Use of the Analog Discovery Boxes as a Spectrum Analyzer or a Bode Plotter (Network Analyzer)

There are four Analog Discovery™ boxes in the ENGN1620 lab area that you will use as spectrum analyzers or Bode plotters. (The formal name for a Bode plotter is 'Network Analyzer.') These boxes have modules designed by Analog Devices Inc. and sold by Digilent, Inc. They are really two-channel, high-speed, 14-bit analog to digital converters with some support circuitry. They are powered by a USB connection, and GUI software on the lab computers can turn them into a variety of instruments. In addition to these two types of analyzers, the boxes can also be oscilloscopes, voltmeters and digital logic analyzers. We have wired them as network and spectrum analyzers, added overvoltage protection circuits, and put them in aluminum boxes.

The software found at Start/All Programs/Electrical/Digilent/Waveforms is not especially user-friendly nor are the input and output connections entirely obvious. Here are the basic tips for using these devices.

Connections: Connect the signal for which you want the spectrum or the signal output from the circuit, for which you want the frequency response, to the "Input to Analyzer" BNC jack. The input impedance is 1.2 Megohm shunted by a little more than 50 pf. This is a significant capacitive load that will affect many signal sources and circuits. You can use a 10X oscilloscope probe to reduce the effect but must be careful with the measurement. The attenuation will only be 8.5X (18.6 dB) for which you will have to compensate when reducing the data. There will also be a distinct loss of high frequency sensitivity. See the section on using these modules for Lab 5. (In lab 5 you are measuring frequency response to 10 MHz and the probe error must be corrected.)

The second BNC connector is labeled "Function Generator&Signal Output" and connects to the input of the Circuit Under Test (CUT). This is a signal generated by a function generator in the module. Apply this signal to the input of a circuit for which you want a Bode plot. The software will adjust the frequency of this output signal repeatedly and will measure the gain and phase at each such frequency.

Spectrum Analyzer:

- When the "Waveforms" software opens, hit the "Spectrum" softbutton on the left side of the screen to open the analyzer.
- On the right side of the screen, find the "Trace 2" pane and uncheck the box in the upper left to turn off the second channel.
- In the "Magnitude" pane on the upper right side, select the upper limit to be 10 or 20 dB to keep the signals from saturation. (The scale of the instrument is dBV, that is, decibels of voltage pp relative to 1.0 volts pp.) For the lower limit, choose a value that makes the vertical axis have reasonable spacing of 10 or 20 dB. It does not make sense to display more than a range of 100 dB as that is somewhat more than the dynamic range of the instrument.

- Along the top edge of the data graph there are a series of edit boxes to set the frequency range. The frequency axis is linear and you need to use some care to get a range that covers what you want to see but does not squash peaks together too much.
- Hit the start button just above the graph to see your data.
- There are two menu bars in the GUI. The lower one, the one directly over the graphing area, has the most useful commands.
- To have the software extract the principal component peaks and display them in a table, use the menu "View" command on the lower menu bar and check "Components." You can set the number of peaks in the list by using the small button in the middle of the top of the table. I have not found a way to save this table.
- You can generally improve the signal to noise ratio of the measurement by averaging many data sets. To do this, click on the edit box "Sample Type" in the middle of the "Trace 1" pane on the right. Select either Linear RMS Averaging or Exponential RMS Averaging. The net effect is similar but the Exponential averaging displays in real time while the Linear averaging updates every 100 sample blocks. The latter does seem to produce slightly better results.
- To save results for later analysis or inclusion in a lab report, use the menu action "Files/Export" and choose the .csv format. This creates an Excel comma separated file. Use Excel to plot the data and do any further analysis.

Bode Plotter (Network Analyzer):

- Connect the output of your amplifier to the "Analyzer Input". For labs 2 and 7, use a 1X scope probe or a BNC cable with an adapter to wire ends. For lab 5, because the frequency of operation is much higher, the capacitance of a simple cable will prevent the circuit from functioning properly. The solution to that problem is the use of a 10X oscilloscope probe, the same tool you analyzed in lab 1.
- Connect the input of the amplifier to the Bode Plotter jack labeled "Function Generator&Signal Output." Use a BNC cable with an adapter to wire ends.
- When you run the Digilent software, select the soft button "Network" on othe left side of the splash screen to run the network analyzer.
- In the Function Generator pane on the upper right side, use the drop-down box to set the amplitude for what is needed to get a strong output signal that is still within the output range of your circuit. The units are volts peak. Do not exceed 1.5 volts peak as the protection circuit against damaging the function generator by touching a power supply connection will limit the output peak at about that value.
- Turn off the display of channel 1 signal by unchecking the channel 1 box in the middle of the group of controls on the right side.
- Set the range of the DB display in frequency with the drop boxes to the right of the Run/Stop button. Set the amplitude range in the drop boxes on the Channel 2 pane on the lower right side.
- Add a cursor to the screen by:
    - Use the View/Cursors menu item to bring up the cursor data display. The pane this opens may be too big – shrink it by using mouse to close down the height of the box to just enough to display the values at the cursor position.

    - Hit the “X” soft button at the lower left corner of the graphing area to bring up the cursor itself.
- When you have run the measurement, you can save the result to a file from the File/Export menu. Both .csv and .txt formats are available.

Lab 5 – Video Amplifier Procedures: TBA