EXPERIMENT DSP1: DSP with MATLAB

Related course: KIE3007 (Digital Signal Processing)

OBJECTIVES:

To perform signal processing with MATLAB

EQUIPMENT:

PC equipped with Simulink MATLAB or MATLAB Online

INSTRUCTIONS:

For each test, student is required to save the results and perform analysis.

REFERENCE(S):

Refer to the main references of KIE3007

EXERCISE:

Exercise 1: Lowpass filter

Exercise 2: Highpass filter

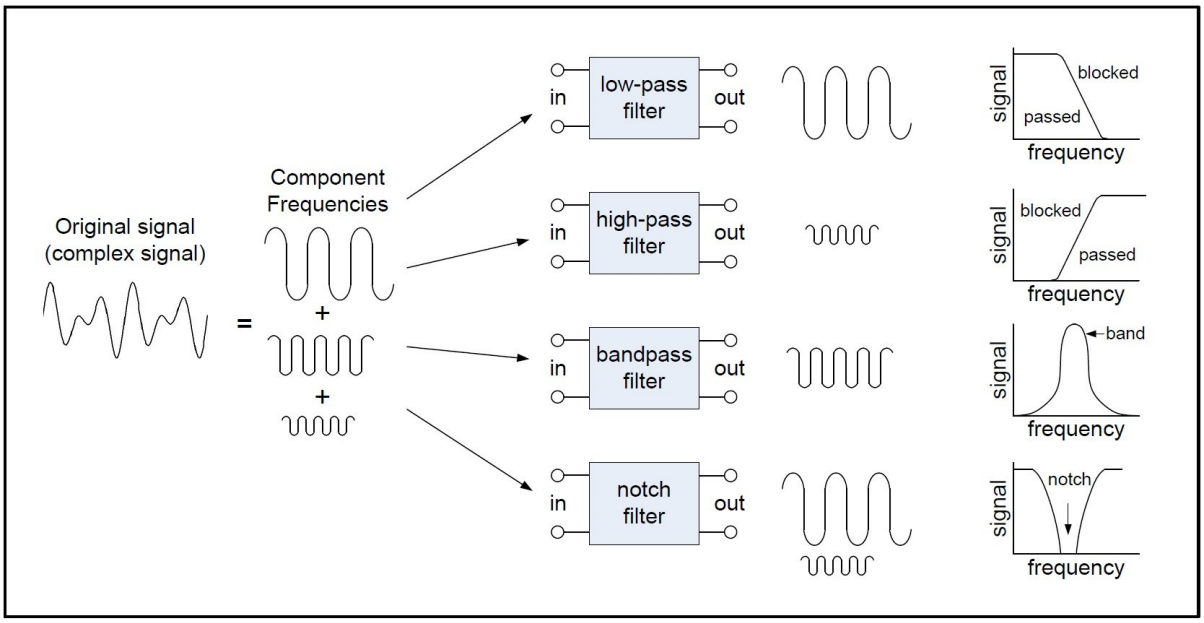
Exercise 3: Bandpass filter

INTRODUCTION:

Filter

A filter is a device or process that removes some unwanted components or features from a signal. Filtering is a class of signal processing, the defining feature of filters being the complete or partial suppression of some aspect of the signal. Most often, this means removing some frequencies or frequency bands. Hence, using appropriate method, we can use filter to reduce the unwanted signal in speech signal.

The four primary types of filters include the low-pass filter, the high-pass filter, the band-pass filter, and the notch filter (or the band-reject or band-stop filter). Take note, however, that the terms "low" and "high" do not refer to any absolute values of frequency, but rather, they are relative values with respect to the cutoff frequency.



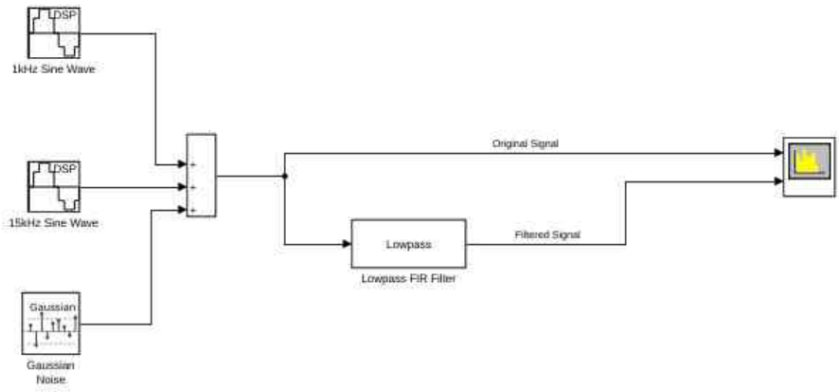
Digital Filter

Digital FIR filters are widely used because of the powerful design algorithms that exist to design such filters. These filters are also inherently stable when implemented in the non-recursive form, and you can easily attain linear phase and extend them to multirate cases, and there is ample hardware support for these filters. This example showcases functions and objects from DSP System Toolbox that you can use to design lowpass FIR filters.

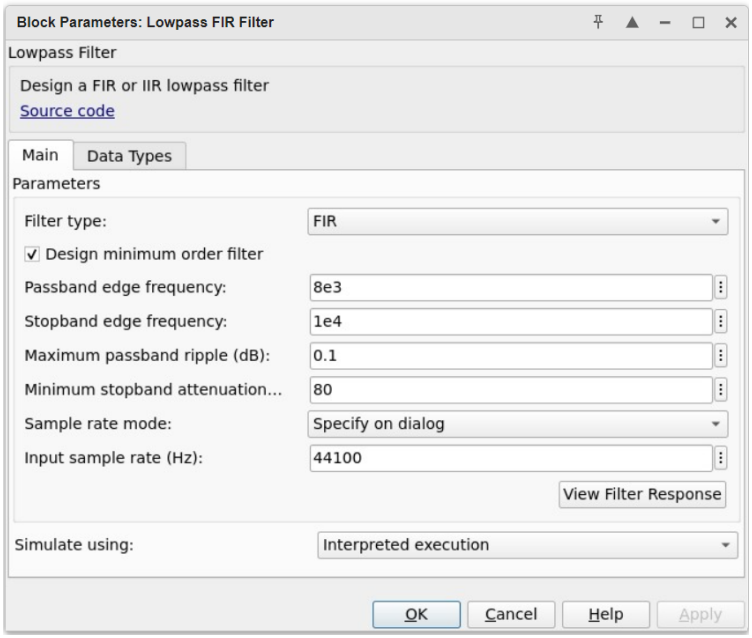
Exercise 1: Lowpass filter

1. Open MATLAB and click **Simulink** app in the **Home** tab in MATLAB. This experiment will require you to use DSP System Toolbox. You can install the toolbox if it does not preinstall in the local computer, or you can also use MATLAB Online which does not require installation.

2. In **Simulink Start Page** window type "**DSP System Toolbox**" in the Simulink search box, and click **Basic Filter** to create model which has the following block diagram:

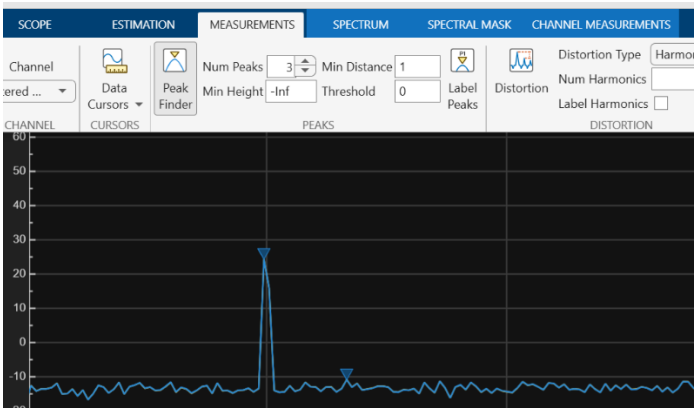


3. In the block diagram, double click the **Lowpass** block and observe the parameter values (do not change the preset values). Explain each parameter showcased in the main tab. Draw example of frequency response diagram to assist your explanation.



4. Close the **Block Parameters** window, go to the **SIMULATION** tab in the Simulink window and click **Run** button. Wait until the **Spectrum Analyzer** window appear and save the image result of the spectrum analyzer.

5. From the result, explain the spikes present in the spectrum of original signal. Calculate the dBm of each spike in the spectrum of original signal and filtered signal (Use **MESUREMENTS** tab, zoom to each spike and use **Peak Finder**). Explain the difference between these signals by relating it to the lowpass filter block parameters that you observed in step 3. Note: some part of the original spectrum may be overlapped with filtered spectrum.

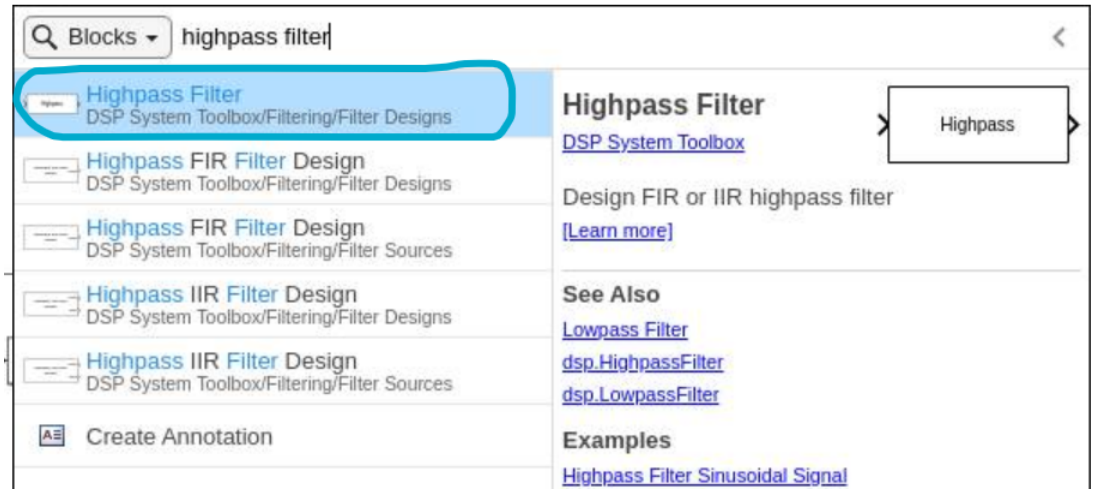


6. Stop the simulation by clicking **Stop** button in the **SIMULATION** tab in the Simulink window and double click the **Lowpass** block in the block diagram in the Simulink window. Then change the parameters so that both sine waveform signal can pass the lowpass filter. Record and discuss the result.

7. Stop the simulation by clicking **Stop** button in the **SIMULATION** tab in the Simulink window and double click the **Lowpass** block in the block diagram in the Simulink window and change the parameter to the original value. Then change the **Minimum stopband attenuation** to a different value. Make sure the change in value is enough that there is noticeable difference when comparing to the filtered signal result in step 5. Record and explain this difference.

Exercise 2: Highpass filter

1. Double click on empty space in the block diagram, type “Highpass Filter” in the search box and click the “Highpass Filter” block to add to the diagram.



2. Delete the **Lowpass** block and replace it with **Highpass** block.

3. Double click the **Highpass** block and design the parameter in such a way that it allows the 15kHz signal but block the 1kHz signal. You can refer to the original **Lowpass** block parameter as reference.

Exercise 3: Bandpass filter (Open ended)

1. In this task, you are required to design a bandpass filter **without** using any predesign bandpass block from Simulink block library. Hint: You can use both lowpass and highpass filter block.
2. You can choose any suitable parameters as long as you can show the bandpass filter effect using the spectrum analyzer. Record the parameters that you use and result of the spectrum analyzer.

END OF EXPERIMENT