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ELCN100—Laboratory

Project Report

Digital Signal Generator and Spectrum Analyzer

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I. Digital Signal Generator

A digital Signal Generator is an electronic device capable of simulating different signals with varied parameters that can be very useful when measuring and modelling electronic measurements. It allows the user to generates electric signals with input parameters as amplitude, frequency, phase, and DC offset. The user can also choose the wave shape of the input signal—sine, square, triangular, or sawtooth.

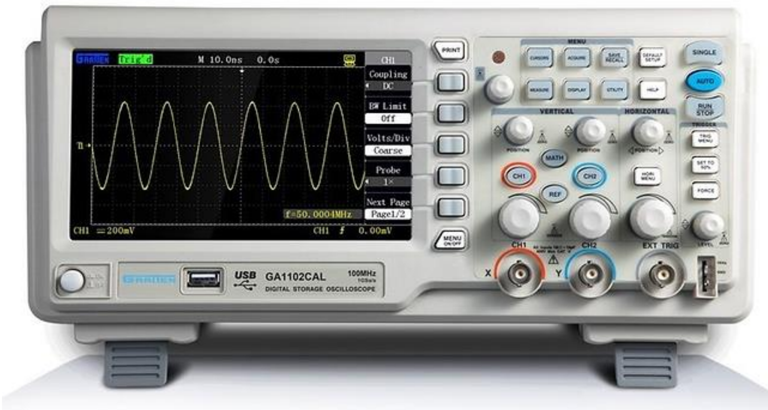


Figure 3. Electronic Signal Generator

II. Digital Spectrum Analyzer

A spectrum analyzer is another common laboratory device used to measure the amplitude of an input signal against frequency within the full frequency range of the instrument. It is primarily used to measure power of the spectrum of a signal. It makes easy the analysis of various signal characteristics such as power, distortion, harmonics, and bandwidth of a signal in the frequency domain, since such parameters are not easily detectable in the time domain. It is extensively used in circuit design, radio communication, and Wi-Fi testing.

Figure 4. Spectrum Frequency Analyzer

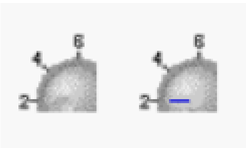
Implementation in LABVIEW:

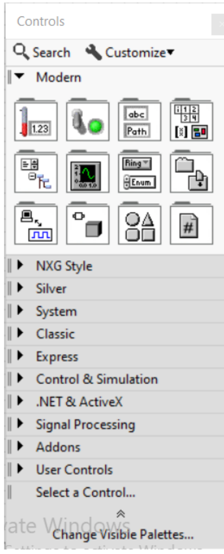
In this project, we implemented the devices as a LABVIEW-based software. It can simulate four different wave shapes—sine, square, sawtooth, and triangular. In this section, we will go through the design steps.

<u>Design Steps:</u>

<u>I. Signal Generator</u>

1. Create a new NI LabView 2022 project.
2. Click on create Blank VI. Two windows will appear—Block diagram and Front panel.
3. Open the "Controls Palette" by right clicking anywhere on the Front Panel window, or press View and drag it.
4. Insert a box to enclose your whole circuit.
5. Insert five "knob" from the "Numeric" section and change their labels—you adjust by sliding the knob, the value appears in the numeric below it.





6. Then from Controls, click on, graph insert a "graph waveform". Relabel the plot and waveform chart title to "Digital Signal Generator".
7. Add a numeric to adjust the type of the signal. Rename.
8. Your front panel should now look like Figure 3.

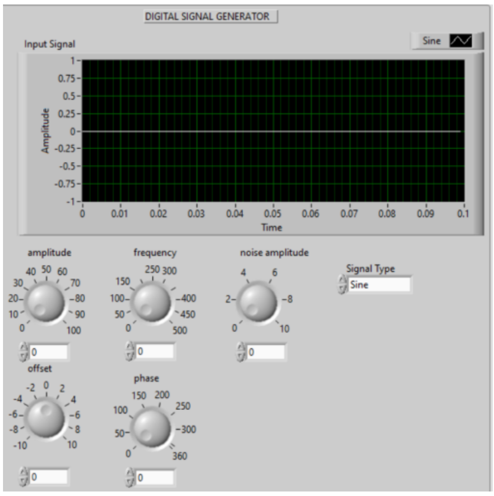


Figure 5

9. You will now find 6 dial boxes in your block diagram. Name them to the needed parameters. Also, rename the waveform to “Input Signal.”

10. On the block diagram, a “Functions Palette” window will be open. If not, click “View” and drag it down.

10. From the functions palette, from “Structures” search for a “case structure” and insert the block.

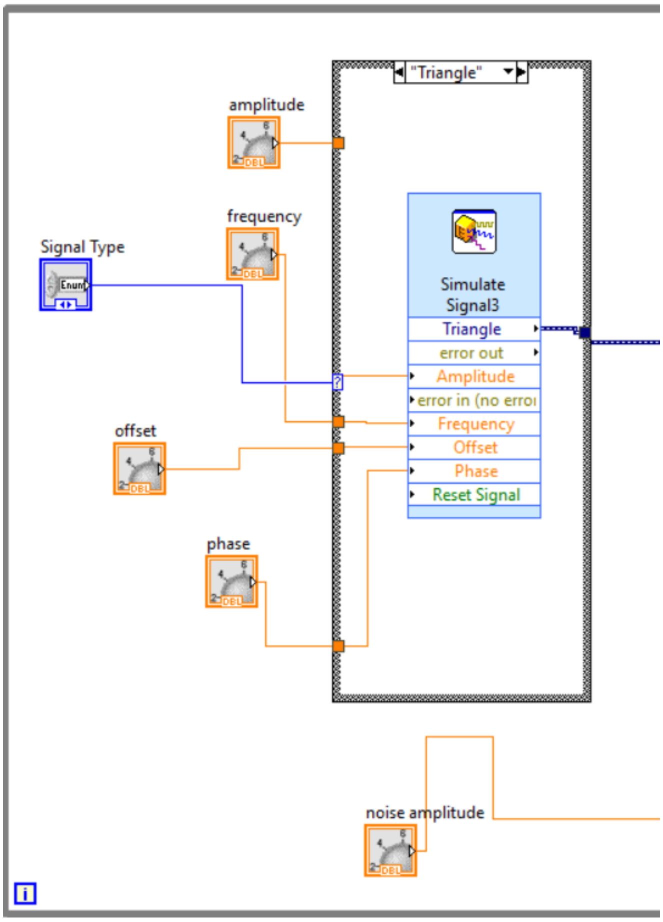
11. Inside the “Case Structure” block, search for “Simulate Signal”. Insert the block and wire your four “tips” to the input parameters of the “Simulate Signal” block. Repeat for the four signal types we have (Sine, Square, Triangle, Sawtooth).

12. Wire the the “Noise Amplitude” knob to the amplitude control of the uniform white noise waveform. From the control palette.

13. open “Enum and Ring” and select “Enum”. Place inside the box and right click, open properties. Rename to “Signal Type” and from “Edit Items” add an item for each of the four waveforms.

14. Wire the “Signal Type” enum as shown in Figure 4.

15. You have now created the Digital Signal Generator part of the software instrument. Your block diagram should now look like this.



Examples of the Front Panel displaying different waveforms:

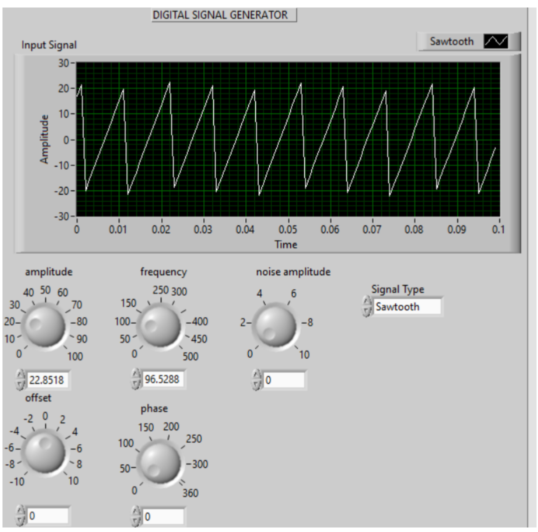


Figure 6 Sawtooth Waveform

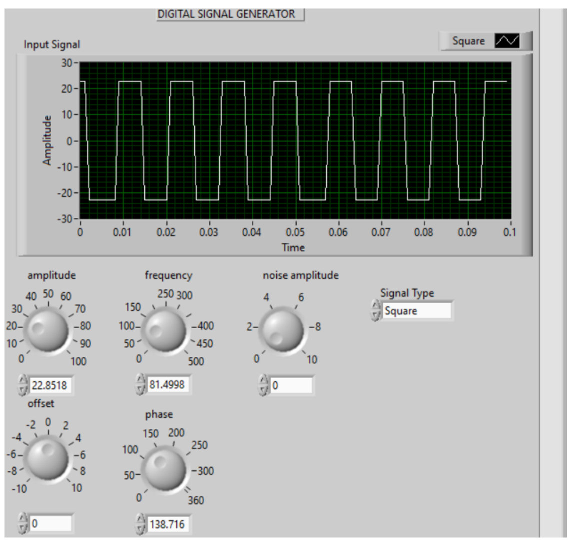
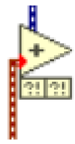


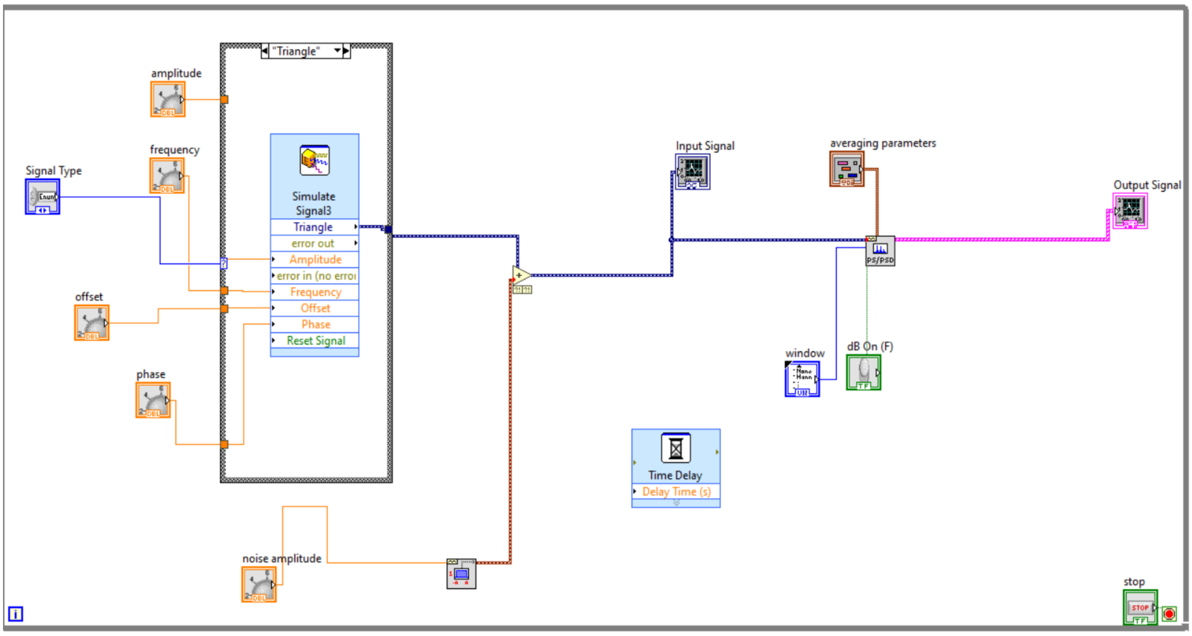
Figure 7 Square Waveform

Now we will view the design steps of the Spectrum Analyzer.

II. Spectrum Analyzer

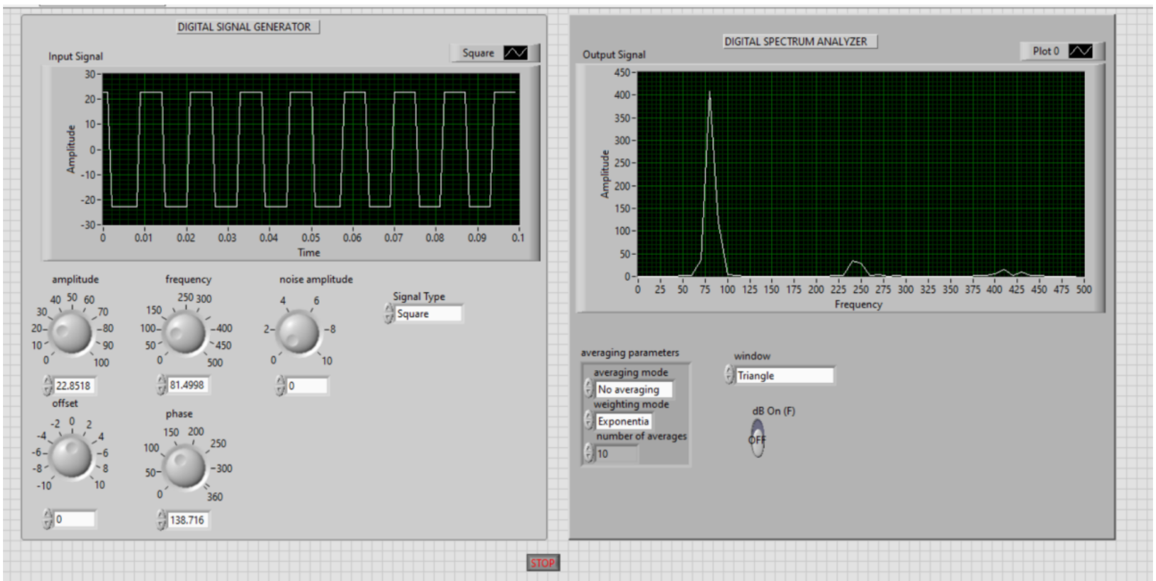
1. In the front panel, make another box.
2. Select another waveform and place it inside the box. Rename the waveform graph title to “Digital Spectrum Analyzer”.
3. Show Indicators and controls for the FFT unit, like (“ dB on F”), Averaging Parameters, and Window.
4. In Averaging Parameters “averaging mode” refers to the way the signal is averaged over the spectrum. “weighting mode” has the
5. Now your block diagram should contain the three dials. Rename the spectrum waveform to “Output Signal”
6. From “Programming”, Select “numeric”. Select “Add” and place it on the block diagram.
7. Wire the “Uniform White Noise Waveform” and the wave output of the Simulate Signal block to the “Add” numeric. 
8. Wire the output of the “Add” numeric to the input signal.
9. Now, search for “FFT power spectrum and PSD.vi” and place on the block diagram.
10. Wire the “Input Signal” to its time signal input.
11. Add a time delay to your circuit to control the speed of the simulation.
12. Add a Stop Button.

Your Block Diagram should now look like this:



User Manual:

The user will see the Front Panel Window.



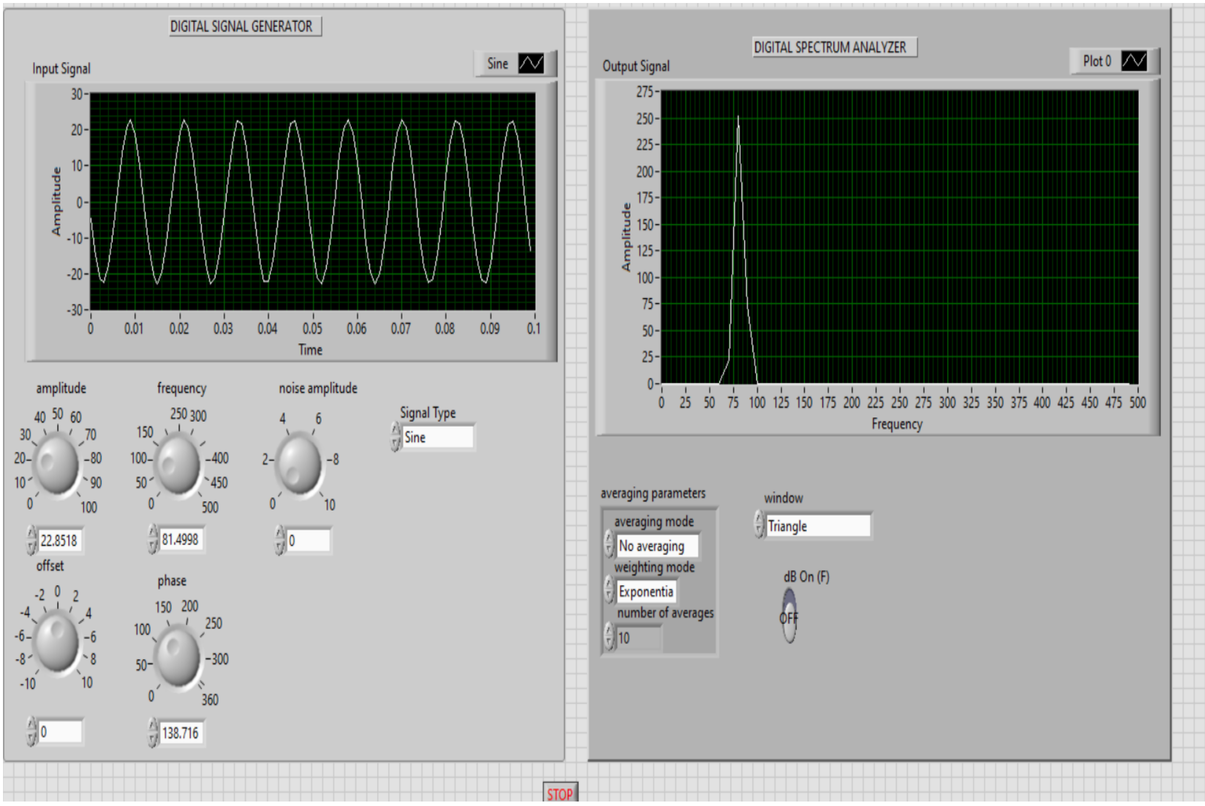
How to use:

1. Use the knobs to selected the desired input parameters—frequency, phase, amplitude, offset. And use the enum to select the signal type.
2. Add noise by turning the noise amplitude knob to observe how the noise affects the spectral analysis graph.

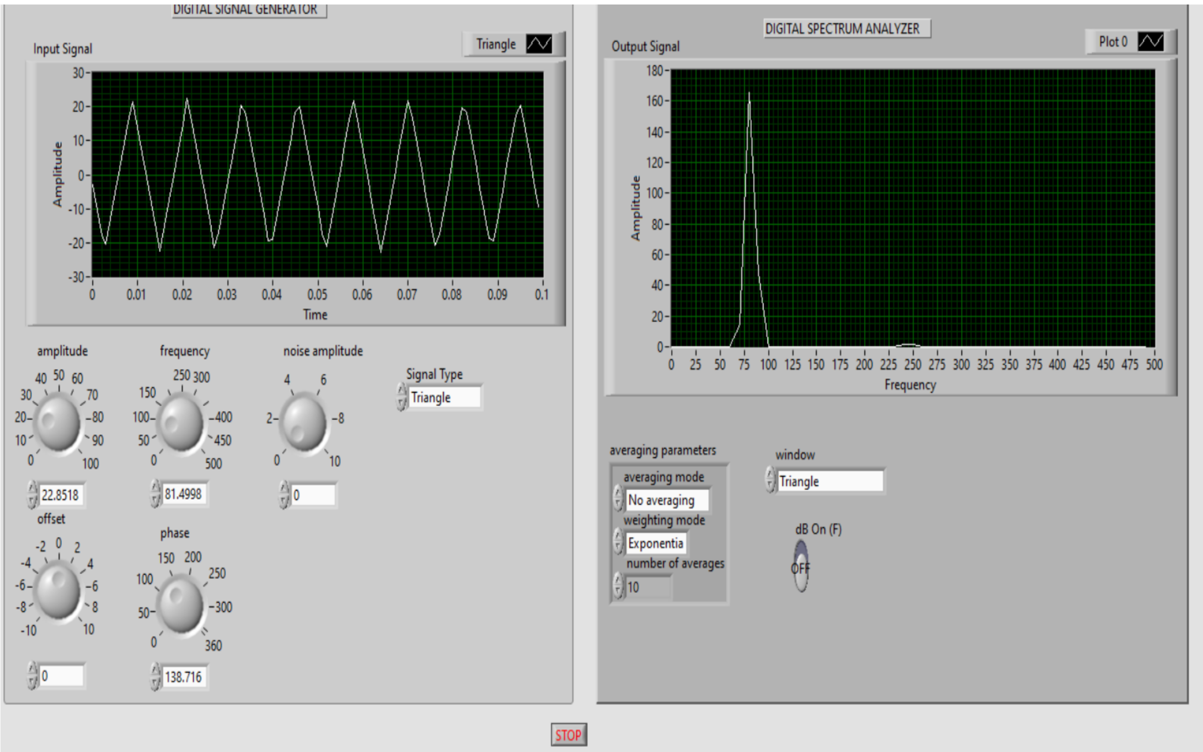
3. On the right side, the user can view the analyzed graph spectra using the FFT, named output graph.
4. Use the dB On(F) switch to display or decibel graph: dB On is a decibel graph, dB off is a linear graph.
5. On the averaging parameters cluster, you can manipulate the averaging parameters: averaging mode, weighting mode and the number of averages, and observe how the spectra varies as we apply different averaging methods.
6. Use the “Stop” button to stop the simulation.

Examples of the simulation of different waveforms:

1. **Sine Waveform**
   Parameters: frequency = 81.5 hz, amplitude = 23, phase shift of 139 degrees, no offset and no noise. Spectrum-analyzed through a triangle window at no averaging.



2. Triangle Waveform



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