

Lab 2: Introduction to NI Elvis Environment.

Objectives:

The purpose of this laboratory is to provide an introduction to the NI Elvis design and prototyping environment. Basic operations provided by Elvis like digital Multimeter, function generator, oscilloscope and bode analyzer are explained. Passive RC high pass and second order low pass filter circuits are characterized using NI Elvis.

List of Equipment required:

- a. NI Elvis bench top workspace.
- b. NI Elvis Digital Multimeter Soft Panel Instrument (SFP).
- c. NI Elvis Function Generator SFP.
- d. NI Elvis Oscilloscope SFP.
- e. Bode Analyzer SFP.
- f. Resistors: different values.
- g. Capacitors: different values.

Introduction:

The National Instruments Educational Laboratory Virtual Instrumentation Suite (NI ELVIS) is a LabVIEW and computer based design and prototyping environment. NI ELVIS consists of a custom-designed bench top workstation, a prototyping board, a multifunction data acquisition device, and LabVIEW based virtual instruments. This combination provides an integrated, modular instrumentation platform that has comparable functionality to the DMM, Oscilloscope, Function Generator, and Power Supply found on the laboratory workbench.

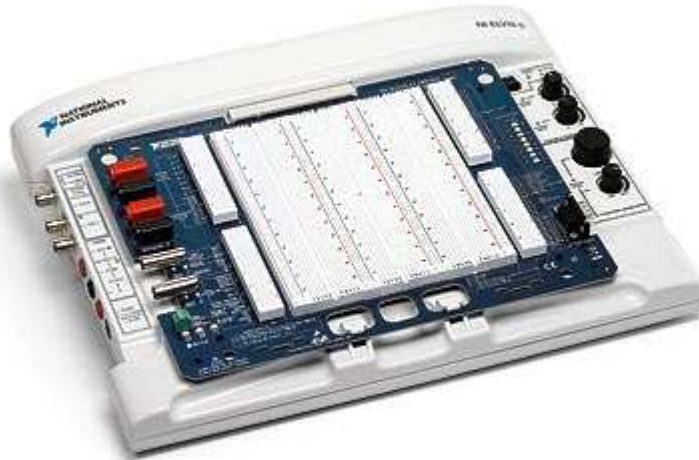


Fig. 1. NI Elvis System

The NI ELVIS Workstation can be controlled either via manual dials on the stations front or through software virtual instruments. The NI ELVIS software suite contains virtual instruments that enable the NI ELVIS workstation to perform functions similar to a number of much more expensive instruments. This lab provides an introduction to NI Elvis workspace environment. This environment consists of the following two components:

1. Bench top hardware workspace for building circuits.
2. NI Elvis Software interface consisting of Soft Front Panel (SFP) instruments.

The NI Elvis software also includes additional Lab view VIs for custom control and access to the features of NI Elvis hardware workspace.

As an introduction to use the NI Elvis workspace environment, we will complete the following tasks in this lab:

- *Part A.* Using Digital Multimeter Soft Panel (SFP) to measure electronic component properties.
- *Part B.* Using Function Generator SFP & Oscilloscope SFP for characterizing a RC high pass filter.
- *Part C.* Using Bode Analyzer SFP for characterizing a RC high pass filter.
- *Part D.* Using NI Elvis to characterize the RC high pass circuits designed in the prelab.

Pre-laboratory exercise:

To complete the initial introduction to Elvis sections (parts A, B & C) of the lab no pre-laboratory exercise is required. Please complete the following pre-laboratory exercises.

1. For the circuit shown in Fig. 2A, derive the transfer function for v_o/v_{in} in terms of R , C and $j\omega$, and find the expressions for the magnitude and phase responses. Express your results in the form

$$\frac{v_o}{v_{in}} = \frac{j\omega}{1 + \frac{j\omega}{\omega_p}}$$

where ω_p is the pole frequency location in radians/second.

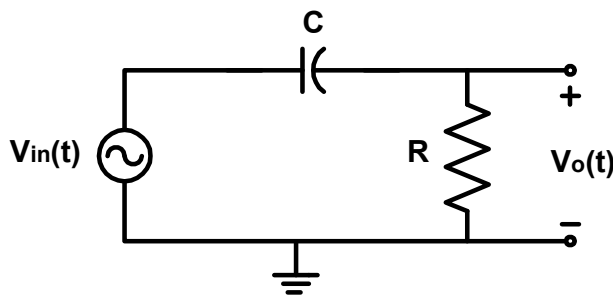


Fig. 2A. First order high pass filter (integrator)

2. For $C = 47\text{nF}$, find R so that pole frequency location is 3.3 kHz. Draw the bode (magnitude and phase) plots.
3. Draw the bode plots, and compare them to the magnitude and phase simulation results using PSpice.

Lab Measurement:

Part A. Measuring Component Values using NI Elvis Digital Multimeter

Complete the following steps to measure the value of a resistor using NI Elvis environment.

1. First ensure that the Power Supply to the prototype board has been switched off. (Refer to figure 2). Note that the system power is switched on. The system power switch is located at the back of the prototyping station.



Fig. 2. NI ELVIS Bench top workstation.

2. Insert the resistor on the prototype board.
3. Connect the two terminals of the resistor between V and COM terminals with banana jack connections (refer to figure 4) on the proto board as shown in figure 3.

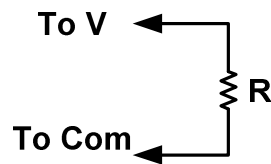


Fig. 3. Using Digital Multimeter SFP to measure value of a resistance.



Fig. 4. DMM Ports on the Elvis Prototype Board.

4. Connect the two terminals of capacitor between DUT+ and DUT- terminals (refer to figure 6) on the proto board as shown in figure 5.

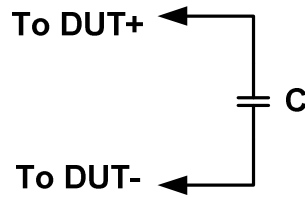


Fig. 5. Using Digital Multimeter SFP to measure value of a resistance.

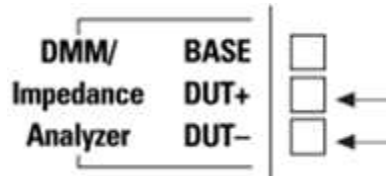


Fig. 6. DMM Ports on the Elvis Prototype Board.

5. Apply power to the proto board by switching the Prototype Board Power switch to the up position. The three indicator LEDs +15V, -15V and +5V should now be lit as show in the figure 7.



Fig. 7. Elvis Protoboard supply LEDs.

6. Go to the program menu on your computer and launch NI ElvisSmx Instrument Launcher in the NI ElvisSmx program. The interface should appear on your screen as shown in figure 8. This interface shows all the Virtual Soft Front Panels (SFP) available in NI Elvis.



Fig. 8. NI Elvis Software interface.

7. Click on the Digital Multimeter(DMM). This SFP can be used for a variety of operations.
8. A message box will open prompting you to use the Null operation for ensuring accuracy in DMM measurements. Read the message and click OK.
9. Click the Null button.

- Click the Ohm button to use the Digital Voltmeter function (DMM-Ohm) to measure the value of the resistor. If the Function Generator is in manual mode, the resistance and capacitance buttons are disabled. In order to control these buttons using the SFP, ensure that the manual mode is turned off on the workstation. Once the measurement is successful the output should appear as shown in figure 9. You have now successfully used the resistor ohm-meter with the NI Elvis SFP.



Fig. 9. Digital Multimeter SFP indicating the resistance value



Fig. 10. Digital Multimeter SFP indicating the capacitance value.

- We now continue to measure value of a capacitance.
- Switch off the Prototype Board Power. Close the Digital Multimeter SFP.
- Replace the 1 kΩ resistor by the capacitor.
- Switch on the Prototype Board Power. Launch the Digital Multimeter SFP.
- Click the Null Button.
- Click the Capacitance button to use the Digital Capacitance Meter function to measure the value of the capacitance. Once the measurement is successful the output should appear as show in figure 10.

Part B. Analog RC Filter Analysis using Function Generator and oscilloscope

This section provides an introduction to using NI Elvis for AC characterization of a simple RC low pass filter. For this purpose we will use the simple RC low pass filter designed in Lab-1 for characterization. The R and C values should for this low pass filter should be the same as used in the first lab.

1. Ensure that the Prototype Board Power is switched off.
2. Connect the RC filter circuit on the proto board as shown in figure 11. The input signal for the filter is obtained between 'FUNC OUT' & 'GROUND' pins. The input signal is also connected to Analog Channel-0 (between AI1+/AI1-) and the output signal across the capacitor is connected to Analog Channel-1 (AI0+/AI0-). Connections on the Analog Channels 0 and 1 are used for oscilloscope SFP as further explained in the below steps.

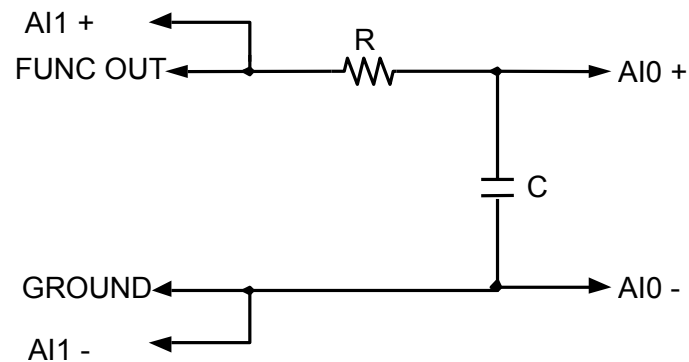


Fig. 11: RC Filter connectivity for AC Characterization.

3. Apply power to the proto board by switching the Prototype Board Power switch to the up position.
4. Go to the program menu on your computer and launch the NI Elvis.
5. From NI Elvis instrument launcher, click on "Function Generator" (FGEN). Ensure that the manual mode is turned off on the workstation so that all the buttons on the function generator window are not disabled. The initial function generator should appear as shown in figure 12.

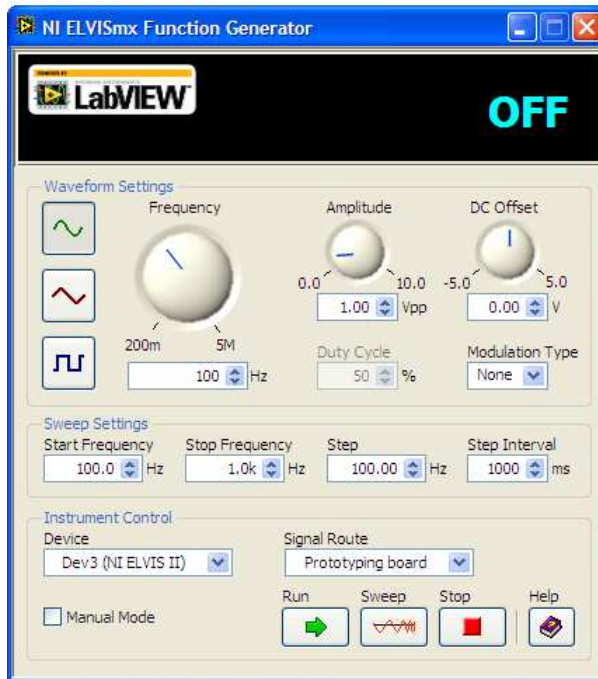


Fig 12. Uninitialized Function generator.

As shown in figures 12 & 13, FGEN SFP has the following controls which can be used to:

- Set the Frequency.
- Select the waveform type (Sine, Square or Triangular).
- Select the waveform amplitude (Peak).
- Select the DC offset of the waveform.

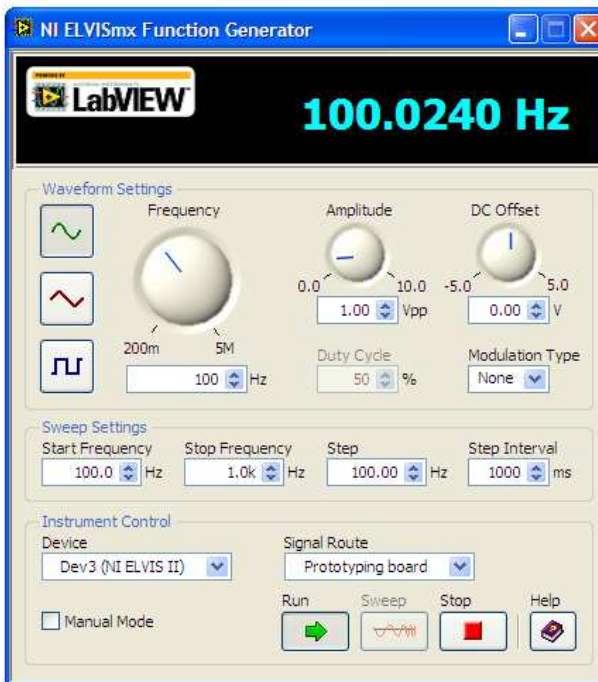


Fig. 13. Function Generator set to produce a 100 Hz sine wave with 1V amplitude.

6. Use these settings to obtain a 100 Hz sine wave with peak amplitude of 1 V and DC offset of 0 V. Note that this signal will be applied to the RC low pass filter. The function generator SFP should now appear as shown in figure 13.
7. From NI Elvis instrument launcher, click on "Scope". The oscilloscope SFP is similar to most oscilloscopes, but NI Elvis oscilloscope can automatically connect to variety of inputs. The initial oscilloscope SFP without any signals should appear as shown in figure 14.

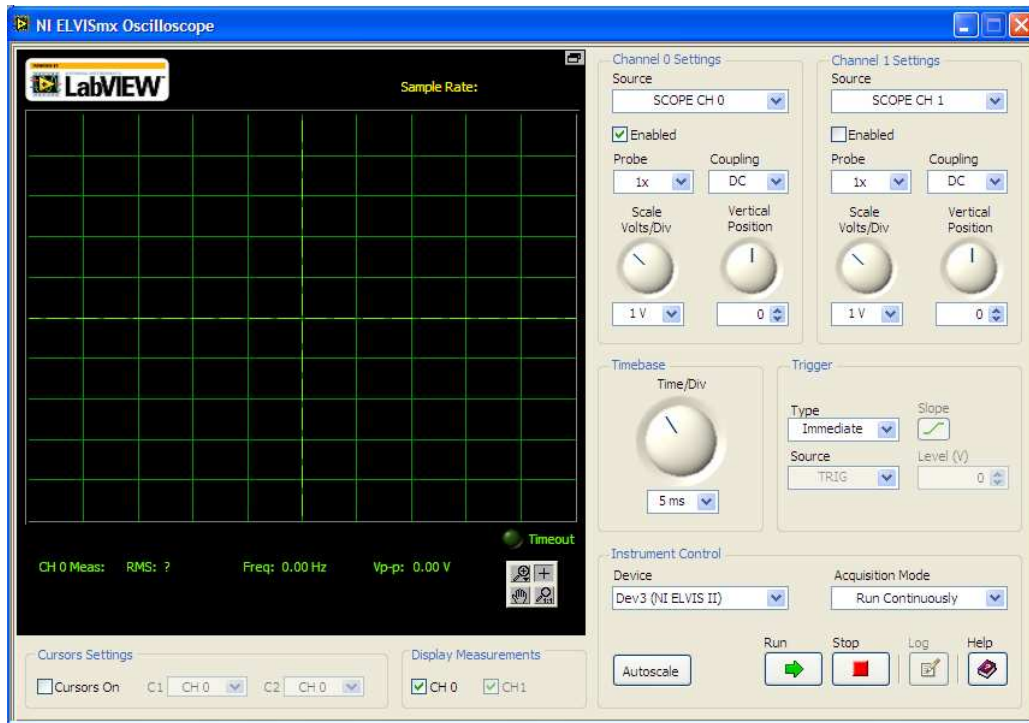


Fig. 14. NI Elvis Oscilloscope interface.

8. You can recall that the input to the RC circuit is connected to FUNC_OUT port on the prototype board. This input is also connected the Analog Channel-0 (AI1+/AI1-). Hence select AI1 in the source pull down list.
9. Click on **Autoscale** for the amplitude display setting of the signal.
10. This input signal originates from FUNC_OUT. The corresponding SYNC signal is TRIG. Hence under in TRIGGER section, select TRIG option. The output should now appear as shown in figure 15. This is the input signal for our RC circuit.
11. We now select the output signal on Channel 1 of the oscilloscope SFP. First enable channel 1 by clicking the ON button under Channel 1. Now select AI0 from the Source drop-down list & Click on Autoscale. You should now be able to see both input and output on the oscilloscope output. Vertical positions of signals on Channel A and B can be separately adjusted using the vertical position knob.
12. You can change the frequency of the input signal on the FGEN SFP to see the corresponding change on the oscilloscope.
13. Cursors can also be used on the Oscilloscope SFP by clicking the Cursor button to ON. An example measurement using two cursors C1 and C2 to measure the phase shift is shown in figure 16.

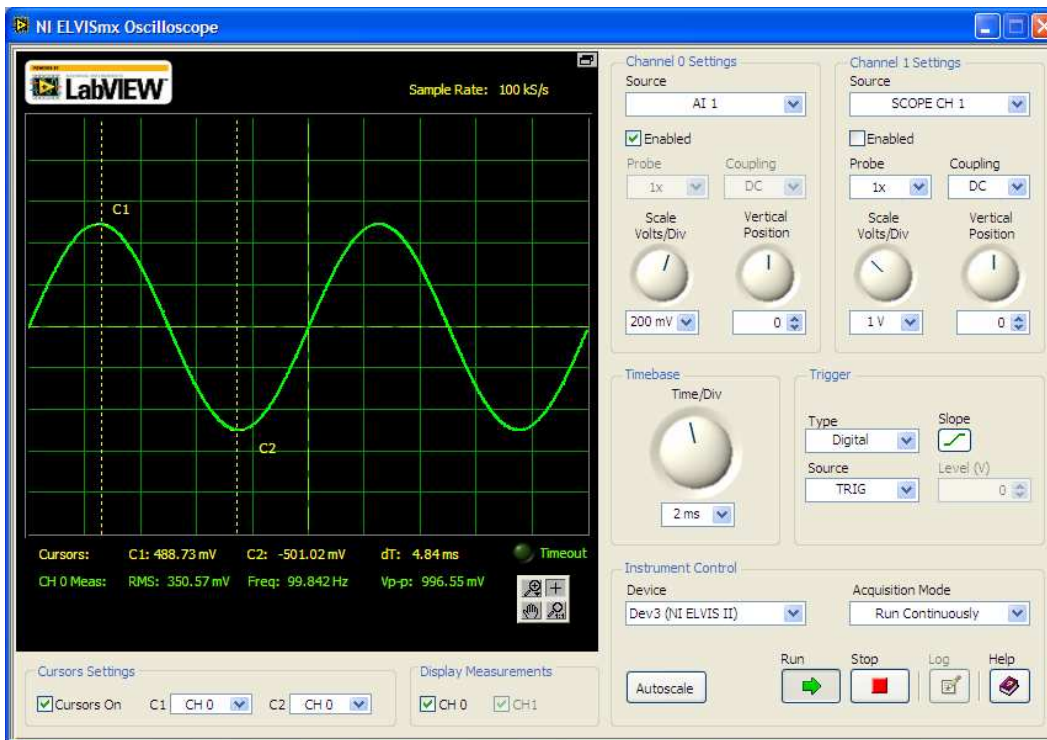


Fig. 15. NI Elvis Oscilloscope showing the input waveform on Channel 0.

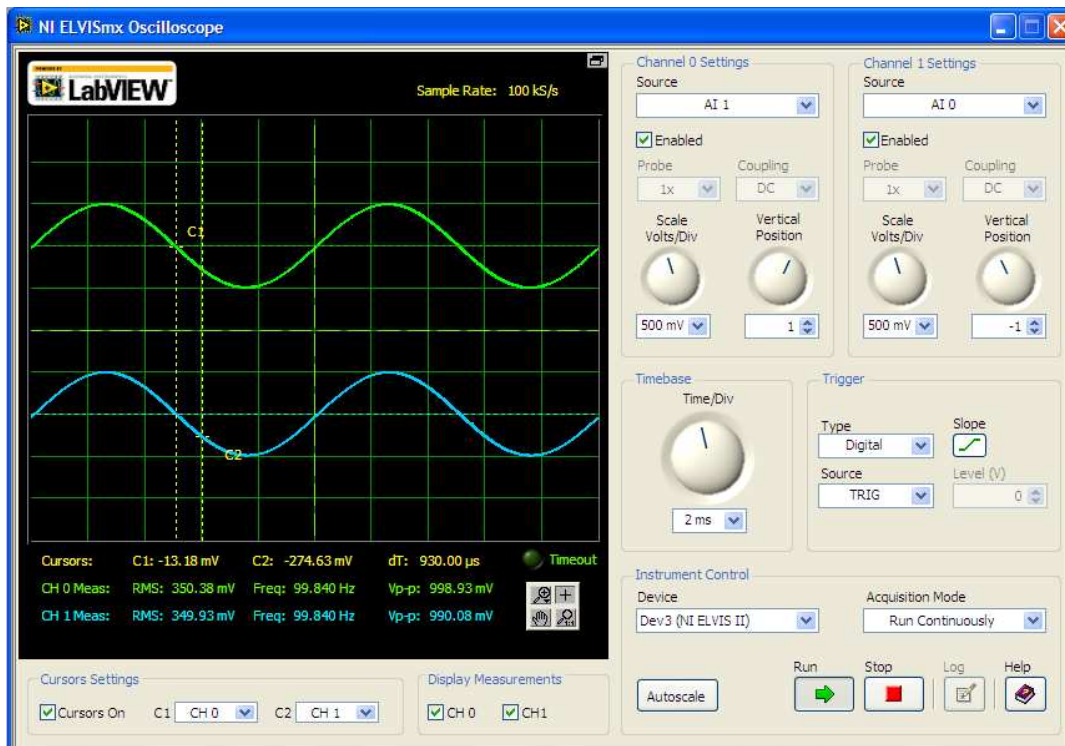


Fig. 16. NI Elvis Oscilloscope showing both input and output on two channels.

14. RMS, Frequency, and Amplitude (Peak-to-peak) measurements are shown at the bottom of the screen.
15. Switch off the supply to the prototype board once the analysis is over.

As explained in this section, we used the function generator (FGEN) and oscilloscope SFP to analyze a RC filter. In this setup:

- The input signal to the filter is provided through the Function generator SFP.
- The input signal to the filter is available on Channel-0 of the oscilloscope (through AI1).
- The output signal of the filter is available on Channel-1 of the oscilloscope (through AI0).
- The trigger source for the oscilloscope is available through TRIG.

By varying the input frequency to the filter, we can obtain the 3 dB bandwidth of the filter using the oscilloscope measurements.

Part C. Analog RC filter analysis using the Bode Analyzer:

A bode plot defines the frequency characteristics of a given circuit. Magnitude response is plotted as circuit gain in decibels as a function of log frequency. Phase response is plotted as the phase difference between input and output signals on a linear scale as a function of log frequency. NI Elvis has a bode analyzer SFP which facilitates **automatic bode plot generation** of a given circuit. Complete the following steps to obtain the Magnitude and Phase response of the RC filter:

1. Retain the circuit configuration from the previous section. Note that the circuit should be setup as shown in figure 11.
2. Ensure that the connections are correct and switch the prototype board power to ON position.
3. From the NI Elvis instrument Launcher, select Bode(Bode Analyzer). The initial Bode Analyzer SFP should appear as shown in figure 17.
4. Bode analyzer controls the input signal to the circuit from the FUNC_OUT ports. The output signal to be analyzed should be connected to Analog Channel 1 (between AI0+/AI0-). The input signal should also be connected to Analog channel 0 (between AI1+/AI1-).
5. Bode analyzer provides the flexibility to automatically scan the input signal frequency over a range specified by Start/Stop frequency values. The incremental value used during this frequency scan can also be set to a specific value. All these controls can be seen in figure 17.
6. For analyzing the RC low pass filter, let's make the following settings on the Bode analyzer SFP.
 - Start frequency to 100 Hz.
 - Stop frequency to 35k Hz.
 - Steps to 20 per decade (Higher the number of steps, greater the number of points for the measurement accuracy).
 - Display section, set Y-scale to Auto.
 - Click on RUN.
7. Once the analysis is complete, the output should appear as shown in figure 18.
8. In the figure 18, cursor has been placed to measure the -3dB frequency. This can be achieved by clicking on the Cursors button to "ON" and dragging the cursor using the left mouse button on the plot to the desired position. The cursor can also be shifted to the desired position using the two diamond shaped buttons in the Cursor Position.



Fig. 4. Uninitialized NI Elvis Bode Analyzer window.



Fig 5. Bode Analyzer output and measuring the 3dB frequency using cursors.

Part D. RC filter characterization using NI Elvis:

1. Build the second order RC low pass circuit shown in Fig. 3 in Lab-1 handout using the R and C values designed in Lab-1. Obtain the frequency response of the filter using the bode analyzer SFP as shown in part C.
2. Build the RC high pass circuit shown in Fig. 2A using the R and C values designed in the pre-laboratory exercise. Obtain the frequency response of the filter using the bode analyzer SFP as shown in part C.

Lab Report:

1. Provide a brief introduction to basic capabilities of the NI Elvis prototype environment.
2. Provide a description of the frequency response obtained for the two circuits (including the screen shots of frequency response plots) obtained in part-D of your lab.
3. Describe and comment on the differences (if any) between the frequency responses plots obtained previously using the traditional function generators & oscilloscopes to the results obtained using NI Elvis.
4. Describe and comment on the differences between first order low pass and high pass filters; consider both magnitude and phase characteristics.