

# Structured Text Lab

## Objectives

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### IN THIS LAB, YOU WILL:

- **Receive a basic overview of Structured Text programming**
- **Write logic using the Structured Text language**
- **Download the logic to a PACSystems controller**
- **Interact with the logic using the QuickPanel display**



## Structured Text Lab

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# Overview

## IEC-61131-3

\*IEC 61131-3 is an international standard first published in December 1993 by the IEC. This standard defines two graphical and two textual controller programming language standards:

Textual	Graphical
<ul style="list-style-type: none"> <li>- Instruction List (IL)</li> <li>- Structured Text (ST)</li> </ul> <pre style="font-family: monospace; margin-top: 10px;">LD TagA ANDN TagB ST TagC</pre>	<ul style="list-style-type: none"> <li>- Function Block Diagram (FBD)</li> <li>- Ladder Diagram (LD)</li> </ul>
<pre style="font-family: monospace; margin-top: 10px;">TagC := TagA and not TagB;</pre>	

Figure 4-1. IEC Programming Languages Summary

The standard also defines both graphical and textual Sequential Function Chart elements to organize programs for sequential and parallel control processing. An example of an SFC is shown below:

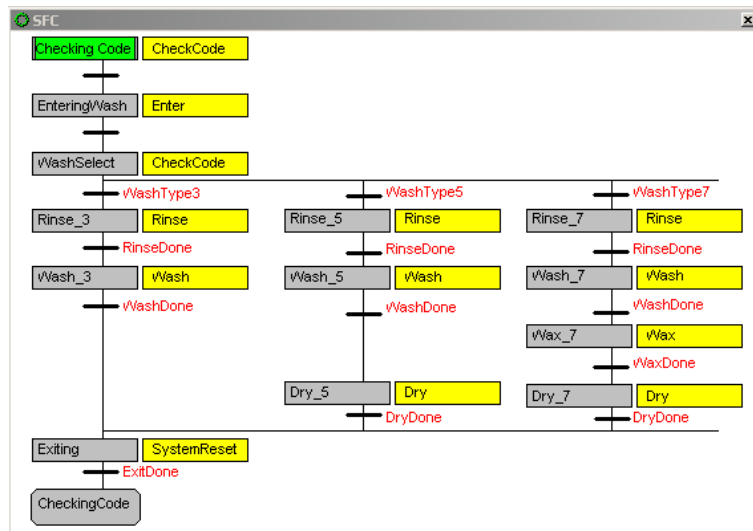


Figure 4-2. Sequential Function Chart (SFC) Example

\*Retrieved from "[http://en.wikipedia.org/wiki/IEC\\_61131-3](http://en.wikipedia.org/wiki/IEC_61131-3)"

## Structured Text (ST)

Structured Text (ST) is a high level textual language similar to the Pascal programming language. It is very flexible and intuitive for writing control algorithms.

Structured Text uses operators such as assignment, logical branching, and loops. People trained in computer programming languages often find it the easiest language to use for programming control logic. When symbolic variables are used, ST logic resembles sentences, making it highly intelligible to beginning users as well.

ST is ideal for tasks requiring complex math, algorithms, or decision-making.

The following are a few examples that show some Structured Text code:

### Example 1

```
//AND Logic  
Motor := Switch_1 AND Switch_2;
```

### Example 2

```
//Conditional Logic  
if ( Switch_1 OR Switch_2 ) then  
    Start_Motor := 1;  
    Motor_Start_Count := Motor_Start_Count + 1;  
end_if;
```

### Example 3

```
//Stop/Start control with seal-in  
Motor := Stop & (Start OR Motor_Aux);
```

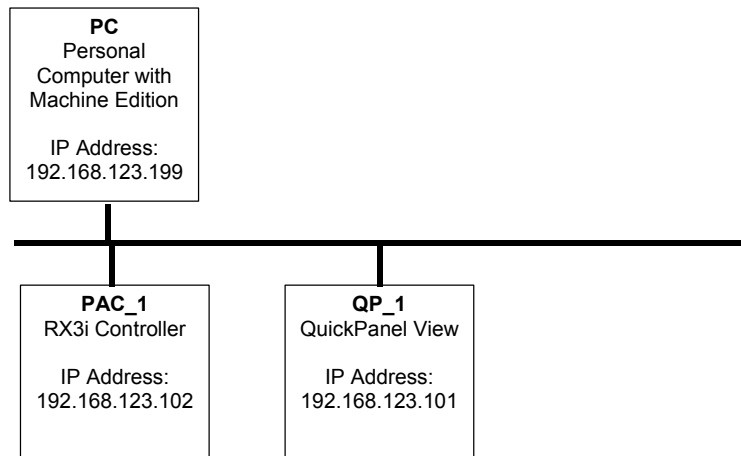
## Benefits of Structured Text

- People trained in computer languages can easily learn to program control logic
- Use of variables make the programs easy to understand
- Programs can be created in any text editor

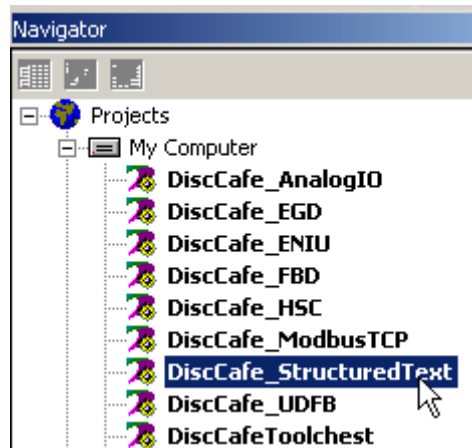
One of the primary benefits of the IEC 61131-3 standard is that it allows multiple languages to be used within the same controller. This allows the program developer to select the language best suited to each particular task.

## Lab Exercise – Writing Logic Using Structured Text

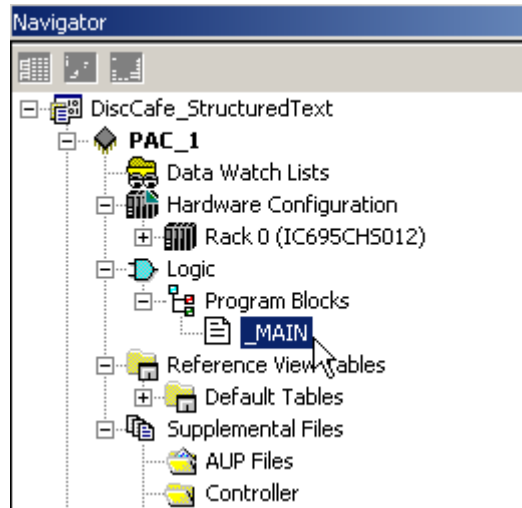
In this exercise you will be writing logic using the Structured Text programming language. This lab assumes the following basic hardware configuration and setup. The IP Addresses defined below are used in the Project provided with this lab.



1. Begin by **double-clicking** on the Project named “DiscCafe\_StructuredText” in the Navigator window.

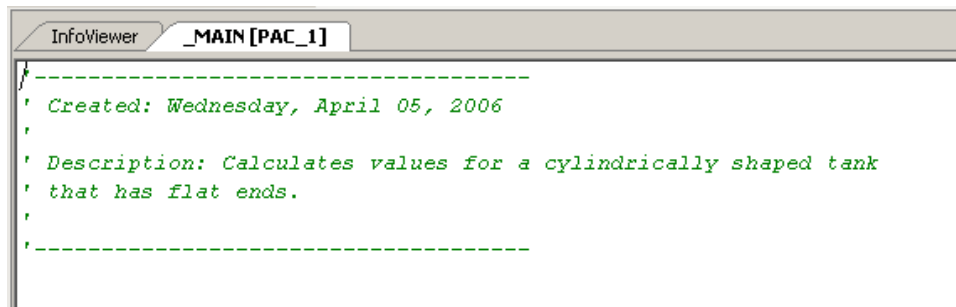


2. Now **double-click** on the **\_MAIN** program block in the **Logic** section of the **PAC\_1** target to open it in the Structured Text editor window.

**NOTE**

The **\_MAIN** block defaults to Ladder Diagram as its' programming language. In this exercise the **\_MAIN** block has been replaced with a Structured Text block.

You will see the following.

**NOTE**

**All of the variables required for this exercise have been previously created for you in the project.**

- Enter the following text exactly as shown.

```
//Value of PI
PI:=3.1416;
//Calculate Area in square feet
AREA:=((DIAMETER/2.0)**2.0)*PI;
//Calculate Circumference in feet
CIRCUMFERENCE:=PI*DIAMETER;
//Calculate Volume in cubic feet
VOLUME:=AREA*HEIGHT;
```

The lines with double slashes are program documentation.

```
//Calculate capacity in gallons
CAPACITY:=VOLUME*7.48;

//Calculate current contents in gallons
CONTENTS:=(AREA*LEVEL)*7.48;
```

An explanation of this Structured Text logic is as follows:

**Line 1 - PI:=3.1416;** sets the variable PI equal to the value 3.1416.

**Line 2 - AREA:=((DIAMETER/2.0)\*\*2.0)\*PI;** calculates the Area by taking the Diameter and dividing it by 2 to obtain the Radius value and then squaring this value (\*\*2.0) and then multiplying by the value of PI.

**Line 3 - CIRCUMFERENCE:=PI\*DIAMETER;** calculates the Circumference by multiplying the value of PI by the value of Diameter.


**Line 4 - VOLUME:=AREA\*HEIGHT;** calculates the Volume by multiplying the value of Area by the value of Height.

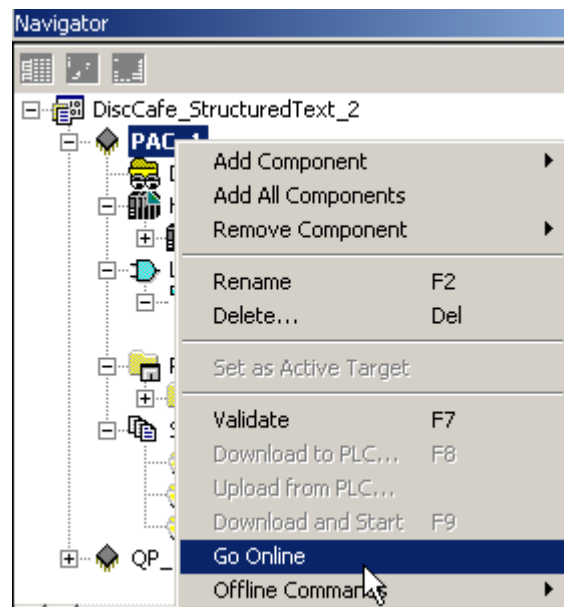
**Line 5 - CAPACITY:=VOLUME\*7.48;** calculates the Capacity by multiplying the value of Volume by 7.48 (gallons in a cubic foot).

**Line 6 - CONTENTS:=(AREA\*LEVEL)\*7.48;** calculates the current contents of the tank by multiplying the value of Area by the actual value of Level and then multiplying the result by 7.48.


**NOTE**

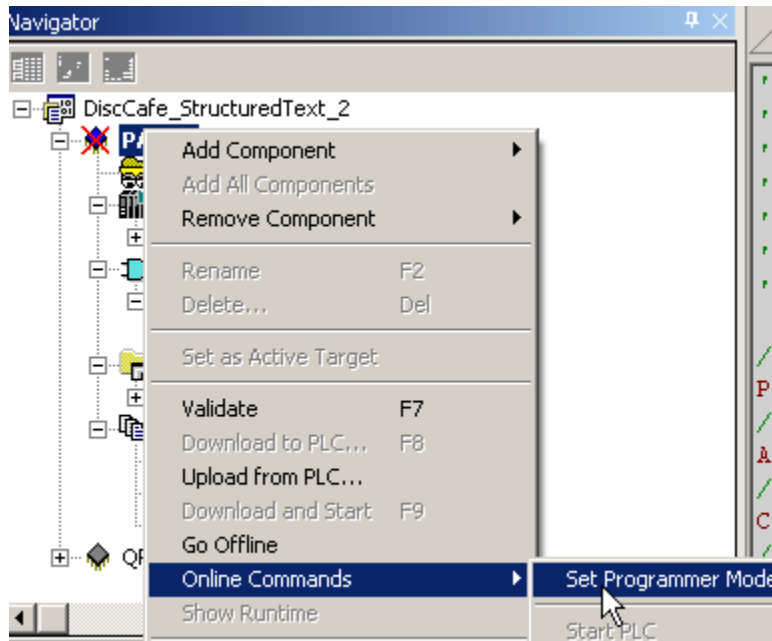
**You will be supplying the values for Height and Diameter via the QuickPanel interface on the PACSystems demo unit. The value for Level will be entered using the potentiometer on the demo unit.**

4. Now, **right-click** on the **PAC\_1** target and select **Go Online** from the menu, or press the **Online/Offline** toolbar button .

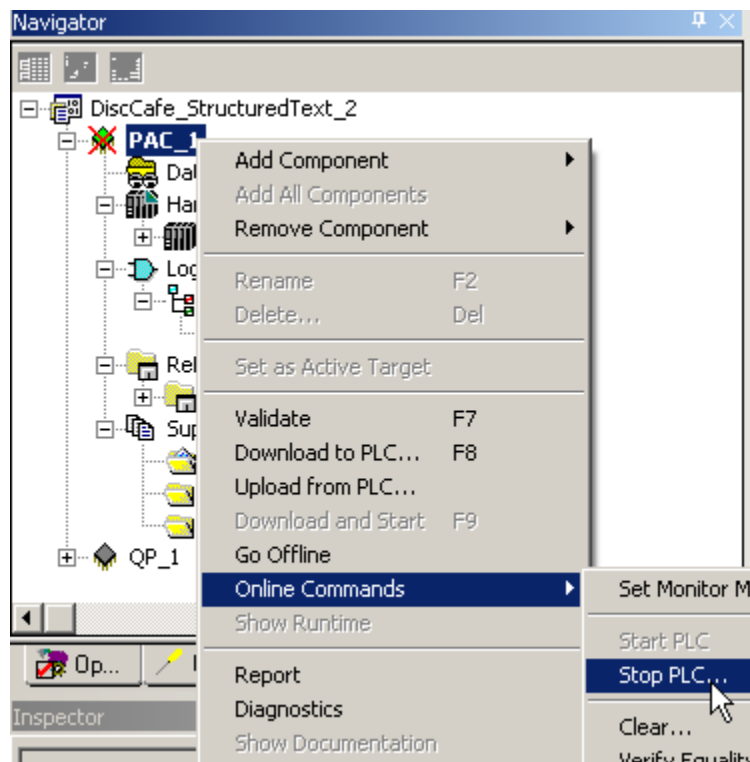


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5. Next, **right-click** and select the **Online Commands, Set Programmer Mode** menu, or press the **Toggle Online Mode** toolbar button .

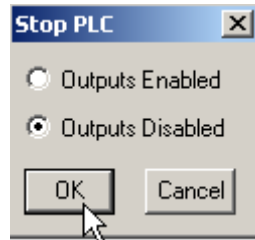


6. Next, select the **Online Commands, Stop PLC** menu, or press the **Stop Active Target** toolbar button .

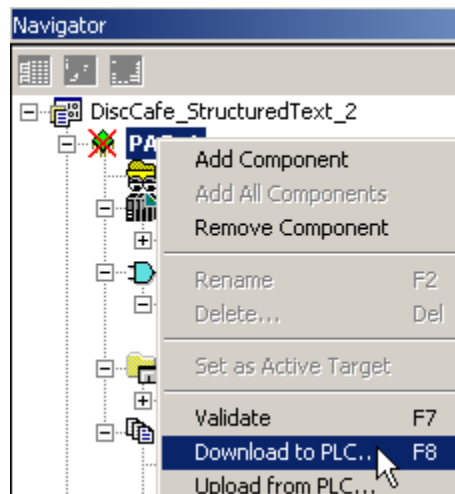




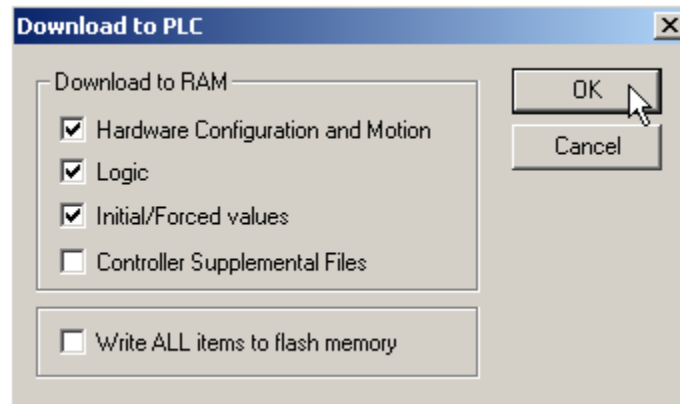
7. Click **OK**.



8. **Right-click** and select the **Download to PLC** menu, or press the **F8** function key, or press the **Download Active Target** toolbar button .

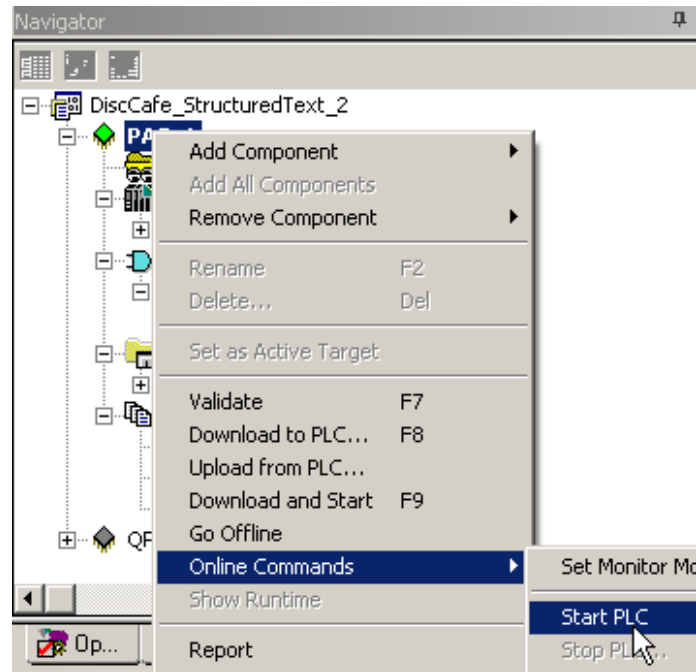


9. Make sure that the items in the dialog box are checked as shown and then click **OK**.

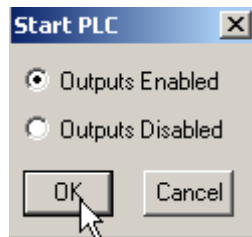


10. Select the **Online Commands, Start PLC** menu, or press the **Start Active Target** toolbar button .

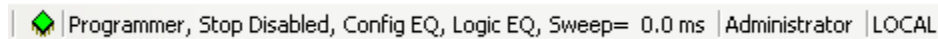
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11. Click **OK**.

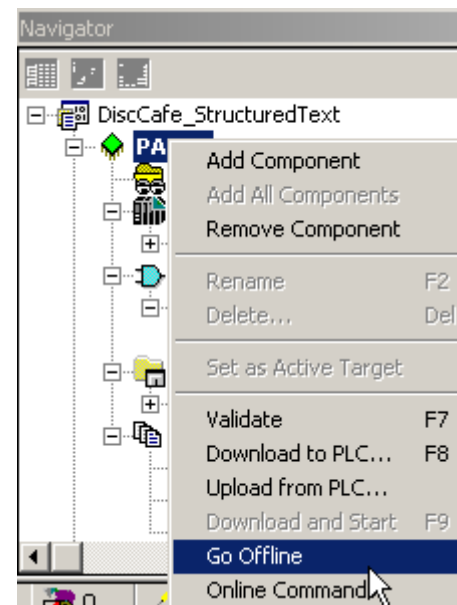


12. Check the information displayed on the Status Bar to verify that the PACSystems controller is in Run Mode, and that the Configuration and Logic are both Equal.

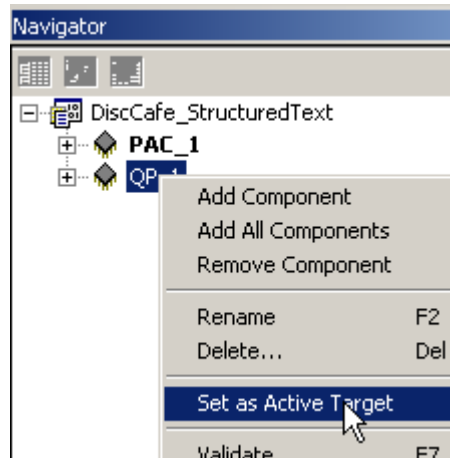


Once you have successfully downloaded and started the controller, you can use the QuickPanel to exercise the application. But first, you need to download the QuickPanel application to the demo unit.

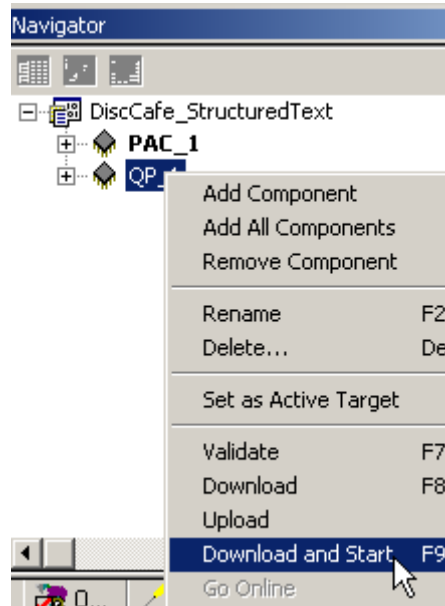
13. **Right-click** on the **PAC\_1** target and select **Go Offline** from the menu.



14. **Right-click** on the **QP\_1** target and select **Set as Active Target** from the menu.



15. **Right-click** on the **QP\_1** target and select **Download and Start** from the menu, or press the **F9** function key, or press the **Download and Start Active Target** toolbar button .



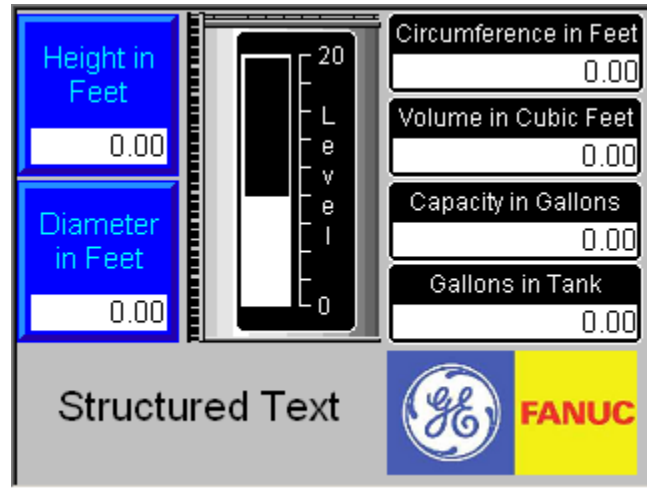
16. After the QP\_1 application has been successfully downloaded to the QuickPanel go to the **QuickPanel** screen on the **PACSystems demo unit** and continue as instructed below.

17. Touch the **Numeric Data Entry** button for **Height** on the **QuickPanel** screen and enter **20** as the height of the tank.

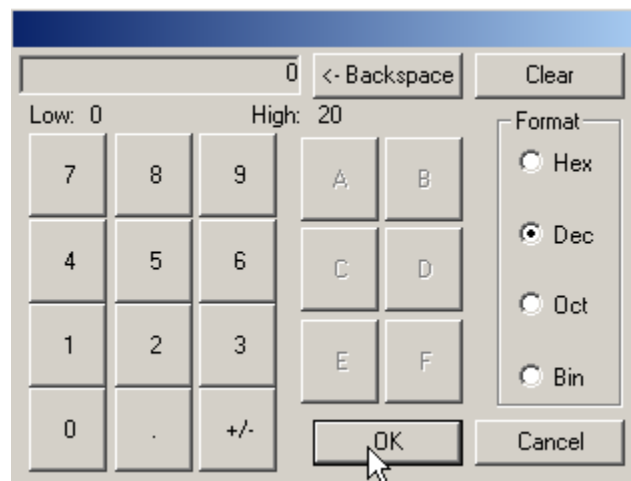
**NOTE**

**The Analog signal for the level has been scaled to provide 0 to 20 as its' overall range.**

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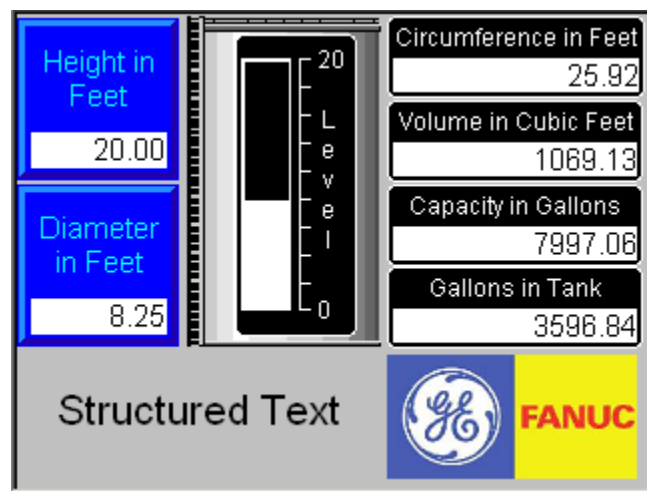


18. Use the keypad to enter the value and then touch the **OK** button.



19. Next, click on the **Numeric Data Entry** button for **Diameter** and enter a diameter of your choice for the tank.

You will now have readings for the values to the right of the tank.

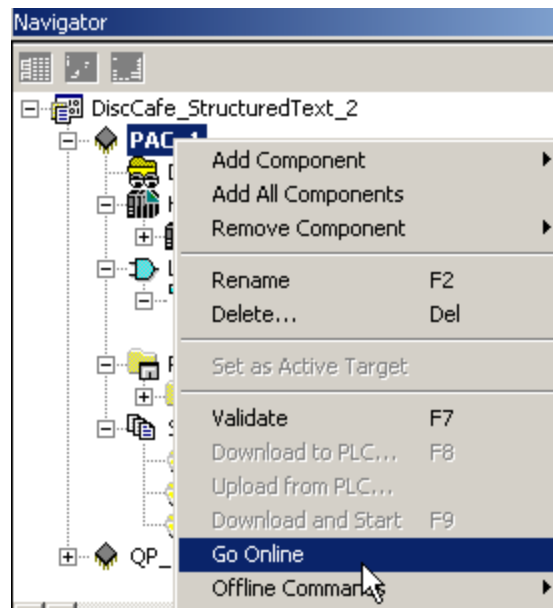


20. Move the **potentiometer** on the front of the **PACSystems demo unit** and you will see the **Level** changing and the **Gallons in Tank** value will change to reflect the change in Level.

If you want to examine the execution of the Structured Text logic while you interact with the QuickPanel, you can go back online with the controller.

21. **Right-click** on the **PAC\_1** target and select **Set as Active Target** from the menu.

22. **Right-click** on the **PAC\_1** target and select **Go Online** from the menu, or press the **Online/Offline** toolbar button ⚡.



23. Next, **right-click** and select the **Online Commands, Set Programmer Mode** menu, or press the **Toggle Online Mode** toolbar button 🖱️.

24. Now you can hover the Tooltip over the variables in the Structured Text logic and see the value of the variables online. In the example below, the cursor has highlighted the **CIRCUMFERENCE** variable.

```
InfoViewer  Main_Panel [QP_1]  _MAIN [PAC_1]
-----
' Created: Wednesday, April 05, 2006
'
' Description: Calculates values for a cylindrically shaped tank
' that has flat ends.
'
'-----

//Value of PI
PI:=3.1416;
//Calculate Area in square feet
AREA:=((DIAMETER/2.0)**2.0)*PI;
//Calculate Circumference in feet
CIRCUMFERENCE:=PI*DIAMETER;
//PAC_1.CIRCUMFERENCE in cubic feet
VOLUME:=25.9182;
//Calculate capacity in gallons
CAPACITY:=VOLUME*7.48;
//Calculate current contents in gallons
CONTENTS:=(AREA*LEVEL)*7.48;
```

## Review

In this lab, you have been shown how to:

- Write logic in the Structured Text programming language.
- Download the logic to the PAC controller.
- Interface with the logic to obtain values.