# Auntie Spark's Guide to creating a Data Collection VI

Suppose you wanted to gather data from an experiment. How would you create a VI to do so? For sophisticated data collection and experimental control, you would use the DAQmx VIs or the DAQmx Advanced VIs. Configuring them can at times be a bit of a chore, so it's much easier to use the DAQ Assistant for simple data acquisition tasks. However, to use it you still need to understand some things. First of all is sample rate. You need to have some idea of how much data you need to collect and how fast. The sampling theorem says that you must sample at least twice the maximum frequency in your signal, but in spite of E59 (because of E59?) few students actually know what that means. Where can you go for hints? Check out the data sheet for the sensor you're using. It will often have either a bandwidth, a response time, or a time constant listed. If it has a bandwidth listed, the sampling frequency must be at least a little more than twice the bandwidth. If it has a time constant, the cutoff angular frequency is the reciprocal of the time constant, and the cutoff frequency is the angular frequency divided by 2π. So the sampling frequency must be at least a little more than the reciprocal of $\pi\tau$. If they give you a response or rise time, you've got some homework to do. Start at http://en.wikipedia.org/wiki/Rise_time. If the above isn't sufficient, talk with a professor or proctor. If you don't mind processing a lot of data, consider 5 to 50 times the minimum sample rate.

With sample rate out of the way, you need to determine the range of your signal. In other words what is the maximum and minimum voltage you need to measure? The myDAQ has two ranges, ±10V and ±2V. If your peak voltages are in the range of ±2V you'll get more accuracy in your measurement if you set the range to ±2V rather than ±10V. The USB-6211 DAQ has ranges of ±10V, ±5V, ±1V, and ±0.2V. It will read signals in the 20mV to 200mV range without an external amplifier. If your signal has excursions outside of ±10V, you'll need to attenuate your signal. For signals in the 0-to-5V range, you'd use the ±10V range on the myDAQ and the ±5V range on the USB-6211.

Let's assume we have a ±1.5V sine wave at 150 Hz that we want to capture. The first step is to determine the sampling rate and voltage range. For a 150 Hz sine wave the sampling theorem says that the sampling rate has to be at least slightly larger than 300 SPS. If you don't mind processing large data sets, the sample rate can be set to 10-to-100 times the signal frequency, in this case 1500 SPS to 15,000 SPS. The myDAQ can sample at up to 200 kSPS and the USB-6211 at up to 250 kSPS, so we're safe with our sampling rate range. The ±1.5V range means that we'd choose the ±2V input range for the myDAQ or the ±5V input range for the USB-6211.

Now, to build our VI: First, we want to make certain that our DAQ is working. Plug one end of the USB cable into the DAQ and the other end into the computer. Depending on the OS version, you may get a message about installing drivers. Let the drivers install. Next, make sure that neither LabVIEW nor any of the NI-DAQ Elvis or myDAQ instruments are running. If they are, quit them. There can be contention among the various programs for the driver for the DAQ, and quitting the other programs minimizes the troubleshooting you'll have to do. Then, start NI MAX, the National Instruments Measurement and Automation Explorer (usually in the National

Instruments folder on the start menu). With any luck it will start up and it will have a list of items on the left hand side.
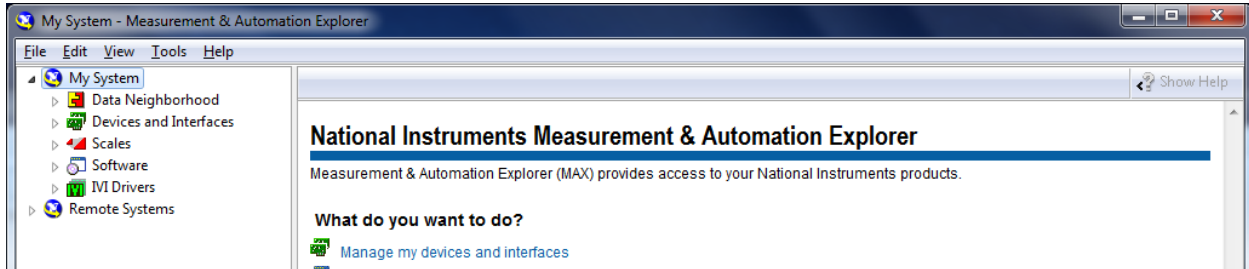
Click on the little triangle next to Devices and Interfaces. Again, with any luck your DAQ will show up in the list, in this case NI myDAQ "myDAQ1" (If a computer has had multiple DAQs or myDAQs plugged into it, you may see numbers other than 1 in the name).
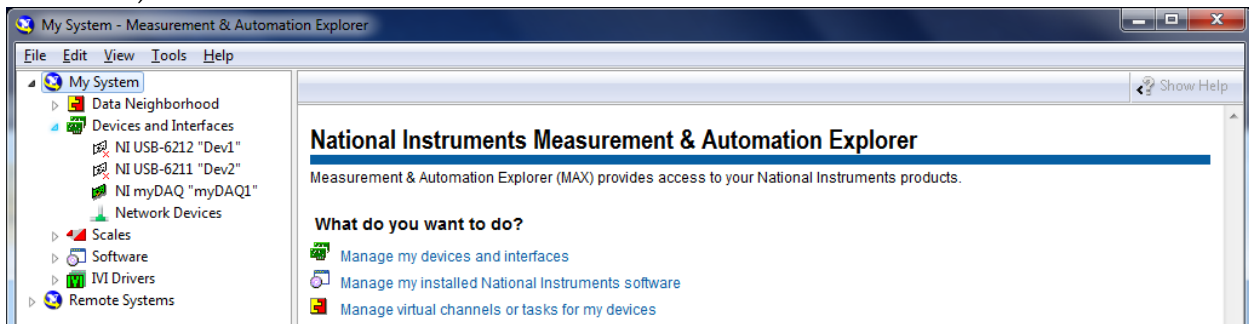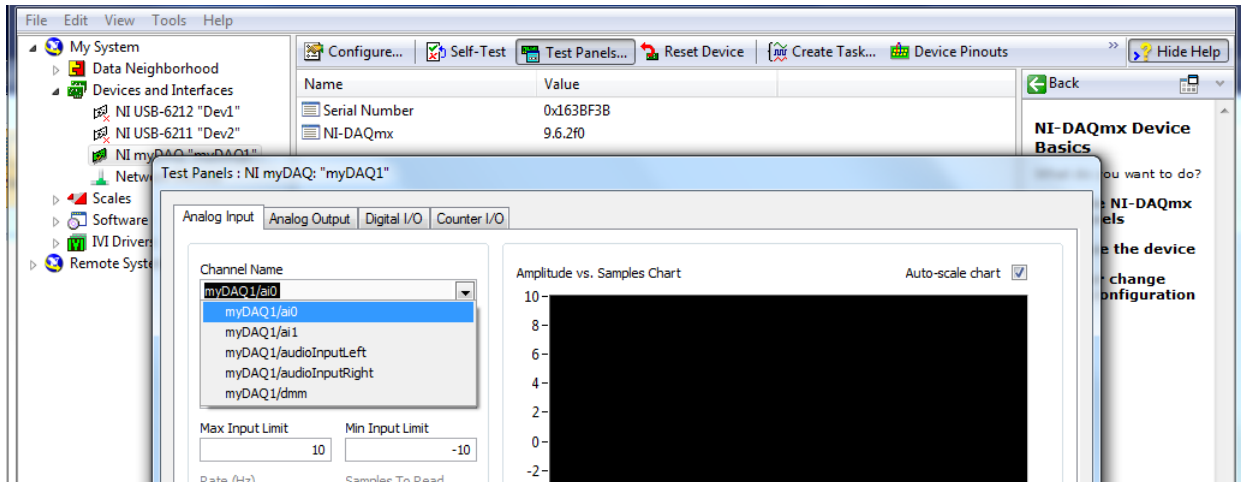


Clinic on the device name and a set of tabs should appear.
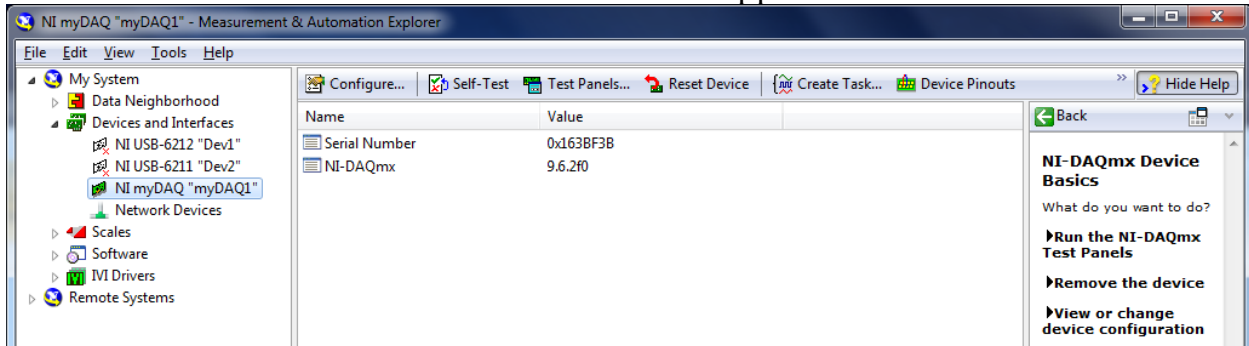
Click on the Test Panels… tab. The test panels should appear. In this case we want to check the analog input so click on the Analog Input tab if it isn't already selected.

First we want to select the correct input channel. For this myDAQ we want analog input channel 0, so we've chosen myDAQ1/ai0.

We also want to choose how the DAQ updates or reads a sample. For our test, On Demand is sufficient.
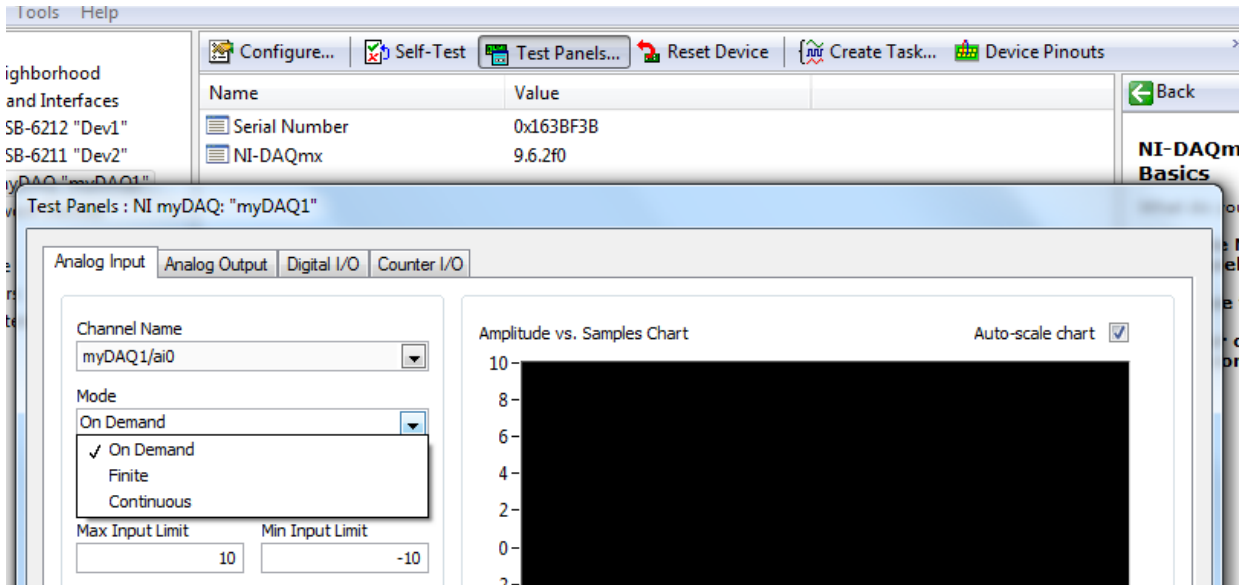
Next, we have to let the DAQ know how we are going to connect the sensor or voltage source. For the myDAQ, the only choice is Differential. For other DAQs you also have a choice of Referenced Single Ended (RSE) or Non-Referenced Single Ended (NRSE). It is extremely rare to use NRSE. The differences are explained in almost any National Instruments device manual or at http://www.ni.com/white-paper/3344/en/. You can also ask a professor.
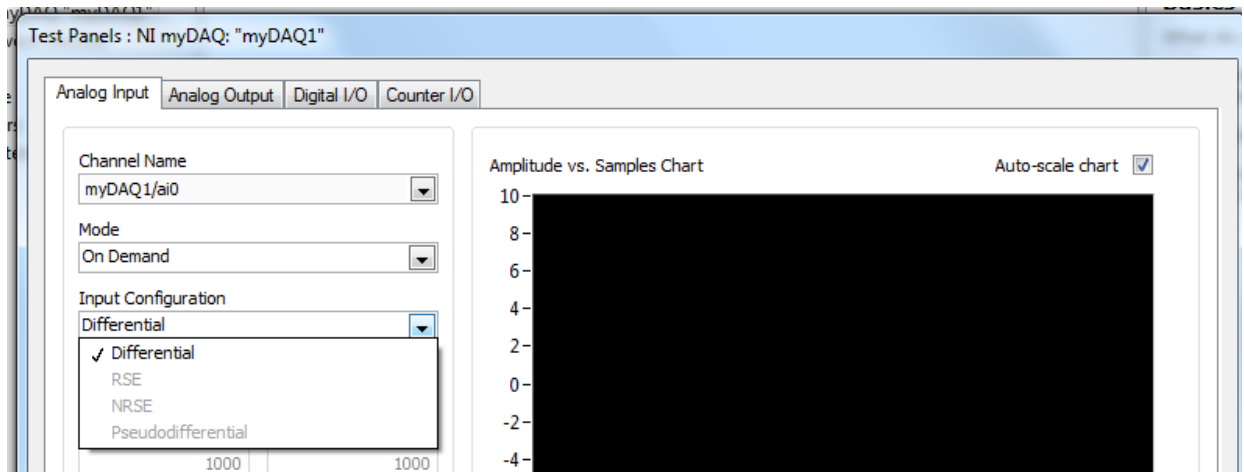
Last we choose the input range, for the myDAQ we choose ±2V for the signal that doesn't exceed ±1.5V.

Now we need to connect the wires to the DAQ. For the myDAQ we'll connect AI0+ to the input signal, and AI0- to the signal ground and AGND on the myDAQ. Press Start on the panel. Because the On Demand samples irregularly and at a slow rate, the output will not appear as a sine wave, but more as a random waveform.
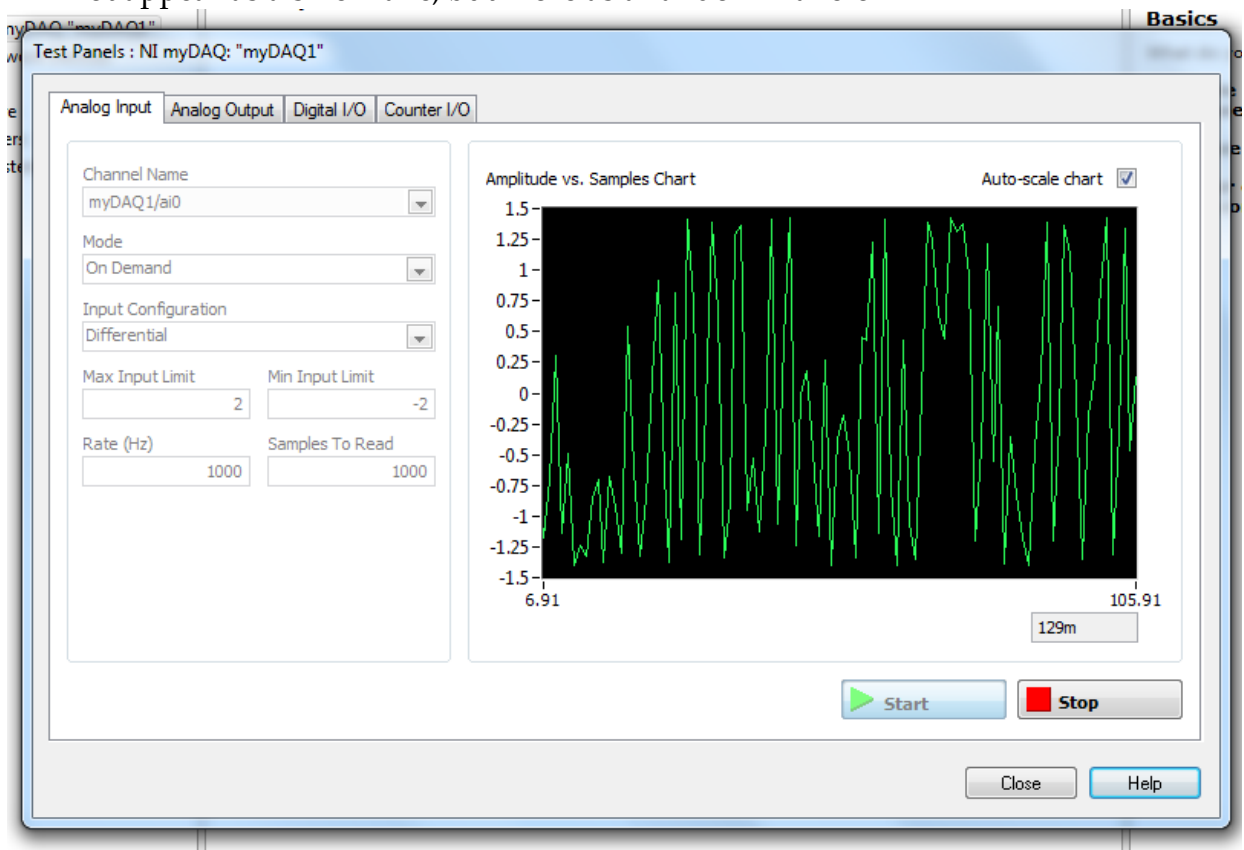

Since we are getting signals and they're staying in range, our test has been successful.

Quit NI MAX and start LabVIEW and create a new VI. Bring up the block diagram and add a DAQ Assist(ant) subVI (either right click and search under the Express VIs pallet and Input sub-pallet, or search for it). After a short (or long) time the Create New… frame should appear.
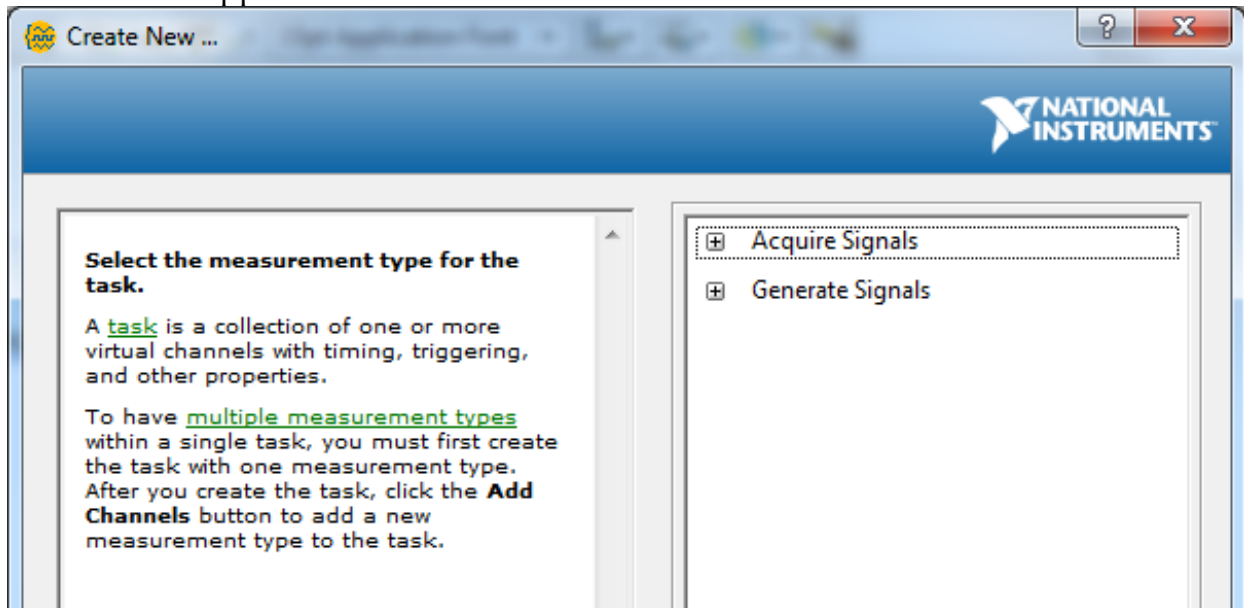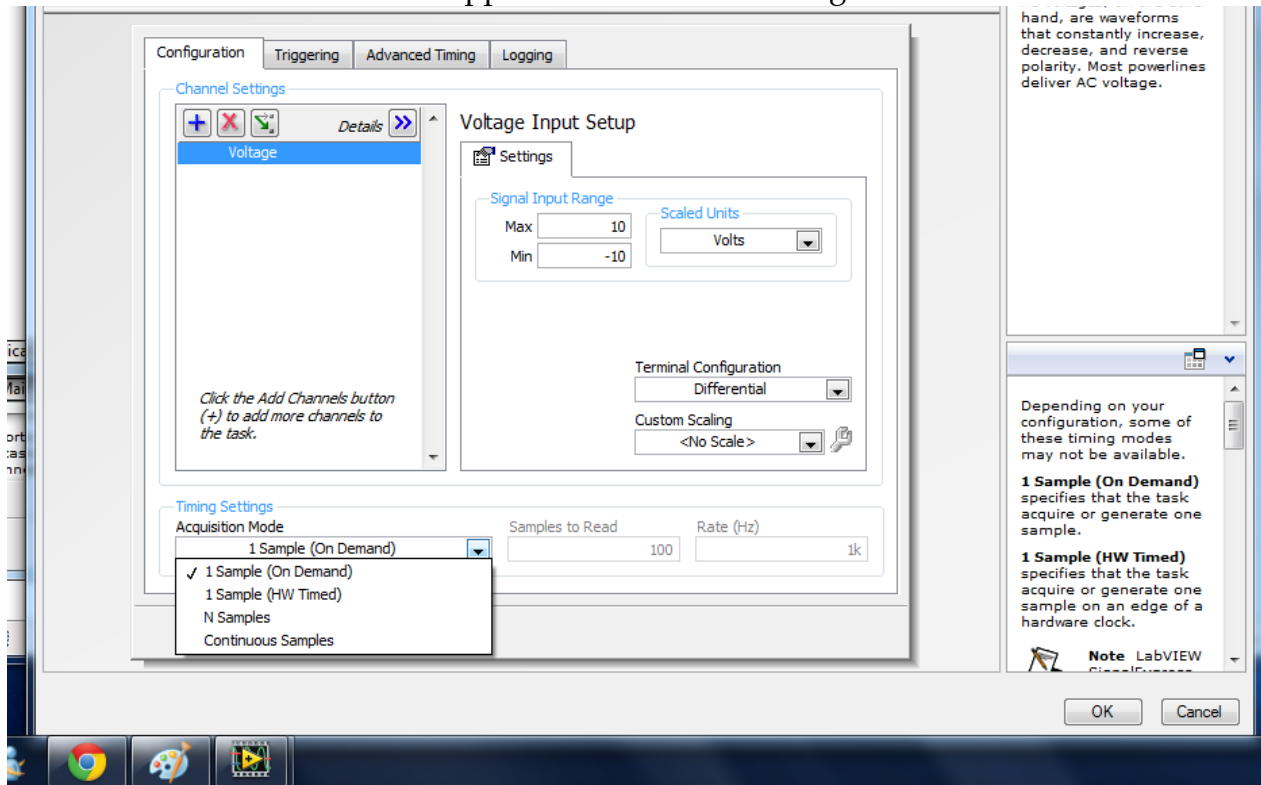

Click on the +-box next to Acquire Signals, and then on the +-box next to Analog Input,
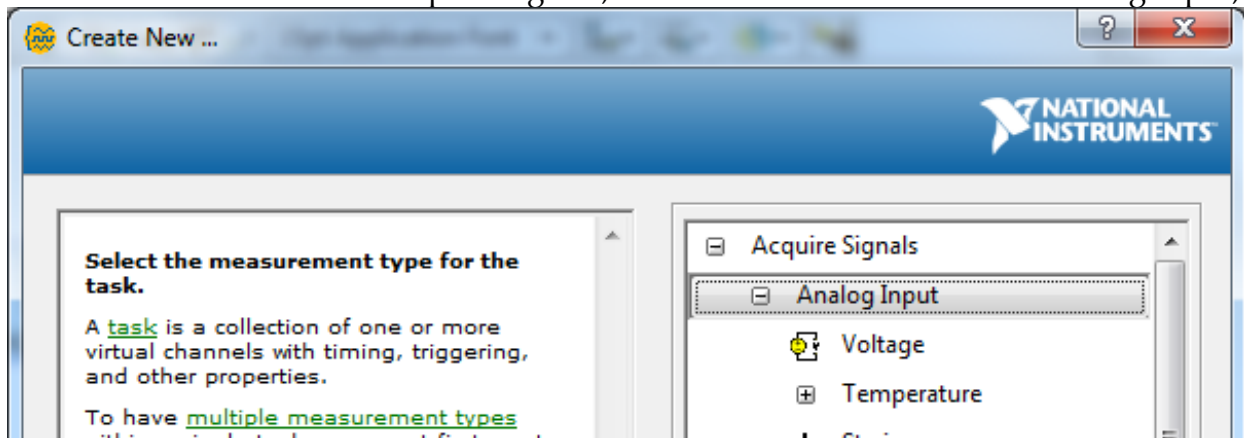
then click on Voltage. The right side of the frame should fill with a Physical tab. Select ai0 and then click Finish.
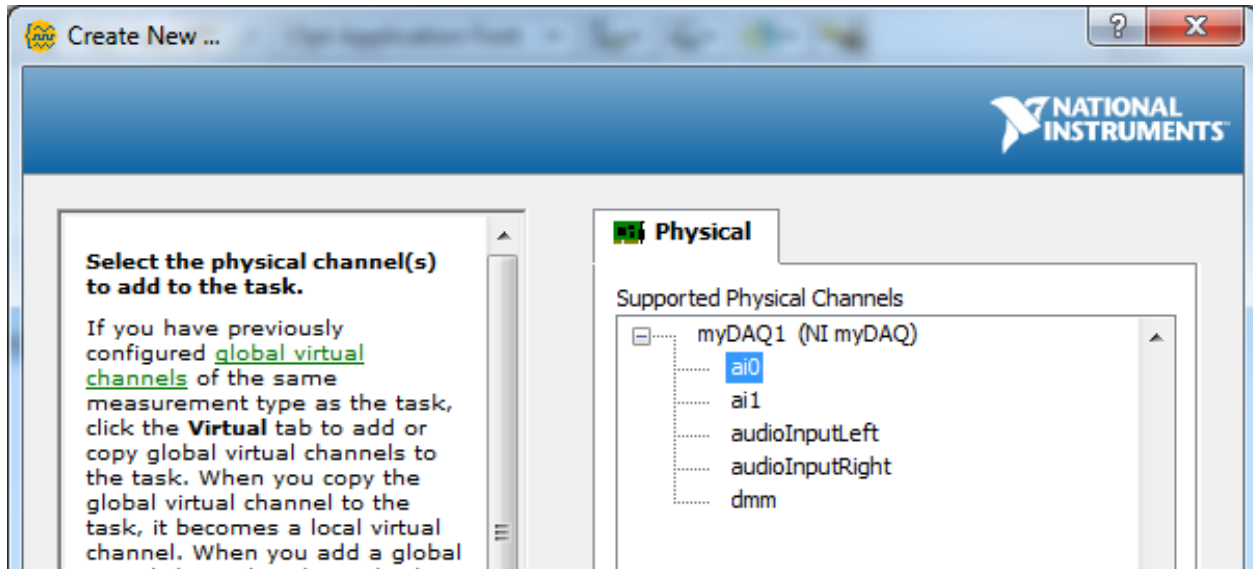
A set of additional tabs should appear. We want the Configuration tab.


Click on the Acquisition Mode pop-up. We will want either N Samples or Continuous Samples. N Samples will fill up one buffer of a size that we select at a rate we select. If you know exactly how many samples you want to collect, and the size isn't too large, N Samples is a good way to go. If you put a DAQ Assistant set to N Samples in a For or While Loop, it will collect a buffer of N Samples and wait for the loop to finish. The next loop it will collect another N Samples, but they probably won't be contiguous with the

buffer you collected before. If you plotted the buffers right after each other, you would probably notice a discontinuity at the buffer boundary.

If you don't know how many samples you need or need more contiguous samples than will fit in one buffer, you probably want Continuous Samples. You can still set the buffer size and the sample rate, but the DAQ Assistant won't reinitialize each loop and if your computer is fast enough, the buffers would be contiguous and wouldn't show discontinuities at the buffer boundaries.

For this VI let's choose N Samples, and the Samples to Read (buffer size) to 1500 samples, the Rate (Hz) (the sample rate) to 15,000 SPS, and the Signal Input Range to a Max of 2 V and a Min of –2 V. After setting things, click the Run button near the top left of the window to make sure data acquisition is working. In this case we get a nice section of a sine wave.
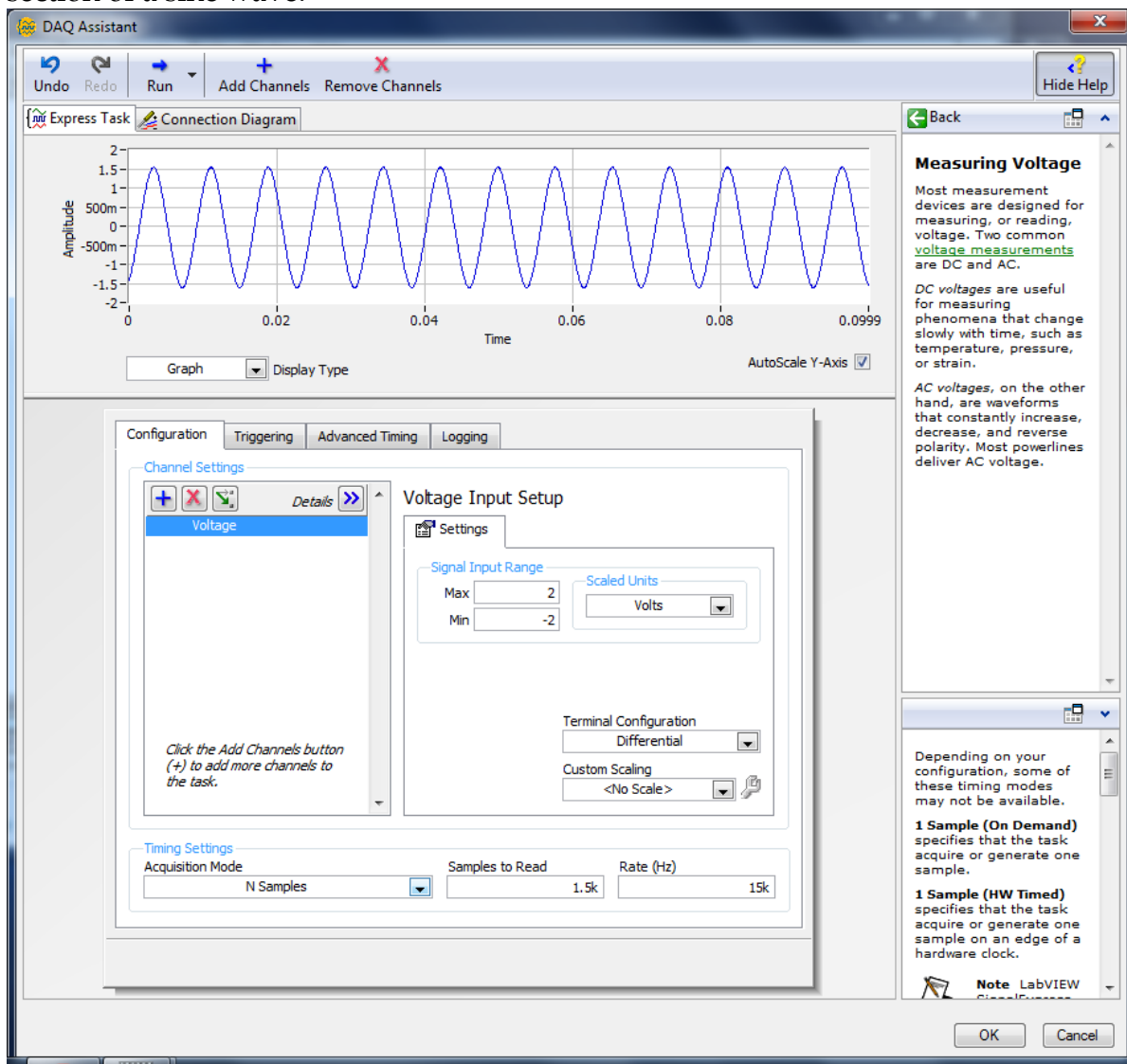
Now that everything is working, click the OK button near the bottom right of the window. After a short while, The DAQ Assistant subVI should appear. It's probably time to save the VI.
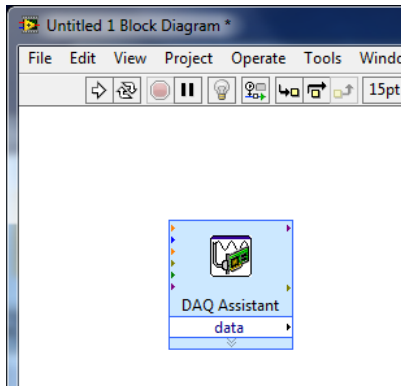

You might want to look at the data. Right click on the data connector on the subVI and choose Create -> Graph Indicator. Then rename the indicator to something more descriptive than "data".
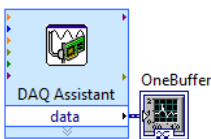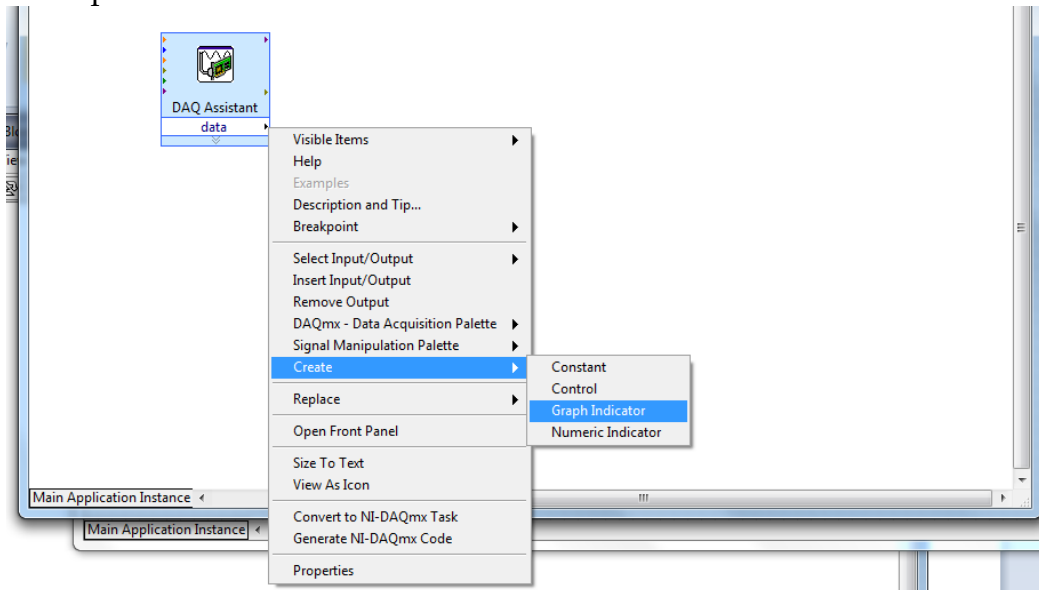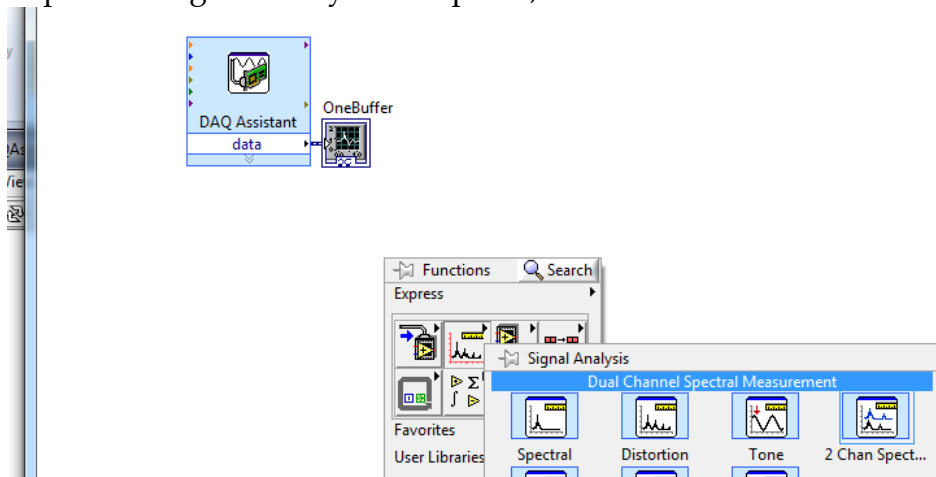

Now bring the Front Panel to the front, and run the VI. You should get one buffer's worth of sine waves. You can resize, re-label, and re-color the graph to suit your tastes. Professors always want to see axis labels with units on the two axes. Each time you run
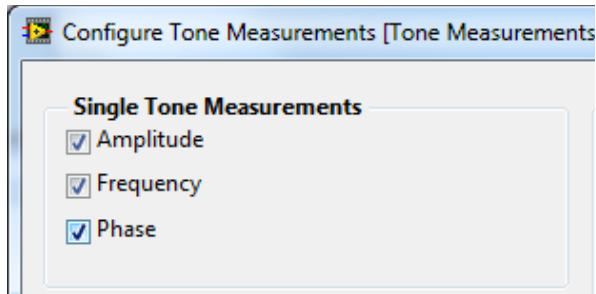
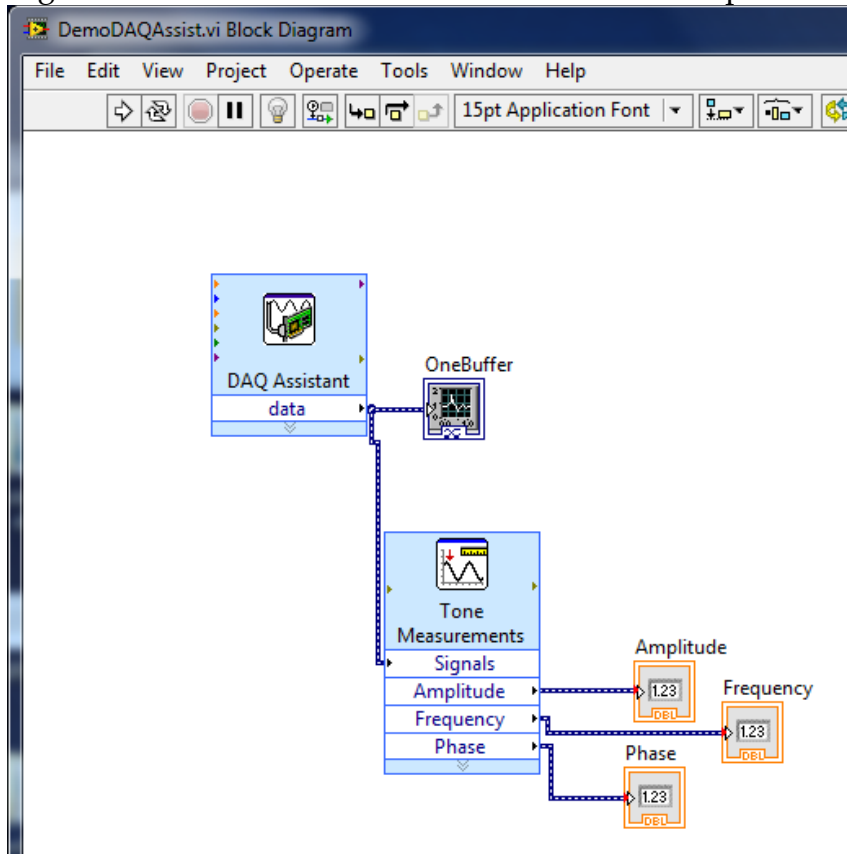the VI you'll get a new buffer of data

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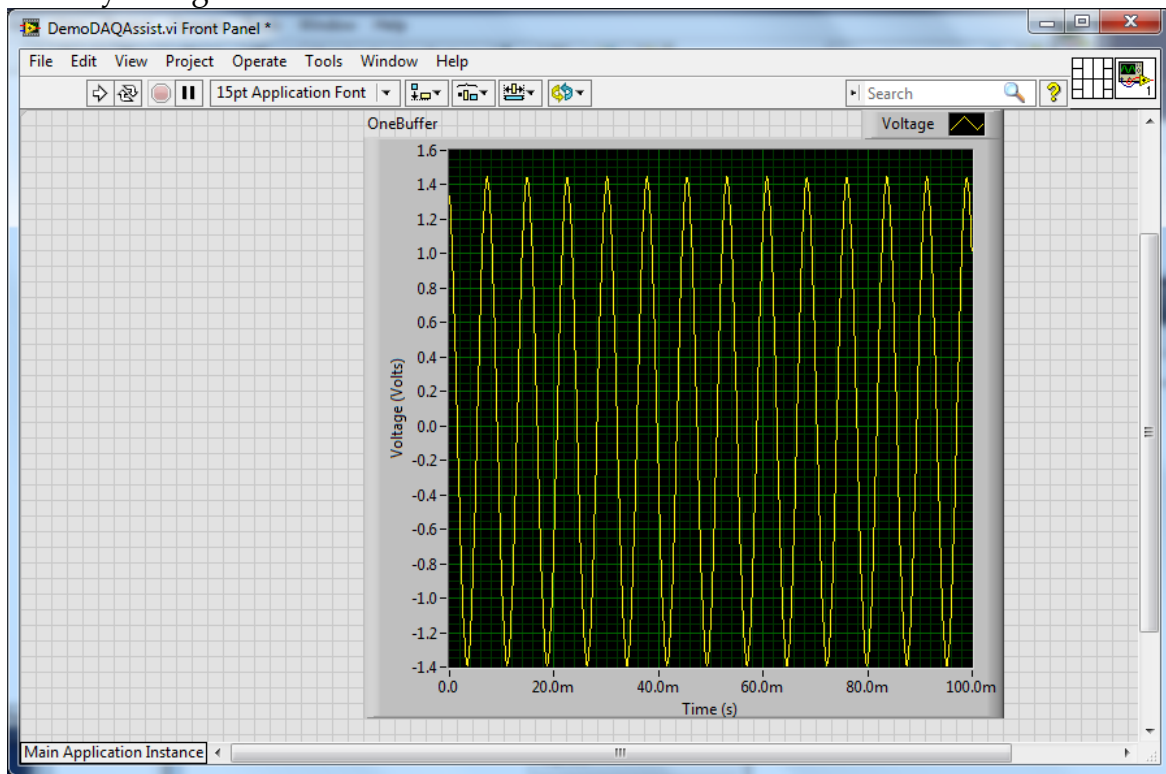
If you want to process the data you can do so. For example, if we wanted the amplitude, frequency, and phase of the sine wave, we could select Tone Measurements from the Express -> Signal Analysis sub-pallet,
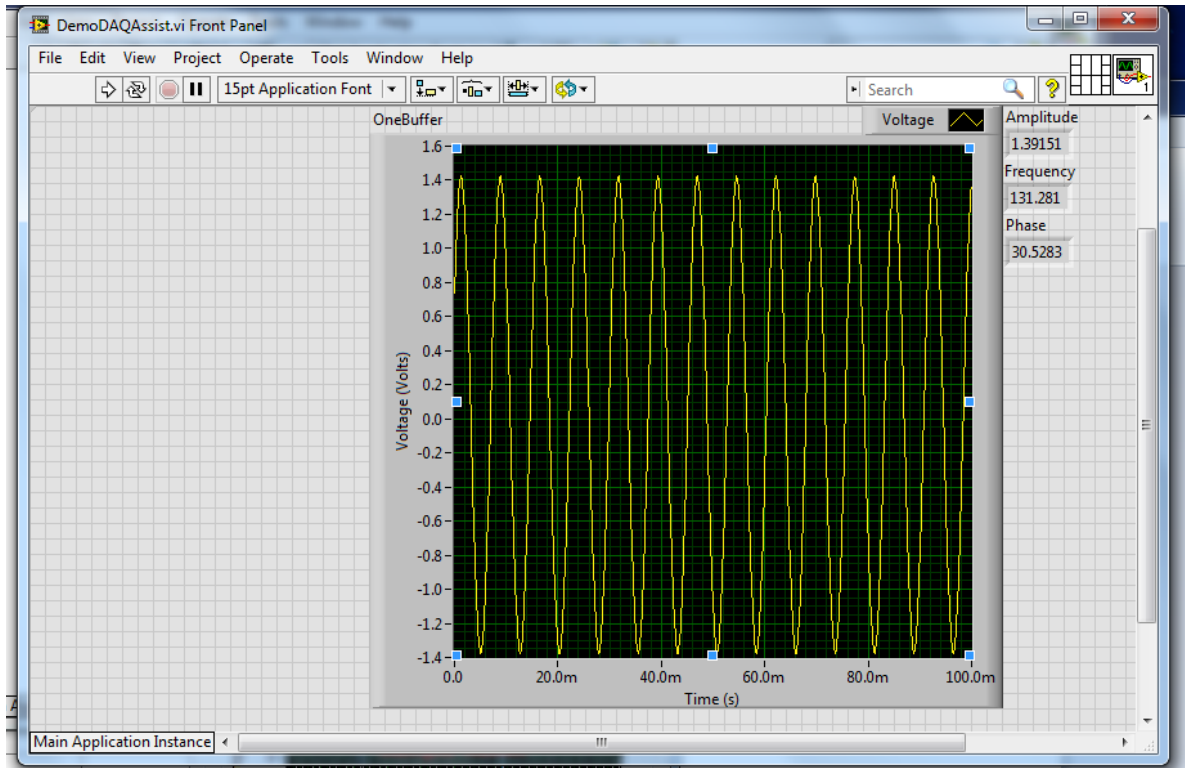

and choose Amplitude, Frequency, and Phase.

Right click and create indicators for each of the outputs.

Switch to the front panel and run the VI. The Amplitude and Frequency should be fairly close to constant, but the phase should vary randomly.
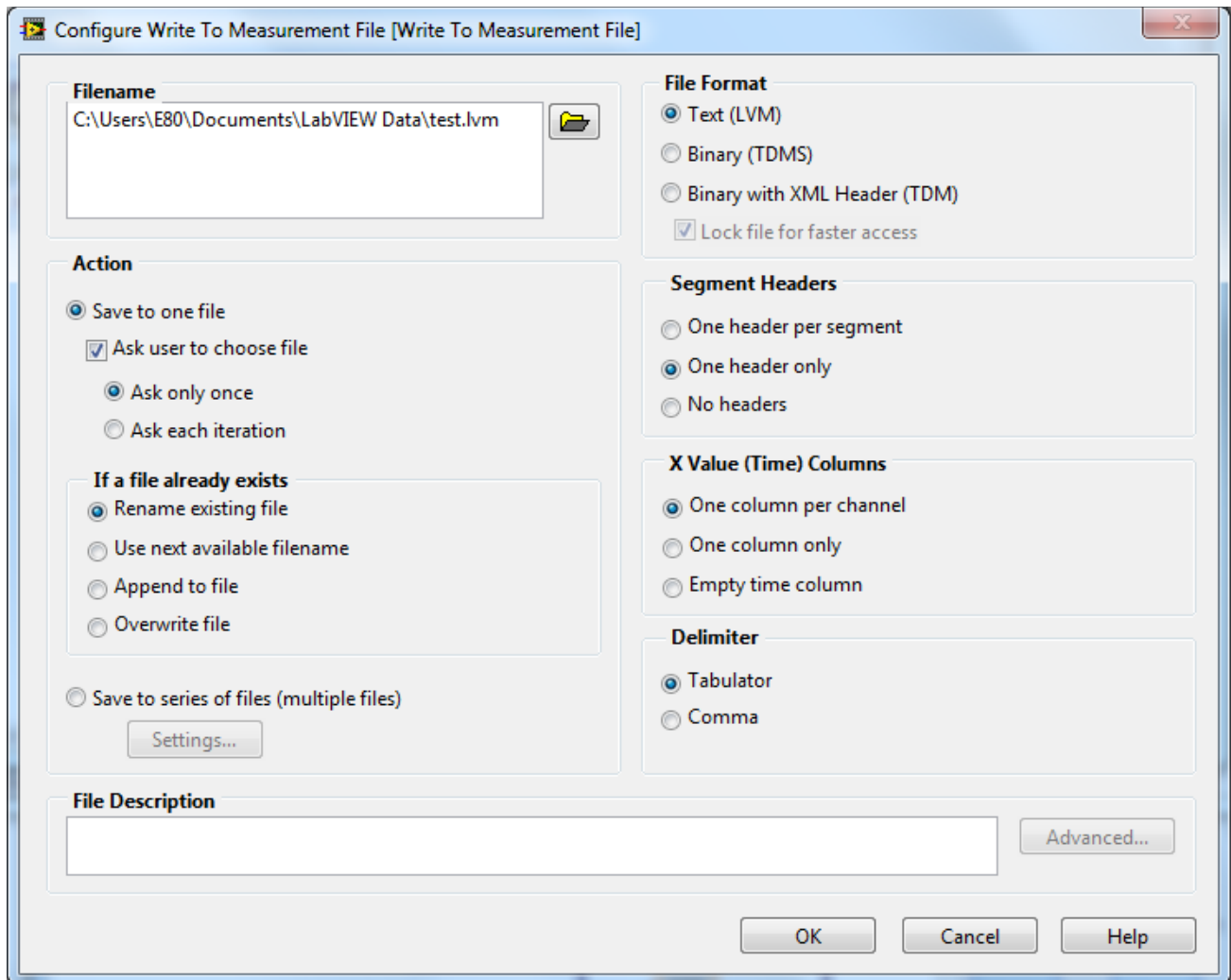
You can save the waveform data and the calculated values to a file for later analysis with the Write To Measurement File VI, in the Express VI -> Output Pallet.
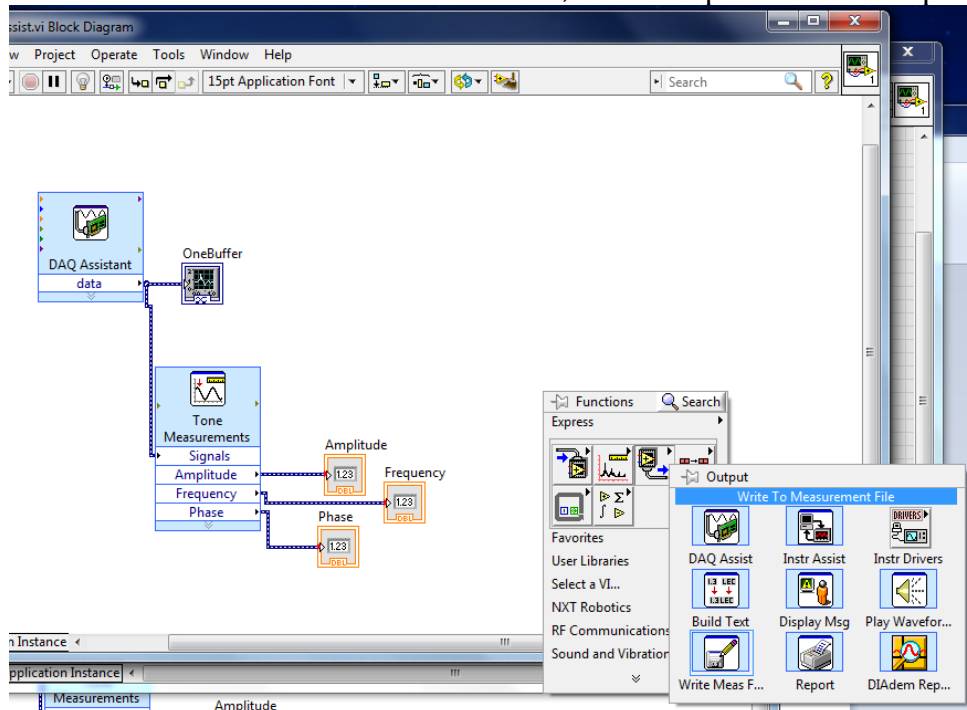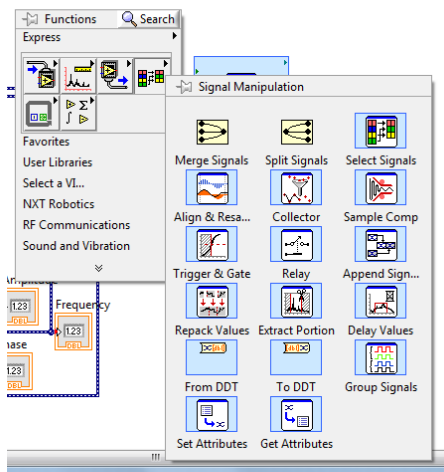

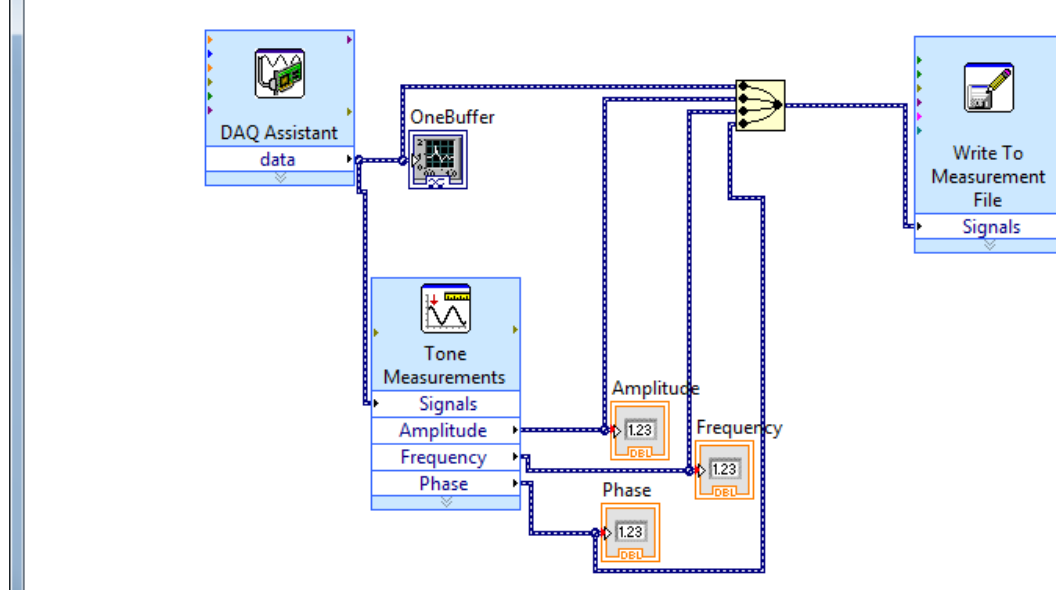Probably the most useful settings are shown below.

The signals can be merged with a Merge Signals VI under Express -> Signal Manipulation.

The resultant file will have both the waveform data and the calculated data and can be opened in a text editor, Word, Excel, MATLAB, or LabVIEW for further processing.

If you need to acquire continuous data you'll want to make a few modifications to the above. Open the DAQ Assistant and change from N Samples to Continuous Samples. When you close the DAQ Assistant you'll get a dialog box asking if you want to enclose the DAQ Assistant in a while loop. Click YES. It won't be very intelligent about the choice of location for the loop. Move the rest of the VI inside the loop. If your sample rate is low (100 SPS or lower) you can probably still let the user choose the file name, but at faster rates the DAQ buffers will overflow while selecting the file name so you'll want to set up a default file name with a number at the end, and uncheck Ask user to choose file. Also set If a file already exists to Use next available file name. That way each time you run and stop the VI it will add a new file and increment the name by one.

You can of course do any other sort of LabVIEW processing you desire in your VI.