

## Filtering toolkit for FIR design by windowing and frequency sampling

### Description

FIR filters are used in many DSP applications. The main advantage of FIR filters, compared to IIR filters, is in the fact that they can be designed to have a linear phase. The linear phase response is desired in a DSP because the filter does not introduce any signal distortion as all the frequency components have the same delay. The simplest design method for a FIR filter design is the windowing method and frequency response sampling. MatDeck provides a filtering toolkit to design the FIR filter by windowing and frequency response sampling as will be illustrated in this example.

### Preparation of test signal

A test signal is not part of the FIR filtering form. However, we need it in order to test the filtering operation, as created the form can filter a signal at the same time. We generate a simple test signal as the sum of two sinusoidal signals of different frequencies. The sampling frequency is also defined for the overall example which is used later for the filter design within the FIR filtering form.

```
Fs := 24000    Sampling frequency
Ts1 := 1/Fs    Sampling period
dt := ynodes(x, 0, 99 Ts1, 100)    Time axis, 100 samples
f1 := 1000    Frequency of the first sinusoidal
f2 := 6000    Frequency of the second sinusoidal
x := 5 sin(2 π · f1 dt) + 5 sin(2 π · f2 dt)    Input signal
```

### Selection of design method and response type

The FIR filtering form provides two design methods with different parameters, which can be selected from the drop down menu: Windowing and Frequency sampling. For both methods, there are four different options for the frequency response: lowpass, highpass, bandpass and bandstop.

### Setting the filter design specifications

The filter design specifications, which can be set, vary according to the design method and response type. For all the options there are two common filter design specifications: filter order and sampling frequency. Other filter design specifications include: single cutoff frequency for all lowpass and highpass cases, two cutoff frequencies, lower and upper, for all bandpass and bandstop cases.

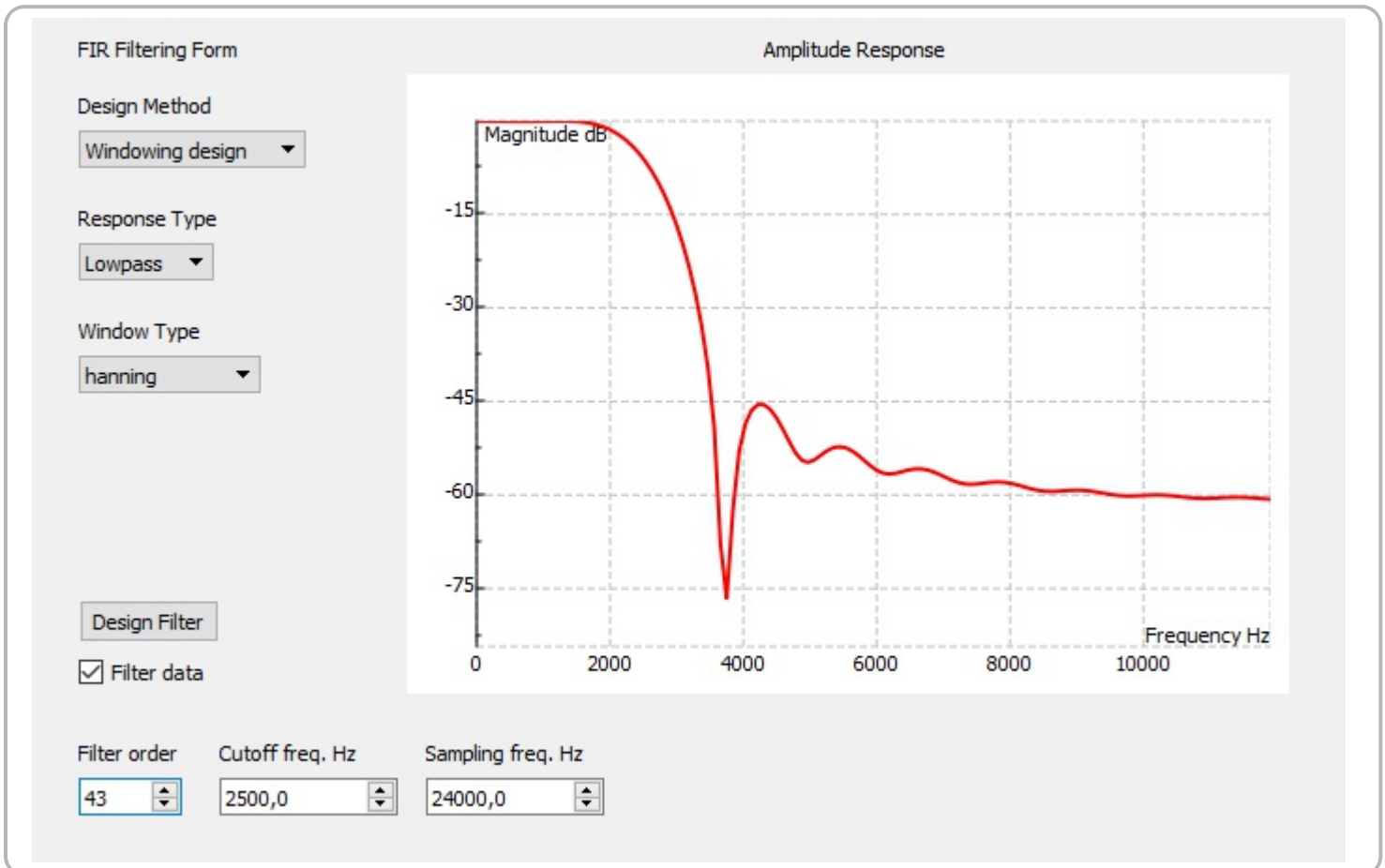
For the windowing method it is possible to select the window function: rectangular, Hanning, Welch, Parzen, Bartlett, Hamming, exponential, Riemann, Blackman-Harris, and Nuttall.

We initiate the FIR optimal form to perform the filter design according to the above requirements, and to filter the test signal. After all the filter design specifications are set, the tab Design Filter enables the filter design, and filtering if the Filter data box is checked. The amplitude response of the filter is shown in the graph which is included in the IIR filtering form.

`f:=firfilteringform(0, "FIRform1")` Initiate the filtering form

`y:=firfilteringresult(f, x)` Filtering signal using above form

The FIR filtering form is created in Canvas at the position where the function embed widget(f) is called. In this example we want to keep the lower frequency sinusoid. Therefore we design a lowpass filter, using the windowing method with the Hamming window and a cutoff frequency equal to 2500Hz. The filter order is set to 40.



The original test signal and filtered signal are shown in the following graph.

`graf1:=join mat cols(dt, x)`

`graf2:=join mat cols(dt, y)`

