INTERMEDIATE LABORATORY
PHYX 3870

Science Workshop Competency Test
Analog Interface Tutorial

Introduction

This *Science Workshop* experiment is the first of three tutorial exercises. They are intended teach you how to use the *Science Workshop* software to collect, record, and analyze data from your experiments. You will be guided through a series of activities that illustrate most of the key aspects and capabilities of *Science Workshop*. You are encouraged to "experiment...make mistakes...get messy," as Ms. Frizzle would say.

Detailed information is available in the *User's Guide*. Relevant page numbers for the Version 2.2 User's Guide are noted below. The *Quick Reference Card* provides a very handy summary of the basic capabilities of *Science Workshop* and how to perform various things using the software.

Science Workshop Experiments

Science Workshop experiments contain information about a particular setup of sensor configurations, displays, data analysis, and data. You can begin a new experiment by selecting New from the File menu. Alternately, you can open a preset experiment by selecting Open from the File menu. New experiments or changes to existing experiments can be saved for later retrieval by selecting Save from the File menu.

The Science Workshop Screen
[See pp. 102-103]

When you open Science Workshop you will see two things. The Tool Bar (the bar at the top with words like File and Edit) provides pull down menus to perform various tasks. For example, the File menu allows you to create new experiments, open old experiments, save experiments, print , and other things. You will also see one or more Windows. In this experiment, two windows are open initially, the Experiment Notes Window and Experiment Setup Window. The Experiment Notes window has two parts, the Text Area where the text you are now reading appears and the Picture Area above the text. You can access the Experiment Notes Window at any time by clicking on the Notes icon in the Experiment Setup Window. Review the information on the Experiment Setup Window and the Experiments Notes Window on the *Quick Reference Card* for further details.

Setting up an Experiment
[See pp. 109-114]

The Experiment Setup Window is used to set up experiments with *Science Workshop*. The set up procedure for any experiment is basically the same. You need to do two things.

(1) Set Up a Sensor

First, you must tell *Science Workshop* what kind of data you want to collect. In this experiment, you will collect temperature data. Plug the temperature sensor into CHANNEL A, if you have not already done so. Click on the analog sensor plug icon (icon on the right hand side of the Experiment Setup Window) and drag it over to the icon for ANALOG CHANNEL A on the interface picture. When you release the mouse, a list of analog sensors will appear. Scroll down the list until you see the specific Temperature Sensor you have. Click on the correct type of temperature sensor to select

it, and then click OK to return to the Experiment Setup Window. The Experiment Setup Window will show the Temperature Sensor icon below the ANALOG CHANNEL A icon. You can customize the sensor calibration by clicking on the Temperature Sensor icon. Refer to the *Sensor Reference Sheet* for further details as needed.

A wide variety of analog sensors are available from *PASCO* and other vendors. Analog sensors measure physical quantities over a continuous range. *Science Workshop* analog sensors all convert the particular physical quantity they measure (for example, temperature) to a voltage, that is then converted in the interface box to a digital number. The interface uses a 12 bit Analog-to Digital Conveter (ADC) to do this; thus the resolution of the interface is one part (bit) in 4096 (2 raised to the twelfth power) or 0.02% or 4½ digits. The sensors can be used to measure voltage, current, pressure, force, magnetic field, sound intensify, or ir, visible and uv light intensity, to name but a few. Refer to the *Pasco* catalog or *Sensor Reference Sheets* for more information on the available analog sensor.

(2) Set Up a Data Display

Second, you must tell *Science Workshop* how you want to display your data. Click the Digits display icon and drag it over to the Temperature Sensor icon. When you release the mouse, a new Digits display window will appear showing temperature. Next, set up a Meter display window by clicking on the Meter display icon and dragging it to the Temperature Sensor icon. Repeat the procedures to open a Table and a Graph. Resize and arrange the windows to your liking.

Collecting Data

[See pp. 142-145]

Click the MON button in the upper left corner of the Experiment Setup Window to begin collecting data. You should see temperature data begin to be displayed in the four data display windows. Hold the temperature sensor in your fingers to increase the temperature and observe the changes.

Click the PAUSE button in the upper left corner of the Experiment Setup window to pause data collection or the STOP button to stop collecting data. The REC button allows you to collect data that can be stored in a data file and analyzed.

Each display window can be customized; you will explore some options for each display in turn. Refer to the *Quick Reference Card* or the noted pages in the *User's Guide* for details.

Customizing the Displays

(1) Digital Display [see pp. 162-165]

Click on the Digital Display to bring up the Digits Setup menu. You can modify the display name or the number of digits displayed. Set the display for three digits to the left of the decimal place and two digits to the right of the decimal place. You can also adjust the type of data displayed and set an alarm threshold.

(2) Meter Display [see pp. 166-169]

Click on the Meter Display to bring up the Meter Setup menu. You can modify the display name or the meter range. Set the meter to a range of 0 ˚C to 100 ˚C. You can also adjust the type of data displayed and set an alarm threshold.

(3) Table Display [see pp. 193-201]

Refer to the *Quick Reference Card* to identify the different parts of the Table Window. The Table display has two columns; the first lists a data point index and the second lists the measured temperatures. You can also display the time each data point was taken by clicking on the Time Stamp (clock) icon. Click on the Statistics (sigma) button to display the minimum, maximum, mean, and standard deviation of the temperature column. Use the mouse to highlight the first five data points; note that the statistics now reflects only these five values.

Now add a third column, one that displays the temperature in alternate units. Click on the Add-A-Column Menu icon;

select Calculations and then Temperature in Kelvin. To see how the calculation works, modify it to calculate temperature in degrees Fahrenheit. Click on the calculator icon in the Experiment Setup Window to bring up the Experiment Calculator Window. Select Temperature in Kelvin from the pull-down list of calculation names. Click on the Dup button to create a copy of the Temperature in Kelvin calculation. Modify the Calculation Name to "Temperature in Fahrenheit", the Short Name to "Degrees F", and the units to "deg F". Finally, change the expression to "32 + (9/5)* @A Temp" in the Expression Field and press return (Note: "@A Temp" in the calculation is the symbol for temperature data from CHANNEL A entered by selecting the "Input" button, "Analog A", then "Temp (deg C)".) Before closing the Experiment Calculator, review the possible functions (e.g., sin(x), log(x), or avg(x)), that can be used in expressions by clicking on the Function [f(x)] button. Finally, click on the Column Input Menu of the third column in the Table. Select Calculations and then Temperature in Fahrenheit. To display only two digits to the right of the decimal in the third column, select the Column Precession (0.00) button.

(4) Graph Display [see pp. 202-228]

Begin collection of a new data set by selecting the REC button in the Experiment Setup Window. Hold the temperature sensor between your fingers and watch the temperature rise. Stop the data collection after several seconds. You may modify the plot range of the horizontal and vertical axes by clicking on the axes or selecting the Auto-Scale Tool button. The Display Options button allows you to change the display attributes of the graph, such as the graph title, line type and error bars. You can plot other data sets (if you have collected any others) by selecting from the list that appears by clicking on the Plot Data (DATA) Menu. You can modify the quantity that is plotted on the x- or y-axis by clicking on the Plot Input Menus. Change the graph to plot the temperature in Fahrenheit by clicking on the Y-axis Plot Menu, selecting Calculations, and then Temperature in Fahrenheit.

To determine the rate of temperature increase while you were holding the temperature sensor, perform some analysis of the graphed data. Select the Statistics button; in the pulldown Plot Statistics Menu of the Plot Statistics Area that appears, select All of the Above and Linear Fit under Curve Fit. The slope, a2, is the rate of temperature increase. You can improve the analysis by fitting the straight line to only a limited range of data, where the temperature in rising. Simply click on the initial data point in the graph and select the region with the expanding box; alternately, you can highlight the range of data in the Table display. The values in the Plot Statistics Area are now those for only the selected portion of the data. Next, use the cursor activated by the Analyze Tool button to confirm the values of the minimum and maximum temperatures and determine at which times these occurred.

Saving Your Results

[See pp. 238-242]

You have completed the first tutorial. To save the changes you made to the *Science Workshop* experiment, including the sensor information, new display windows, data, and analysis, select Save As... from the File menu. Be sure to give the modified experiment a new name so that the original experiment is not overwritten. With this and all data, you should save it in your own directory or disk so that you can find it later and so that the computer does not get filled up with extraneous files.

Often, you would like to save a particular data set in a file of tabulated numeric values. For example, you may wish to export your temperature data and analyze it further with *Mathcad*. Highlight the Table, then select Export Active Display from the File menu. Data is saved as a text file. An alternate method uses Cut, Copy and Paste. From within a Table window, highlight the data you would like to save, then select Copy from the Edit menu. The data is stored in the clipboard and may now be pasted into another program. Data pasted into a text editor (e.g., *WordPad* or *NotePad*), word processor (e.g., *Microsoft Word* or *WordPerfect*), or *Mathcad* is pasted as text. Data pasted into a spreadsheet (e.g., *Excel*, *Matlab*, or *Igor*) is recorded in cells.

You may also save data from Graph, Scope or FFT Windows. Using the Export Active Window method saves the Graph Window as a *Windows Metafile*. Cut, Copy and Paste can also be used to import graphical images of the Graph into other applications such as word processors or *Mathcad*.