

PC-ControLAB™ 3

PC-ControLAB 3 FAMILIARIZATION

PURPOSE: To familiarize the user with operation of **PC-ControLAB 3**.

(This exercise only demonstrates how to manipulate program elements; it is not intended to describe the meaning of the features or options. For example, it demonstrates how to enter new controller tuning parameters but not how to determine the correct value for tuning parameter. That comes in subsequent exercises.)

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1. START PC-ControLAB 3.

If there is an icon on the desktop labeled **PC-ControLAB 3**, double-click the left mouse button on this icon. This will start PC-ControLAB 3 immediately.

If there is no icon on the desktop labeled PC-ControLAB 3, click on the “START” button at the lower left hand corner of the screen. (You may have to move the cursor to the bottom of the screen to cause the task bar with the “START” button to appear.)

Click on “Programs” from the Start Menu.

From the list of workgroups that appears, highlight “PC-ControLAB 3”.

Then from a short list of programs that appears, double-click the left mouse button on PC-ControLAB 3.

After using one or the other of the above procedures, the title display for **PC-ControLAB 3** appears. Then after a period of time, the initial operational display appears.

2. COMPONENTS OF THE OPERATIONAL DISPLAY.

The initial operational display is that of a feedback controller, controlling a simulated, generic process model.

Observe, but do not manipulate, the following. Check-off each item when you have observed it:

Continuously scrolling strip chart recorder.

- _____ Horizontal coordinate labels indicating "time" at the top of the recorder. (A simulated time span of 60 minutes is visible at any time. The coordinates are marked in 10-minute intervals.)
- _____ Vertical coordinate labels, 0 to 500 (DegF) at the right and 0 to 100 (%) on the left hand side of the strip chart. The scales may be changed between percent and engineering units from the "View>Display Range" menu item.
- _____ Process variable selection buttons. These are located directly above the strip chart time scale and are used to select which process variable scale is displayed on the right side of the strip chart.
- _____ Three traces (records) labeled "PV" (process variable), "OUT" (controller output) and "LOAD" (process disturbance).
- _____ Set point pointer (silver triangle) at the right of the strip chart.
- _____ The word "MANUAL," indicating the current controller mode, below the strip chart. This will change to "Auto" when you select the AUTO Command Button on the faceplate.

Faceplate (mimic of a generic panelboard mounted instrument).

- _____ Red vertical bar, indicating the present value of the process variable. (Compare the top of the bar with the PV trace on the strip chart.)
- _____ Wide green vertical bar (may appear as two bars on either side of the red bar) indicating the present value of the controller set point. (Compare the top of this bar with the set point pointer at the right of the strip chart.)
- _____ Horizontal blue bar, indicating the present value of the controller output. (The output scale, although not labeled, represents 0-100%, with graduation bars every 20%. Compare the position of the output bar with the OUT trace on the strip chart.)

- _____ Simulated LEDs labeled AUTO and MAN, indicating the current controller mode. (In Manual, the MAN LED should be red, and the AUTO LED grey. In Auto, the MAN LED will be grey and the AUTO LED green.)
- _____ Command buttons at the bottom of the faceplate labeled MAN and AUTO.
- _____ JOG buttons with left and right pointing arrows. In the Manual mode these can be used to decrease or increase the controller output.
- _____ JOG buttons with up and down pointing arrows. These can be used to increase or decrease the controller set point.

Command buttons beneath the strip chart recorder:

_____ [SP] [OUT] [TUNE] [PAUSE] [ZOOM] [LABEL] [EXIT]

Command buttons above the strip chart recorder:

_____ [StepIncr] [StepDecr] [AutoLoad]

Menu bar at the top of the screen:

_____ File View Control Process Load Calculator Help

Program title bar above the menu bar, indicating:

_____ (1) the current process model: GENERIC Process

_____ (2) the program name: PC-ControLAB 3

_____ (3) the current control strategy: FEEDBACK Control

Alternative Procedure for Minimizing Mouse Usage.

In the following instructions, you will be asked to press (click on) a command button, such as [AUTO], or to select an item from the Menu Bar, such as "Process". This means to move the cursor to that item and click the left mouse button. If the item has an underlined letter (such as the "A" in AUTO), then the following alternative procedure can be used which will minimize the use of the Mouse: When you are asked to select an item from the Menu Bar, you can hold down the [ALT] key on the keyboard while pressing the underlined letter, then press [Enter] in the keyboard to make the selection. To select an item from a drop-down menu, you can press [ALT] plus the underlined letter to make the selection. If you are asked to press (i.e., click on) the screen-displayed button, such as "AUTO", if the button has an underlined letter, you can press [ALT] plus the underlined letter to initiate that command.

3. STRIP CHART SCROLLING RATE ADJUSTMENT

Before going further, you may wish to consider the strip chart-scrolling rate. For most processors, the strip chart-scrolling rate is preset to provide comfortable viewing, scrolling neither too fast nor too slow. For much faster machines or much slower machines, you may wish to adjust the scrolling rate to suit your personal preference.

Unless the default scrolling rate is definitely uncomfortable, however, it is recommended that you retain the default scrolling rate of the program. In this case, you can skip to the next section.

The screen-scrolling rate is controlled by the time (Delta-T) of the program calculation cycle, since this sets the amount of screen advance on each calculation cycle. The default calculation cycle is 0.1 (simulated) minutes. Since the visible screen width is 60 (simulated) minutes, then the horizontal display resolution is 1:600.

To change the calculation cycle and the screen-scrolling rate, select “View” from the Menu Bar, then click on “Select Chart Scroll Rate” from the drop-down menu. The next menu permits a selection of 0.05, 0.10, 0.20, 0.50 minutes for Delta-T. Selection of a larger (smaller) value will cause a slower (faster) strip chart-scrolling rate. Experiment with these until you obtain a scroll rate that is comfortable for you. In selecting a Delta-T, keep in mind, however that:

Changing the value for Delta-T will cause the control strategy and process model to be reinitialized. You will have to reenter tuning parameters, controller set point, etc. Recorded chart data will also be lost. Therefore it is best to select the scroll rate only at the beginning of a session.

The behavior of several of the program elements to be encountered later (random load change, process noise generation, jog buttons, etc.) has been optimized for a Delta-T setting of 0.10 minutes. This is the default setting. Therefore, unless you are on a computer with a very slow or very fast processor, it is advisable to retain this setting.

Press [OK] to clear the Delta-T option dialog box.

4. PROCESS VARIABLE RECORDING

From three to six process variables are recorded automatically, depending upon the control strategy selected. The default set of recorded variables can be changed, however. To add or eliminate variables from the chart record, select View from the Menu Bar, and then select “Variable Plot Selection.” A dialog box appears, listing the total set of variables that can be recorded for the current control strategy. Click on the option “YES” to add a particular variable to the chart record; click on the option “NO” to remove a variable from the chart record.

The traces can be “thickened”; this is useful if the display is being projected onto a wide screen for audience or classroom viewing. From the “Variable Plot Selection” dialog box, choose either “thin lines” or “thick lines.”

The process variable traces are labeled automatically as the “00” vertical grid marker crosses the grid boundaries. The traces can also be labeled on demand by pressing the button [LABEL] beneath the grid. If desired, the automatic labeling can be turned off, permitting labeling only on demand. To turn off automatic labeling, select OFF from the options at the bottom of the dialog box. Remove the dialog box by pressing [OK].

5. CONTROL LOOP MANIPULATION

Click on faceplate button labeled [AUTO]. Note the color change of the LEDs; also note the mode designation beneath the strip chart changes to AUTO.

Return the controller mode to Manual by clicking on (pressing) the [MAN] button.

In the Manual mode, press and hold the right pointing Jog button. Note the controller output increase, slowly at first, then more rapidly if the button is held for longer than about 2 seconds. Note also that a change in controller output (simulating a change in signal to valve) will eventually have an effect on the process variable, through the process model simulation.

Return the controller output to about 35%.

Change to the AUTO mode, and press and hold the up pointing Jog button. Note the controller set point increase, slowly at first, then more rapidly. Notice also that the controller output changes, which in turn causes the PV to change. Disregard the fact that the PV does not reach the set point.

Click-and-hold on the set point indicator (silver triangle) and drag it to a new position. Return the set point to about 52%.

Be sure the controller is in Auto. Observe the [OUT] button beneath the strip chart. The text should be a fuzzy grey, not black. This indicates that in this controller mode, this button is disabled, preventing changes to the controller output. Click on the button. Nothing should happen.

Change the controller to Manual. Observe the text color of the [OUT] button. Click on it. Now a dialog box appears, permitting precise entry of a controller output value.

In the dialog box, observe the present value of the controller output. (You can also see the set point and PV values.) In the blank field labeled “New Output,” key in 40.0 then press [ENTER] on the keyboard or click on [OK]. Does the controller output value change?

The scroll bar beneath the New Output field can also be used for changing the output.

Click and drag the square in the center of the scroll bar (the scroll bar "handle") slightly to the left. This enters a new target value for the set point, just as if you had keyed it in. When the value is satisfactory, press [Enter] or click on [OK]. Does the controller output change?

Move the scroll bar handle almost all the way to the left, and then make a slight change to the right. Notice how much the output changes. Then continue moving the handle to the right. Notice that for the same amount of handle movement, the amount of output change increases. This scroll bar, as well as others in the program, has a nonlinear graduation so that small values can be entered more precisely with the scroll bar.

Move the scroll bar handle slightly until a value is displayed in the "New Output" field. Then click-and-hold the arrow at the right or left end of the scroll bar. Notice that the target output value changes. Change the target output with the arrows until it is about 35.0%, then press [Enter] or [OK]. Does the controller output go to 35%?

REFLECTION: There are three different ways of changing the controller output, whenever the controller is in the Manual mode:

- (1) Jog buttons;
- (2) Key in a new value in the dialog box;
- (3) Scroll bar adjustment.

Change the controller mode to AUTO.

Press [SP]. A dialog box (similar to the previous one) appears, permitting set point entry, either by keying in a new value, or changing a scroll bar. Try both of these.

You can also change the set point by clicking-and-dragging (press and hold the left mouse button while moving the cursor) the silver set point indicator at the right of the grid. Change the set point in this manner, and then leave the set point at 52.5%.

You can also ramp (gradually change) the set point from its present value to a new value at a specified rate.

Press [SP]. Click in the circle by "Yes" under the label "Set Point Ramp?". (The controller must be in Auto for this choice to be available; otherwise the options "Yes" and "No" are greyed out.)

An additional portion of the dialog box is revealed, with the cursor in a field labeled "Ramp Rate, %/Minute". Key in a value greater than zero, but equal to or less than 100.0, then press [Enter]. Now key in a new target set point value and press [Enter] or [OK]. Notice that the set point gradually changes to the new target value at the specified rate.

(If desired, you can abort the set point ramping before it gets to the new target value. Press [SP] to recall the dialog box, then select “No” underneath the label “Set Point Ramp?”.)

REFLECTION: There are five ways by which the set point can be changed:

- (1) Jog buttons
- (2) Click-and-drag the set point indicator
- (3) Key in a new value in the dialog box
- (4) Scroll bar adjustment
- (5) Ramp to new target value

6. CONTROLLER TUNING

Press [TUNE].

A dialog box appears, permitting entry of controller gain, reset and derivative parameters. Each parameter can be entered by keying in a precise value or by scroll bar entry.

A data entry field must "have focus" before a new value can be keyed in. Note the blinking vertical bar in the Gain entry field; this signifies that this box has focus when the tuning dialog box initially appears.

Click on the Reset entry field. Notice that it now has focus - that is, can accept data entry.

Click in the Gain field so that it has focus, then key in 2.00 for Gain and press [Enter]. Notice that the Reset entry field now has focus

Key in 10.00 (Minutes per Repeat) for Reset, then press [Enter]. Note that the Deriv entry field now has focus.

Click on [Clear] to remove the tuning entry dialog box without entering a value in the Deriv field.

Options

If desired, these values can be entered and displayed as Proportional Band and Repeats per Minute, rather than as Gain and Minutes per Repeat.

Press [Options].

An auxiliary dialog box appears. Click in the circle “Display Gain as PROP BAND”; also, click in the circle “Display Reset as Repeats/Minute.” Press [Clear].

Note that the tuning dialog box now displays:

Prop Band	50
Reset (Repeats/Min)	0.10

The tuning dialog box also displays the message “Reset is ON”. Integral action can be inhibited if desired. Press [Options] and select “Reset Action OFF”. Press [Clear]. Now the tuning dialog box displays "Reset is OFF."

Press [Clear] to remove the tuning dialog box.

7. CHANGING CONTROLLER OPTIONS

Be sure the controller is in Manual. Then from the Menu Bar, select “Control”, then “Control Options” from the drop down menu.

A table of controller options appears. Some of these options may not be available, depending upon the selected control strategy.

Select “Set Pt Tracking? YES”. Then press [Clear] to remove the options selection table.

Increase the controller output by 10% (say, from 35% to 45%) by any means. When the process variable begins changing, observe that the set point follows (tracks) the measurement.

Before the process variable comes to equilibrium (if necessary, make another change to controller output), change the controller mode to Automatic. Note that the set point stops at that point.

(The option Set Point Tracking causes the set point to follow the measurement whenever the controller is in Manual. When this option is selected, a set point value cannot be entered by the user.)

Be sure the controller is in Automatic, then select “Control” from the Menu Bar, then "Control Options." Note that all of the option choices are now disabled.

(Controller options cannot be changed when the controller is in the Automatic mode.)

Press [Clear] (or click anywhere outside the options table) to remove the options table.

8. CONTROL STRATEGY SELECTION

Select “Control” from the Menu Bar, then “Select Strategy.”

From the auxiliary menu, select “Cascade.”

The display changes format, displaying a narrower strip chart grid and two faceplates. The faceplates are labeled at the top “PRIMARY” and “SECONDARY”.

A subsequent laboratory exercise covers the detailed operation of a Cascade control loop. The following is intended only for familiarization with aspects that are common to Cascade and other control strategies that employ two faceplates (i.e., Ratio, Feedforward, Override and Decoupling).

Note the following:

The label “SECONDARY” is in white letters with a red background, whereas the label "PRIMARY" is in fuzzy dark grey letters with a light grey background. This indicates that the Secondary controller is currently the selected controller.

The set point indicator matches the set point of the Secondary controller.

The controller mode designation beneath the strip chart refers to the mode of the Secondary controller.

Press [TUNE]. The title of the tuning dialog box indicates that it provides access to the Secondary controller tuning parameters. Press [Clear] to clear the dialog box.

Press [OUT]. The data entry dialog box indicates that it provides access to change the Secondary controller output. Press [Clear] to clear the dialog box.

Select the Primary controller by pressing [SEL] at the upper left hand corner of the faceplate. Note the following:

The “PRIMARY” and “SECONDARY” faceplate labels have swapped their color combinations, indicating that the Primary controller is now selected.

The set point indicator now matches the set point of the Primary controller.

The controller mode designation beneath the strip chart now refers to the status of the Primary controller.

Press [TUNE]. The title of the tuning dialog box indicates that it now provides access to the Primary controller tuning parameters. Press [Clear] to clear the dialog box.

Press [OUT]. The data entry dialog box indicates that it provides access to change the Primary controller output. Press [Clear] to clear the dialog box.

With the Primary controller still selected, press [CAS] on the Secondary controller faceplate.

Select the Secondary controller, then press [AUTO] on the Primary controller faceplate.

REFLECTION: The faceplate manipulation buttons are accessible, regardless of which controller is selected. Other items, such as the set point indicator, the buttons beneath the strip chart, the tuning, output and set point entry dialog boxes and the options table are associated with the current controller selection.

9. PROCESS MODEL SELECTION

Return to the Feedback control strategy.

(Select “Control” from the Menu Bar, then “Select Strategy,” then “Feedback”.)

Select “Process” from the Menu Bar, then “Select Model.”

If a list of process models (Example: “flowlp1.mdl”) appears in the large box above the [Cancel] and [OK] buttons, then select (click on) “flowlp1.mdl.” Then press [OK].

The Flow Loop 1 process model is now read from disk file into the program. (Note the change of the name of the process model in the title bar above the menu bar.)

(If you attempted to change to the flow loop model while you were still in the Cascade control strategy, you got a message indicating that the selected process model was not compatible with the current control strategy. Reason: The flow loop returns only one process variable from the process to the control strategy, whereas the Cascade strategy requires both a Primary and a Secondary PV. You can continue reading in the flow loop model, but the simulation will be in a paused state until a compatible control strategy is selected. Once a compatible control strategy (e.g., Feedback) is selected, the simulation can be resumed by pressing [RUN])

A subsequent laboratory exercise will explore the aspects of a flow control loop. A typical aspect of a flow control loop is measurement noise. This can be suppressed by a parameter change.

Select “Process”, then “Change Parameters.”

From the PROCESS PARAMETERS data box, select the line reading “Meas noise: 0=off; 1=on”. A sub dialog box appears, indicating the current value of this parameter is 1.0 (i.e., NOISE is on. Enter “0” in the “New:” field and press [OK]. Notice the effect on the PV record on the strip chart.

Press [Clear] (or click anywhere outside the Process Parameters data box) to clear the box from the screen.

10. PROCESS DISTURBANCES (LOAD CHANGES)

Select the “Generic” process model.

Select the “Feedback” control strategy, if this is not the current selection.

The grey trace on the strip chart represents a process load. For example, if the control loop were controlling the temperature of a process stream leaving a heat exchanger, the load variable could represent the flow rate of the process stream.

Press [StepIncr] above the faceplate. This causes a step increase in the process load (e.g., an increase in the process flow rate to the heat exchanger). If the controller is in Manual, then a load increase will affect the process variable.

Press [StepDecr]. Note the opposite effect on the PV.

Press [AutoLoad]. This causes the load to vary continuously, in a random sort of way. Note the grey trace on the strip chart, and its effect on the PV.

Press [AutoLoad] again. This stops the random variation of the process load.

Other forms of load disturbance are possible. Select “Load” from the Menu Bar. The Load Changes Set Up dialog box appears. This dialog box permits:

Setting the size of the step load change activated by the [StepIncr] and [StepDecr] buttons.

Setting the statistical characteristics of the load change form activated by the

[y-AutoLoad] button. Possible forms of load change are: random walk, random step, sinusoidal and ramp. Each of these can be independently or collectively enabled or disabled. Only the forms of load change that are enabled are activated by the [y-AutoLoad] button.

Set the maximum and minimum excursion allowable for random load changes.

(If the control strategy employs two faceplates, the load change buttons above the faceplates and the Load Change Set Up dialog box are, in general, associated with the controller that is currently selected. There are some exceptions to this, which are covered in Laboratory Exercises for specific control strategies.)