

Waveform Data Acquisition Experiment

Pre-lab Questions

1. What is the difference between a Waveform Chart and Waveform Graph in LabView?
2. How can you create and wire a constant to the terminal of an icon automatically?
3. How can you change the background color of a chart or graph from the default (black) to white to save yourself some ink in printing the Front Panel?
4. What does the key combination CNTL-H produce in LabView?

Purpose

- To familiarize students with data acquisition concepts
- To gain practice using LabView

Learning Objectives

Upon completion of the laboratory, the student will be able to:

- Develop a sub-VI using LabView to control the data acquisition of an analog signal
- Interface a PC based data acquisition card with a signal source
- Output acquired data to a file that can be read by a spreadsheet program

Components

<u>Qty.</u>	<u>Item</u>
1	National Instruments DAQ Signal Accessory (PN 777382-01)
1	National Instruments PCI-6024E Multifunction DAQ board
1	Ribbon Cable, 1m (PN R6868)
1	Jumper wire, 24 AWG, 2 inches long

Introduction

It is very common practice in laboratory work to acquire an analog (that is, a continuously varying (usually voltage)) signal using a PC-based data acquisition card and some kind of software to control the acquisition process. LabView is a graphical programming language that can control a data acquisition card and analyze and present the acquired data.

Several important parameters associated with controlling the acquisition process are the sampling rate, usually expressed as samples/second, and the number of samples taken. The sampling rate is how often the measurement is made. Sampling rate is important especially with signals whose amplitude changes relatively quickly in time. The sample rate needs to be high enough to keep up with the changing signal or else you will obtain spurious data. That is, if you try to reconstruct the original waveform from the data that you sampled, you will see frequency components that were not part of the original signal. (For more information on this, see the following websites):

<http://www.cage.curtin.edu.au/mechanical/info/vibrations/tut3.htm>

<http://www.mustagh.com/alias/Alias.html>

The number of samples is important in determining memory requirements, data acquisition time, and frequency resolution (for frequency content analysis).

In this lab, you will use a high-level analog input VI, build a user-friendly front panel to enable a user to enter data acquisition control parameters, display results of your data acquisition, and write the data to a file that can be opened as a spreadsheet and subsequently analyzed.

Procedure

1. Pair up with another student in the class, and get set up at one of the computer stations in the lab.
2. On the DAQ Signal Accessory, connect the sine wave output to the AI channel 1 input using a short length of jumper wire. See your lab instructor if the DAQ Signal Accessory does not already have a jumper wire. Note that the sine wave generated by the DAQ Signal Accessory is 2 V peak-to-peak.
3. Open a blank VI. Press Cntrl-T to get the Front Panel and Block Diagram fully visible. Press Cntrl-H to open Context Help (if not already open).
4. Download the ME120WaveformAcq.vi from the ME 120 website (under Lab View Resources) to the Desktop of your PC. Use the 'Select a VI...' menu pick to insert the ME120WaveformAcq.vi into your Block Diagram.
5. Build a VI using the AI Acquire Waveform (ME120).vi with the following features:
 - a. Allows the user to input the Sample Rate and Number of Samples in an intuitive and user-friendly way.
 - b. Displays the sampled waveform on a plot of amplitude vs. time
 - c. Displays the Power Spectrum of sampled waveform on a graph of amplitude vs. frequency. (The power spectrum shows the frequency components of a waveform (remember the Fourier Series for a signal?) The ordinate of the power spectrum has units of volts RMS squared, $(V_{RMS})^2$ and is a measure of the power in the harmonics of the signal. The Power Spectrum.vi is under Functions → Signal Processing → Spectral Analysis)
 - d. Outputs the waveform data from part b and c to spreadsheet files. (It is recommended to save time in data collection that you incorporate this functionality by giving the user the *option* to save (say through a switch) rather than automatically saving the data each time the VI is run. Once you get a sense for which measurements are worth saving, then you can enable writing to a file.)
6. Investigate (that is, record data for) how the sampling rate affects the acquired waveform as function of frequency. To do this, you will want to choose a wide range of sampling rates. For example, if the frequency of the sine wave is 1 kHz, choose at least five sampling rates between, say 100 Hz and 10 kHz. As you investigate what happens to the power spectrum, you may want to try more sampling rates.

Think about how to summarize your findings from this step. Graphs are commonly used to summarize measurements in engineering reports. What would be a good graph to summarize how sampling rate affects the acquired waveform? Ask yourself what is the *independent* variable of such a graph (i.e., what do you as the user control and vary

independently in the experiment?), and what is the dependent variable (i.e., what varies as a result of the user input?)

7. Investigate how the number of samples affects the amplitude vs. time graph and the power spectrum of the sampled waveform. In other words, observe carefully and try to quantify how the amplitude vs. time graph and the power spectrum changes as you change the number of samples for a fixed sampling rate. Again, a graph would be a good way to summarize your findings.
8. Try inputting a square wave instead of a sine wave into Channel 1 of Analog In on the DAQ Signal accessory. Does the power spectrum graph look different? Describe the power spectrum and compare it to that for the sine wave. What happens to the amplitude vs. time graph and the power spectrum when you change the sampling rate and number of samples for the square wave?
9. (Optional) Add the capability to trigger the acquisition of the signal from the Digital Trigger button on the DAQ Signal Accessory. In other words, instead of starting the acquisition of data immediately by clicking on the Run arrow, your modified VI will start taking data after the Digital Trigger button is pressed. Hint: the 'Find Examples' option under help has many example VIs that may stimulate your thinking.

Report

Write up your results as an Executive Summary following the guidelines posted at:

<http://www.engr.sjsu.edu/bjfurman/courses/ME120/me120pdf/ME120labreportguide.pdf>

Read the entire guideline very carefully. Page 7 gives more specific instructions for the Executive Summary report format, however most of the rest of the guideline also applies to the Executive Summary. Students who fail to read and follow the report writing guidelines usually do poorly on this and subsequent writing assignments. Don't let that happen to you!

Your report is due in two weeks.

References

Cerna, M and Harvey, A. F., "The Fundamentals of FFT-Based Signal Analysis and Measurement," [National Instruments Application Note 041](#).