overwrite the previous bake out data, and must end in **.hcg**).
   4. Hw cfg Creation date will automatically update.

h) When finished, press Check Configuration, Save, OK.

11) MAIN SCREEN (The Hardware Configuration button should now be green)

12) RUN CONFIGURATION *(or Process Configuration)*

a) From the main screen, press the Run Configure button.



b) Enter SOAK temperature, RAMP RATE, and end soak pressure. (This information is to be provided by the Supervisor).

c) Set limit temp offset. A minimum offset of 15°C (default) is necessary for proportional control.

d) The default upper pressure limit is 5.0E-06 Torr. When the vacuum system reaches this pressure, the computer will turn off all heater tapes until the pressure comes back in tolerance. To run the ion pump at a higher limit, the user can override the default value; however, the GP330 will trip the interlock chassis at 1.0e-05 Torr.

e) Fill in the following text fields and change the filenames.
   Run configure file name (note: this must be renamed every bake or it will overwrite the previous bake out data, and must end in **.rcg**).
   Run cfg Creation date will automatically update.
   Run configuration Title.
   Run Configuration Author.

f) When finished, press Check Configuration, Save, OK.

13) MAIN SCREEN (Both Hardware and Run Configuration buttons should be green. Display should read CONFIGURED).

14) PLAN A HEATER TAPE BAKE OUT

a) Locate POWER RELAY CHASSIS.

b) Connect extension cord to the back of the unit to 208 VAC (3 phase, 30A).

c) Turn on both power switches on the front panel.

d) Verify that the cooling fans are spinning in back of unit (one fan per switch).

PLAN B OVEN BAKEOUT

a) Verify the lid is on and plug in two 208V oven base extension cords to wall outlets.

15) START BAKEOUT

a) Check the interlock system again.

b) Click the RUN button.

c) Watch for 10-15 minutes to make sure system is operating properly. Progress should be monitored periodically to ensure that no errors have occurred. It is quite possible to make an error in the hardware configuration that enables the computer system to

overheat the process until the interlock chassis trips it off (e.g. assigning TC#6 to HT#2 and TC#9 to HT#3 when it should be the other way around).

16) COMMON MISTAKES

If the bake out is trying to ramp up but the thermocouples aren't responding:

a) Verify that the interlock chassis is "made-up" and that the auto dialer or a jumper plug is connected to the back of the patch panel (J08).

b) Check that the set point (SP) matrix in the Hardware Configuration has been defined.

c) Check that the power relay chassis has 208V power.

d) Check that the SCXI chassis is ON.

e) Verify 24V controller enable cable form interlock chassis to thermal process control patch panel interlock input is connected.

If certain channels seem to be out of control:

a) Check the physical connection of the heater tapes to the power relay chassis. (Make sure that heater tape 3 is really plugged into channel 3.)

b) Check the hardware configuration. (Make sure that the TC's are connected correctly to the heater tapes in the hardware configuration matrix.)

c) Check that the TC signal is a reasonable value. (The TC might be shorted or could have fallen off the system.)

17) TO PRINT GRAPH

a) Use the analog history buffer.

b) Click on Analog History.

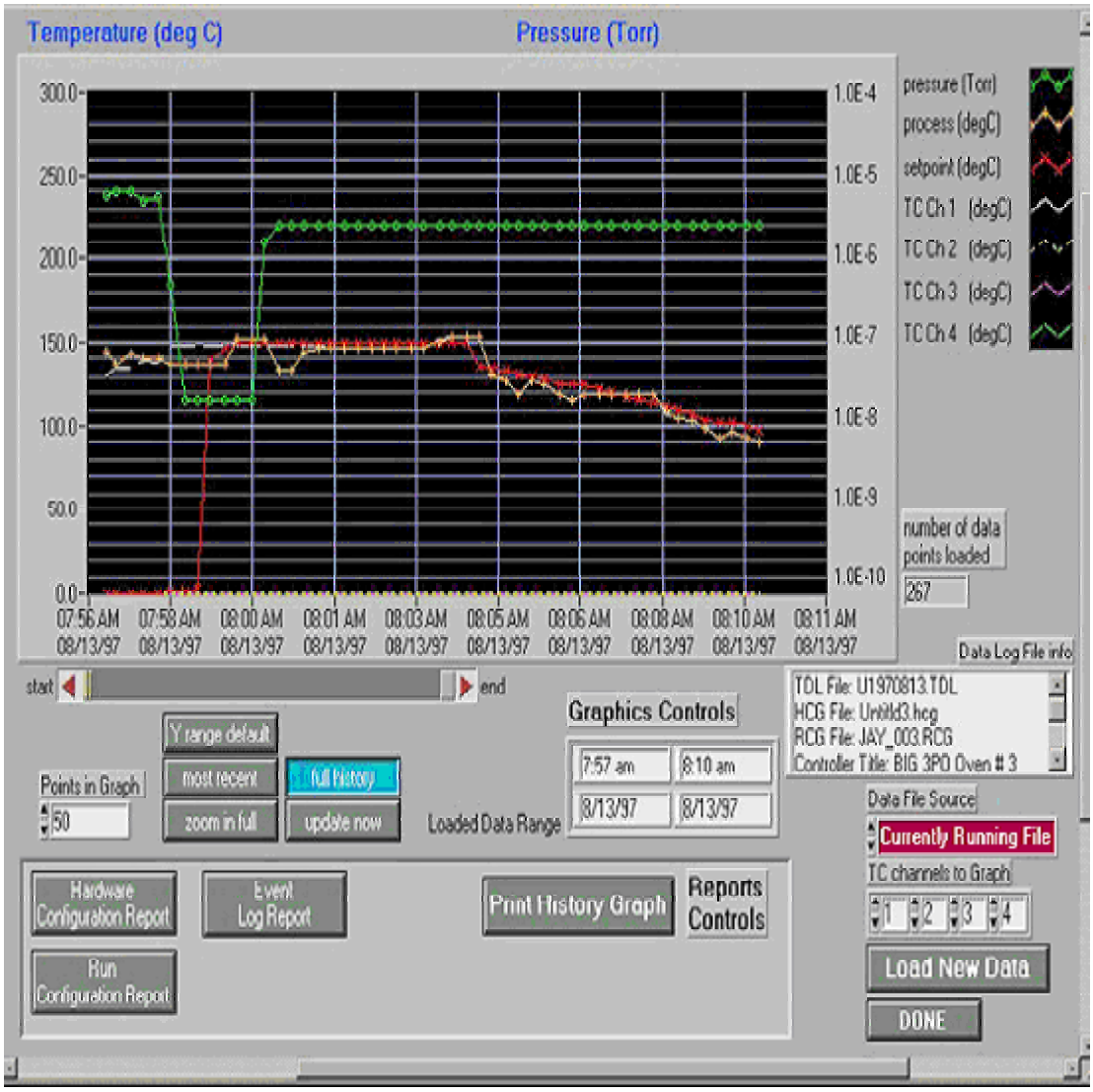
c) Under Data File Source, highlight currently running file.

d) Click on Load New Data.

e) Click print History Graph.

f) Click Done.

Example:



18) RAMP DOWN

AUTO RAMP DOWN initiation:

The system will automatically ramp down when the following conditions have been met:

a) System must be in SOAK mode.

b) Pressure must be below the END SOAK PRESSURE (as specified in the Run Configuration) for at least 35 minutes.

c) The bake has achieved a pre-selected (end soak pressure)

FORCED RAMP DOWN initiation:
To force the system to ramp down when desired:

a) Click manual override.

b) Click force ramp down. (Keep in mind that once a bake out changes it the RAMP DOWN state, there is currently no way to turn it around.)

c) Click OK.

d) Verify that the status is reading RAMP DOWN.

19) SHUTTING THE SYSTEM DOWN

a) Click terminate run.

b) Click OK.

c) To exit LabView click exit controller.

d) Click OK.

e) Click quit.

f) Close window.

g) File, exit.

h) Exit Windows NT.

i) Turn off computer.

20) SYSTEM OPERATION NOTES (Lights, warnings etc.)

Process: The process is the average of all the TC's that were checked SP in the hardware configuration.

Set point: The set point is a number calculated by the computer from bake out configuration for temperature control. (This number is based on the ramp rate, elapsed time, and soak temperature.)

Matrix: An arrangement of elements into rows and columns for performing specific functions as interconnected.

Windows NT: The computer operating system. NT stands for New Technology

Over temp: A red light indicates that one of the thermocouples has exceeded its maximum temperature limit (as defined in the Run Configuration).

Vacuum: A red light indicates that the vacuum is either not real or has exceeded the upper pressure limit (as defined in the Run Configuration). The power to the heater elements will be disabled until the vacuum return within the operating tolerance.

Heat enable: A yellow light indicates that the control power to all heater tapes is disabled. This could result from one of the thermocouples exceeding its maximum temperature limit (as defined in the Run Configuration), or the system is in some operating state other than RUNNING.

Set point Hold: A red light indicates that one of the heater tapes is on 100% but the TC(s) associated with it are more than 20-30 degrees away from the process temperature. The system will try to stay at the current set point until the lagging TC catches up.

APPENDIX

Miscellaneous notes:

If the system is very large, it would be a good idea to use a Multiple TC interlock chassis. (SLAC currently has one stored on one of the TPC units; it plugs into the main interlock chassis, SLAC drawing # 238-000-60.)

Images are JPEG files, 9" and 5" wide, height proportional or gif

Drawings required per Roger Nelson

Drawing List
Materials List
Schematic
Front and Rear Panel Fabrication
Front and Rear Panel Silkscreen

238-000 50 through 99

THERMAL PROCESS CNTRLR

THERMAL PROCESS CONTROLLER GP DRAWING OF GENERAL SETUP

MFD VACUUM
THERMAL PROCESS CNTRLR
RACK INSTALLATION

SCHEMATIC DRAWING OF HOW THE BOXES ARE ALL WIRED TOGETHER

50 GP drawing/rack installation
51 schematic diagram
52? list of cables that we need for the rack installation?

60 INTERLOCK CHASSIS
60 Drawing List
61 Materials List
62 Schematic
PF-238-000-63 THERMAL PROCESS CNTRLR, INTERLOCK CHASSIS, FRONT PANEL FABRICATION
PF-238-000-64 THERMAL PROCESS CNTRLR, INTERLOCK CHASSIS, REAR PANEL FABRICATION
SI-238-000-65 THERMAL PROCESS CNTRLR, INTERLOCK CHASSIS, FRONT PANEL SILKSCREEN
SI-238-000-66 THERMAL PROCESS CNTRLR, INTERLOCK CHASSIS, REAR PANEL SILKSCREEN
67 mounting plate

70 PATCH PANEL CHASSIS
70 Drawing List
71 Materials List
72 Schematic
PF-238-000-73 THERMAL PROCESS CNTRLR, PATCH PANEL CHASSIS, FRONT PANEL FABRICATION
PF-238-000-74 THERMAL PROCESS CNTRLR, PATCH PANEL CHASSIS, REAR PANEL FABRICATION
SI-238-000-75 THERMAL PROCESS CNTRLR, PATCH PANEL CHASSIS, FRONT PANEL SILKSCREEN
SI-238-000-76 THERMAL PROCESS CNTRLR, PATCH PANEL CHASSIS, REAR PANEL SILKSCREEN
77 mounting plate

80 POWER RELAY CHASSIS
80 Drawing List
81 Materials List
WD-238-000-82 THERMAL PROCESS CNTRLR, POWER RELAY CHASSIS, WIRING DIAGRAM
PF-238-000-83 THERMAL PROCESS CNTRLR, POWER RELAY CHASSIS, FRONT PANEL DIMENSION (fabrication?)
PF-238-000-84 THERMAL PROCESS CNTRLR, POWER RELAY CHASSIS, REAR PANEL DIMENSION (fabrication?)
SI-238-000-85 THERMAL PROCESS CNTRLR, POWER RELAY CHASSIS, FRONT PANEL SILKSCREEN
SI-238-000-86 THERMAL PROCESS CNTRLR, POWER RELAY CHASSIS, REAR PANEL SILKSCREEN
87 mounting plate