LabVIEW Day 3: Bode Plot, Property Nodes, Color Boxes

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One of the common means of characterizing an electronic circuit is to give its frequency response. Amplifiers, filters, and microphones are some examples. Usually the frequency is chosen on a logarithmic scale, often with 3 points per decade, that is steps of 1, 2, 5, 10, 20, 50, etc.

Often the voltage gain is described in decibels, dB, or alternately on a logarithmic scale.

Many filters can be described by the type of filter (low-pass, high-pass, band-pass, band-reject), the cutoff frequency or frequencies, and order of filter that determines the slope of the rolloff.

First-order filters have slopes of magnitude 20 dB/decade (or 6 dB/octave) meaning that the gain changes by a factor $g$ when the frequency changes by the same factor $g$. Second-order filters have twice the slope.

Here is an outline of a test fixture. In LabVIEW generate a frequency and use it to control an external sine-wave generator. Measure the input and output amplitudes and compute the gain, Repeat for the desired frequencies and plot on a log-log graph.

1 Basic Simulation

Here is a program that simulates this process. Figure 1 shows the block diagram.

(a) The formula node creates a factor of $10^{1/3}$ to allow 3 points per decade

(b) The For Loop will run 11 times. For reasons not yet clear to me, the first point gives bogus data, perhaps because of the properties of the Simulate Signal. Therefore the starting frequency will be $10/10^{1/3}$, then this point will not be included on the graph.

(c) The shift register $f_{n-1}$ frequency is multiplied by $10^{1/3}$ to get the $f_n$ frequency. The $f_{n-1}$ is used to control the Simulate Signal.
(d) The amplitude and frequency of this “input” signal are measured. The signal is then filtered and the amplitude of the filtered signal is measured.

(e) The gain is computed as the ratio of amplitudes. Gain and frequency are taken out of the loop through indexed tunnels, resulting in arrays for frequency and gain.

(f) Array Subsets are taken to eliminate the first point. Remember that array elements are numbered 0 to \( N - 1 \), so we use as inputs to the Array Subset the first point to keep, 1, and the length of the subset, \( N - 1 \).

(g) The frequency and gain are bundled for the XY Graph. Using Properties of the graph, both axes are set to log.

(h) The Property Node and Color Boxes will be discussed shortly.

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**Fig. 1:** This simulates collecting data for a Bode Plot. Frequencies are adjusted with 3 steps per decade, a second-order Butterworth Low-Pass filter is used. Property nodes allow selection of some of the graph properties.

The front panel for the vi is shown in Figure 2. Notice that the filter is a low-pass and it rolls off by two decades (0.01 to 0.0001) when the frequency increases by a decade (1000 to 10000 Hz). This means that the filter is second order, with a slope of -40 dB/decade.
2 Property Nodes and Color Boxes

On the front panel there are 4 controls. Three of them are color boxes that allow you to choose the colors of the background, the data point, and the line joining data points. The fourth control is a numeric control for line width. It is an unsigned integer, 8 bit, with values limited to be 0 to 5.

Some of the properties can be set using the Properties of an icon as you have done before. Property nodes allows software control of these and even more properties.

Fig. 2: The front panel for the Bode plot looks like this. The square boxes are Color Boxes.

When a color box is selected, a window like that in Figure 3 pops up allowing a choice of color.

Fig. 3: Pop-up when a color box is selected.

Here are the steps for creating the property node shown
(a) Select the graph icon on the block diagram, right click and Create→Property Node
(b) A menu of properties then appears, scroll down to Plot Area→Colors→BG Color and place the icon outside the loop.
(c) Expand the Property Node to have a total of 4 inputs. They will be the properties that follow the first one you chose. Right click on the second property, Select Property→Plot→Color. Similarly make the other two properties Plot→LineWidth and Plot→Fill/Point Color.
(d) The Property node is in Read mode: it reads the values of the 4 properties and sends their values out. We want to control these properties, so right click on the property node and Change All to Write.
(e) Rather than try to determine what integer represents a desired color, we will use a color box control. Go to the Front panel place a Numeric→Framed Color Box to the left of the graph. Name it something meaningful like “Background.” Repeat for color boxes for the line (Plot.color) and point (Plot.Fill/PtColor). Return to the block diagram and connect the color boxes to the appropriate inputs on the property node.
Finally hover over the line width property and Create a control. On the front panel, right click on this control and for Data Entry make the range 1 to 5 and coerce if values are out-of-range.