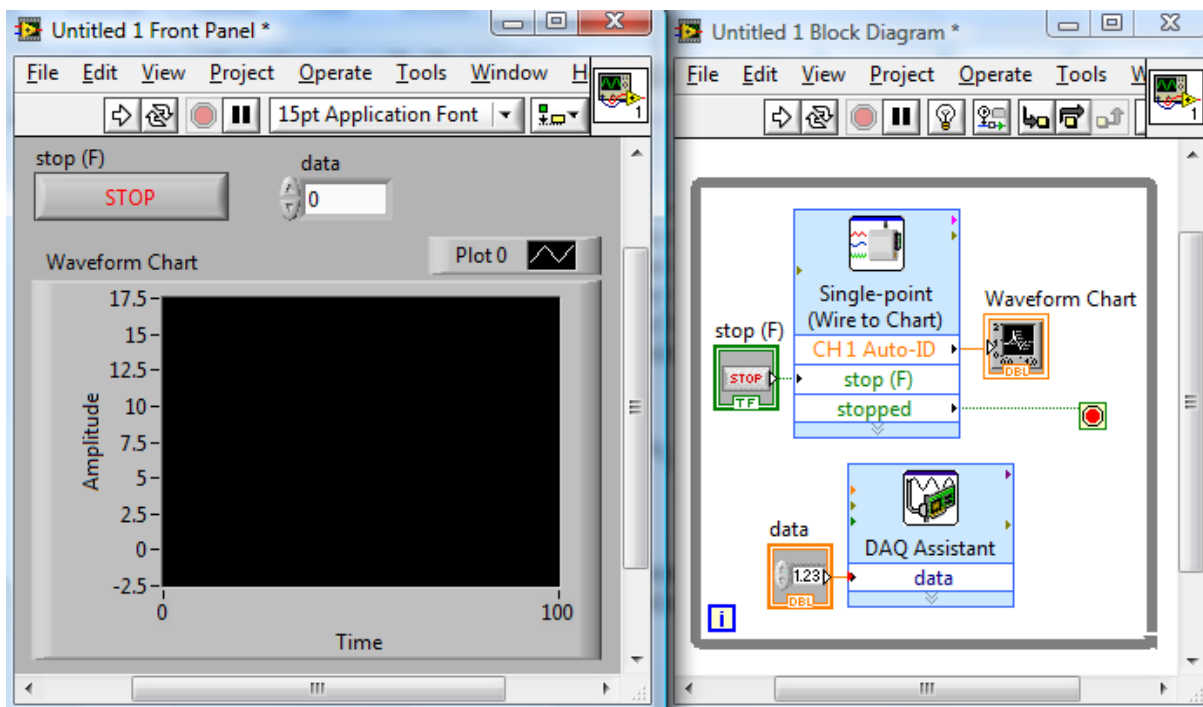# Control Analog Out, Digital Out, and Pulse Out

Completed front panel and block diagram

In this exercise, you will create a program to control the SensorDAQ's analog out terminal (pin 9 of the screw terminal connector).[1] In addition, a Voltage Probe will be used to read the voltage of the analog out terminal. The Analog Express VI is a simple way to program data collection from a Vernier sensor. The DAQ Assistant Express VI is a simple way to control the SensorDAQ's screw terminal channels. Steps will be taken to modify the VI to control the digital-out line and the counter line.

OBJECTIVES

In this exercise, you will

- Create a LabVIEW VI to control and measure the screw terminal analog-out line.
- Modify the VI to control and measure one of the four digital-out lines.
- Modify the VI to control and measure a pulse train output from the counter line.
- Learn to use DAQ Assistant.

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[1] This exercise applies specifically to the Vernier SensorDAQ interface. If you are using a LabQuest interface, skip this exercise.

MATERIALS

SensorDAQ

USB cable

computer

LabVIEW

Vernier Voltage Probe

small slotted screwdriver

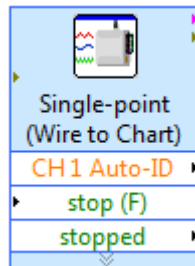short wire stripped of electrical
    insulation on both ends

PROCEDURE

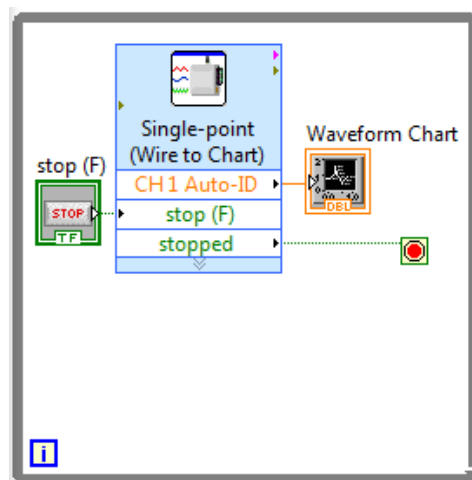**Part I Connect Equipment to Perform Analog Output**

1. Connect the USB cable to the SensorDAQ.

2. Connect the other end of the USB cable to any available USB port on your computer. The green LED on the SensorDAQ (next to the USB cable port) should be blinking.

3. Connect the Voltage Probe to Ch. 1.

4. Connect two short wire segments to SensorDAQ screw terminal AO (pin 9) and GND (pin 10).

5. Clip the red lead of the Voltage Probe to the pin 9 wire and the black lead to the pin 10 wire.

Part II Start LabVIEW and Create a VI to Control and Measure Analog Output
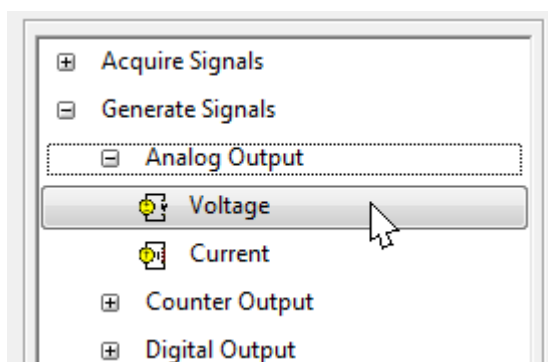
6. Start LabVIEW.

7. In the Getting Started window, click the Blank VI link in the New category.

8. View the block diagram using <Ctrl-E>.

9. Place the Analog Express VI in the block diagram. Leave the sample rate and experiment length at the defaults of 10 samples/second and 10 seconds, respectively.
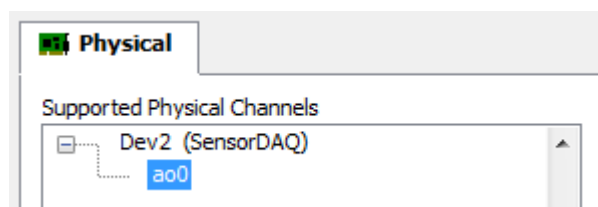
10. Place the Express VI within a While Loop. Create a STOP button control and a Waveform Chart indicator, and wire them appropriately to the Analog Express VI. Wire the Express VI's "stopped" terminal to the While Loop's conditional terminal.

11. Place the DAQ Assistant in the While Loop. The DAQ Assistant is found in the Measurement I/O ► DAQmx – Data Acquisition palette.

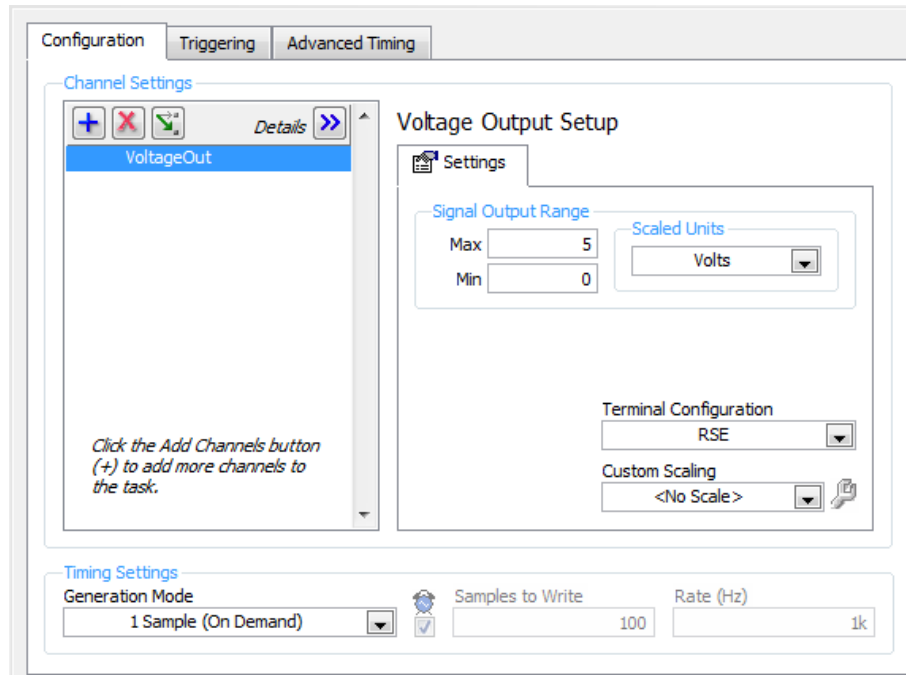12. Configure the DAQ Assistant for Generate Signal ► Analog Output ► Voltage.

13. SensorDAQ has one analog-output channel on the screw terminal called ao0. Select this channel by clicking on it. Click Finish to close this dialog box.
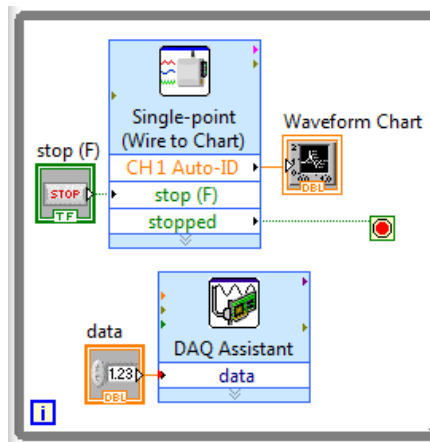
14. Keep the default configuration values: Signal Output Range of 0 to 5 Volts, Terminal Configuration of RSE, Custom Scaling of <No Scale>, and Generation Mode of 1 sample (On Demand).
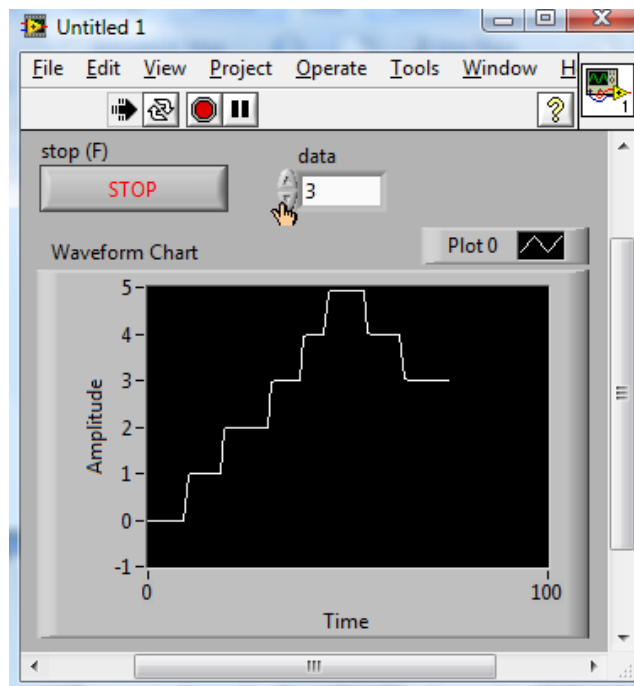

15. Click OK to close the DAQ Assistant's Configuration window.

16. Create a control to control the analog out value (right-click the DAQ Assistant's data input terminal and select Create ▶ Control).

17. Go to the front panel and organize the location of the "data" control, the STOP button, and the Chart.

Tip: To avoid an error message during operation, set the minimum and maximum values for the "data" control by right-clicking the control, selecting Properties, and clicking the Data Entry tab. The minimum should be set at 0, the maximum at 5.

18. Run the VI and change the "data" control's value to a value between 0 and 5. The Chart is reading the Voltage Probe and should verify the voltage output from the analog output line.
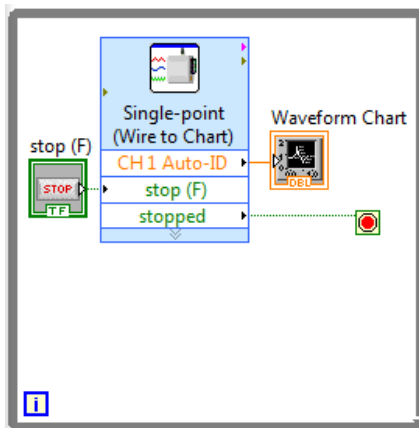

Part III Modify the Equipment Connections to Perform Digital Output

19. Connect two wires to SensorDAQ's digital I/O screw terminal PO0 (pin 1) and GND (pin 10).

20. Clip the Voltage Probe red lead to the pin 1 wire and the black lead to the pin 10 wire.

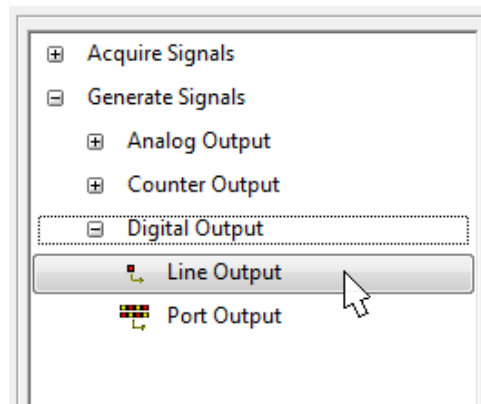**Part IV Modify the VI to Control and Measure Digital Output**

21. View the block diagram using <Ctrl-E>.

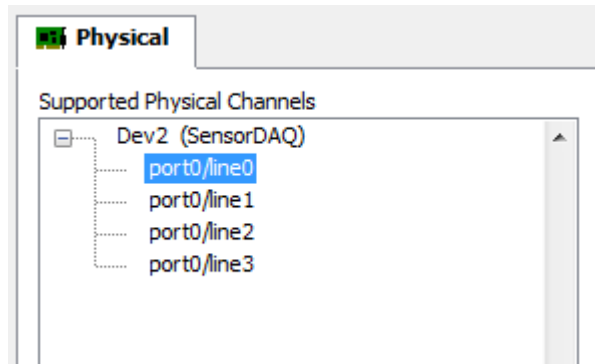22. Highlight and delete the DAQ Assistant and the data control.

23. Place a new DAQ Assistant in the While Loop (the DAQ Assistant is found in the Measurement I/O ► DAQmx – Data Acquisition palette).
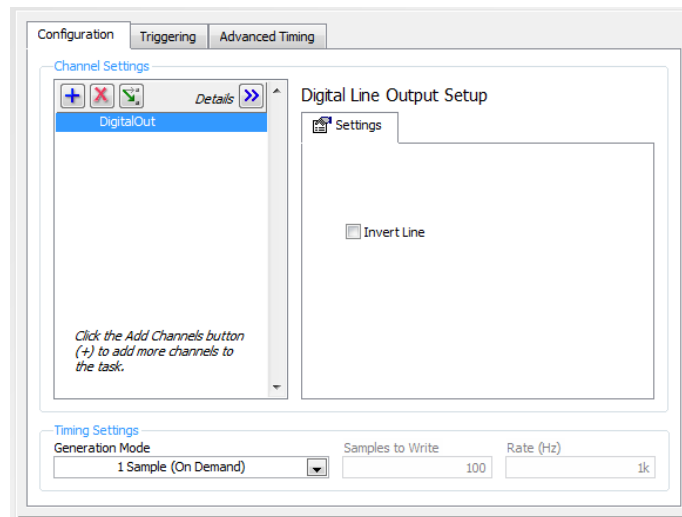
24. Configure the DAQ Assistant for Generate Signals ► Digital Output ► Line Output.

25. SensorDAQ has four digital output channels on the screw terminal. Select port0/line0 from the list by clicking it. Click Finish to close this dialog box.
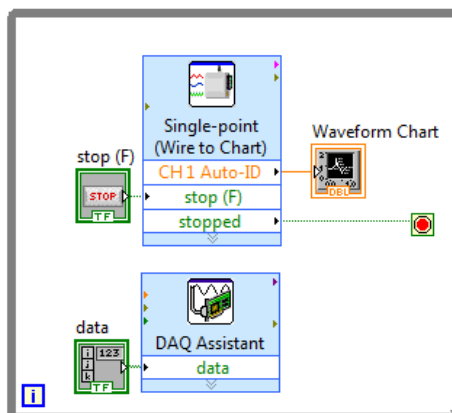

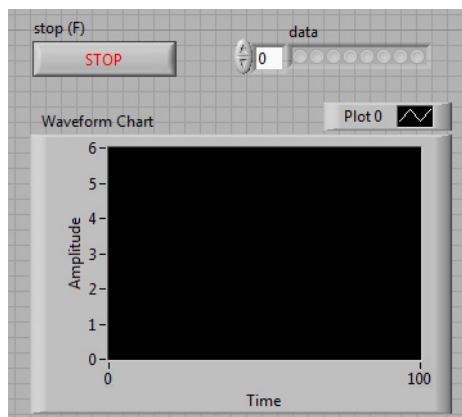26. Keep the default configuration values.

27. Click OK to close the DAQ Assistant's Configuration Popup.

Hands-On Introduction to NI LabVIEW with Vernier

28. Create a control to control the digital out value by right-clicking on the DAQ Assistant's data input terminal and selecting Create ► Control.

29. View the front panel using <Ctrl-E>. Arrange the controls and clear the chart. The chart can be cleared by right-clicking on the chart and selecting Data Operations ► Clear Chart.
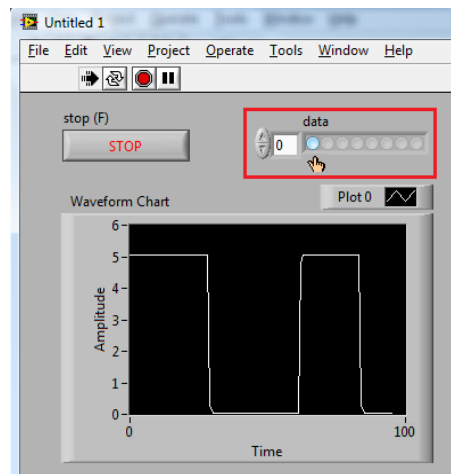

30. The data control for controlling the digital output line is an array of Boolean values. The Boolean elements are dimmed, indicating that they are uninitialized. Initialize the first element by clicking the element; it should turn blue. The Boolean value is now initialized with a True value. All of the other elements are not necessary for controlling the first digital line. The other elements are left uninitialized, making this an array of one element.

Tip: An array includes elements that are values or data (in this case, the data are Boolean) and an index display. The index display (the number and the increment/decrement arrow button) is to the left of the elements. If you have an array with many elements, the index display allows you to view the elements that are not readily visible. For example, to view element 56 you would enter that number in the index display. Do not confuse the index display as a way to change the values of the elements.

31. Run the VI and change the first Boolean element in the data array from True to False a few times. The digital line is controlled by this element, and the voltage measurement on the chart should reflect the line turning on (5 volts) and off (0 volts).
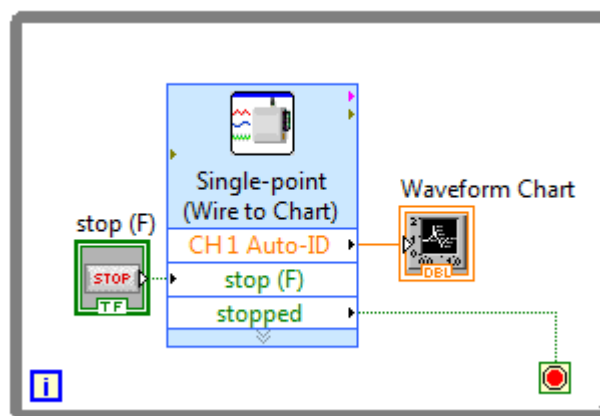

Part V Modify the Connections to Perform Pulse Output

32. Connect wires to SensorDAQ's counter screw terminal PFI 0 (pin 7) and GND (pin 10).

33. Clip the Voltage Probe red lead to the pin 7 wire and the black lead to the pin 10 wire.

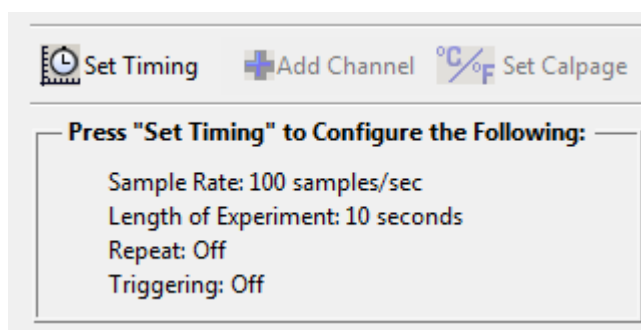**Part VI Modify the VI to Control and Measure Pulse Train Output**

34. Go to the block diagram using <Ctrl-E>.

35. Highlight and delete the DAQ Assistant and the data control, and resize the While Loop to contain the STOP control, the Analog Express VI, and the Chart.

36. Open the configuration dialog of the Analog Express VI by double-clicking on it.

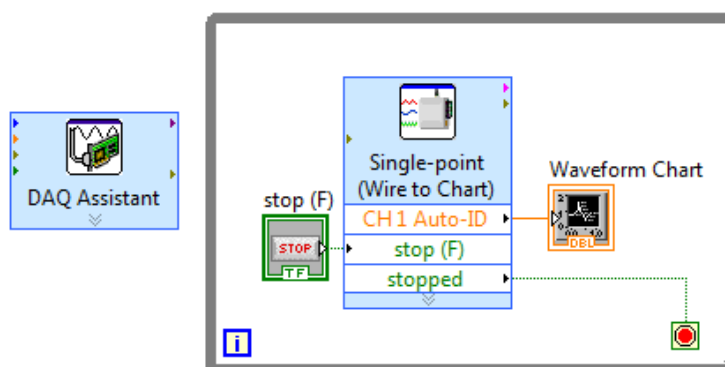*Hands-On Introduction to NI LabVIEW with Vernier*

37. Modify the timing for a sample rate of 100 samples/second for 10 seconds.
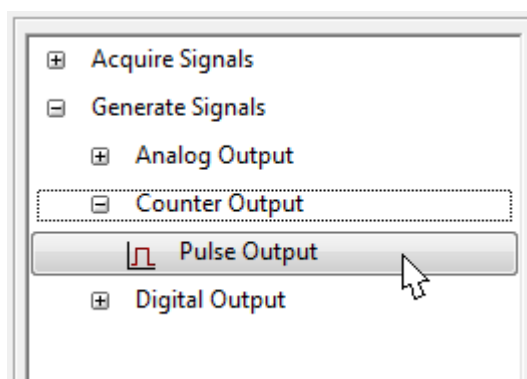

38. Place a new DAQ Assistant to the left of the While Loop (the DAQ Assistant is found in the Measurement I/O » DAQmx – Data Acquisition palette).

Tip: The DAQ Assistant is not wired to anything; it is floating outside the While loop. This is because we want to start the pulse output, and start monitoring the voltage probe reading at the same time. The DAQ Assistant is not placed inside the While loop because we only want to start pulse output one time. In addition, the design of the Analog Express VI does not allow you to start data collection and then start pulse output.
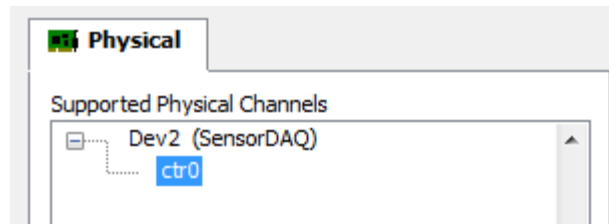

39. Configure the DAQ Assistant for Generate Signals ► Counter Output ► Pulse Output.
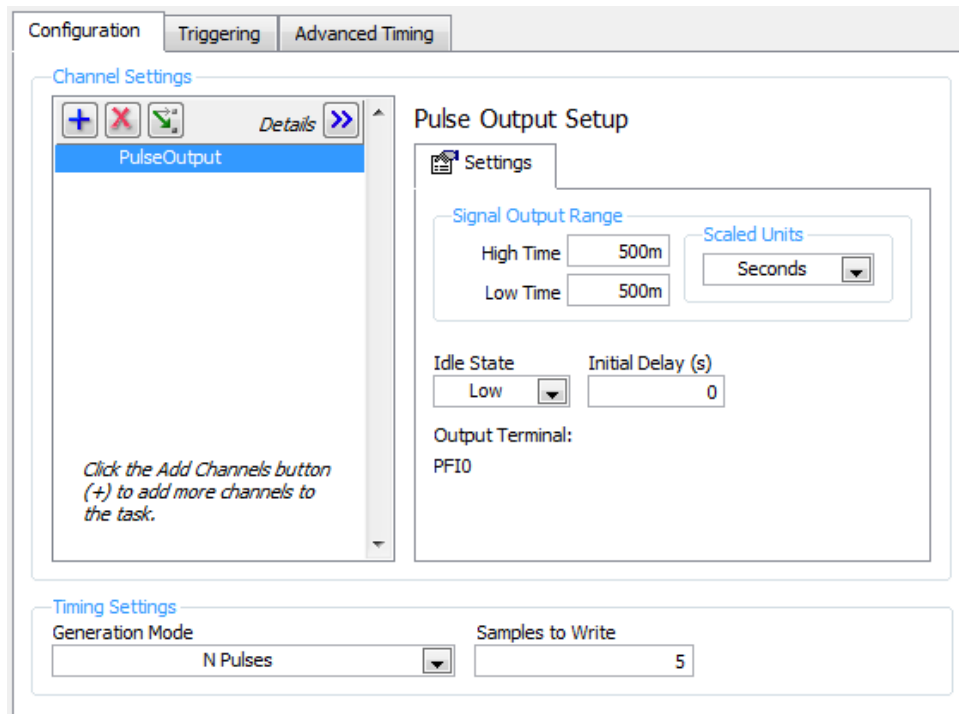
40. SensorDAQ has one counter/timer channel on the screw terminal, called ctr0. Select this channel by clicking it. Click Finish to close this dialog box.
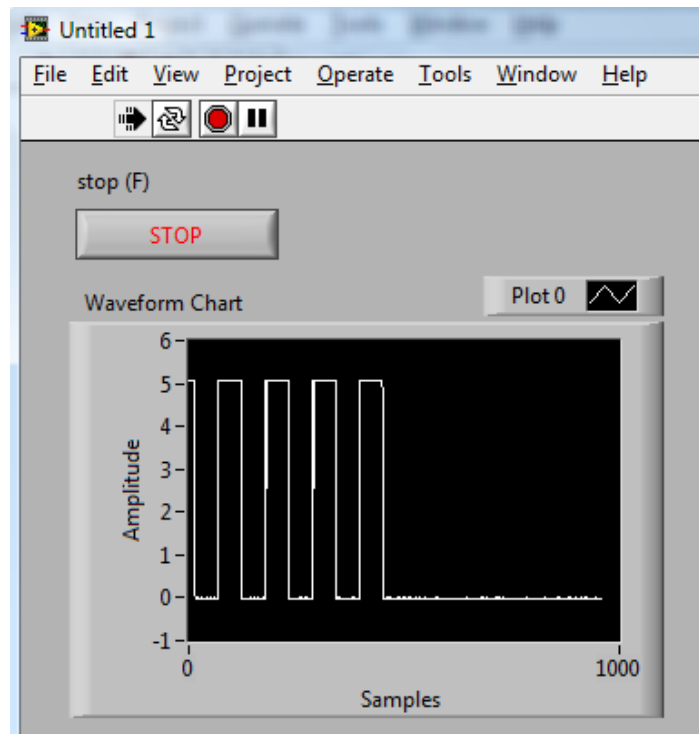
41. Modify the pulse output configuration with a high time of 500 milliseconds, a low time of 500 milliseconds, generation mode of N Pulses, and with 5 Samples to Write. Click OK to close the DAQ Assistant's Configuration window.

42. Go to the front panel.

43. Change the x-axis on the chart to "Samples" and a maximum x scale value of 1000.

44. Clear the chart's previous plot (right-click on the chart and select Data Operations ► Clear Chart).

45. Run the VI. The voltage measurement of the 5 pulses should show on the chart's plot line.

EXTENSIONS

1. Write a program to automate analog output. The voltage should increase by 0.1 volts, every second, for 50 seconds.

2. Write a program to produce a sine wave voltage output pattern with a frequency of 1 Hz and an amplitude of 5 volts. Consider using the Simulate Signal Express VI to generate the output values. This Express VI will create an array of all of the values, but you will need to feed them into the DAQ Assistant one value at a time.

3. Write a program to turn on digital output line 1 if a sensor reading is above a user-defined threshold, and turn on digital output line 2 if the sensor reading is below the threshold.