Poznan University of Technology
Faculty of Computing and Telecommunications
Institute of Multimedia Telecommunications

COMPUTER AIDED DESIGN

LABORATORY

Instruction for the laboratory exercise

Multisim: Introduction to NI Multisim

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1. The aim of the exercise

- Learning the basics of using *NI Multisim 10* simulation program through the testing of active filters.

2. Examine active filter in *NI Multisim* program

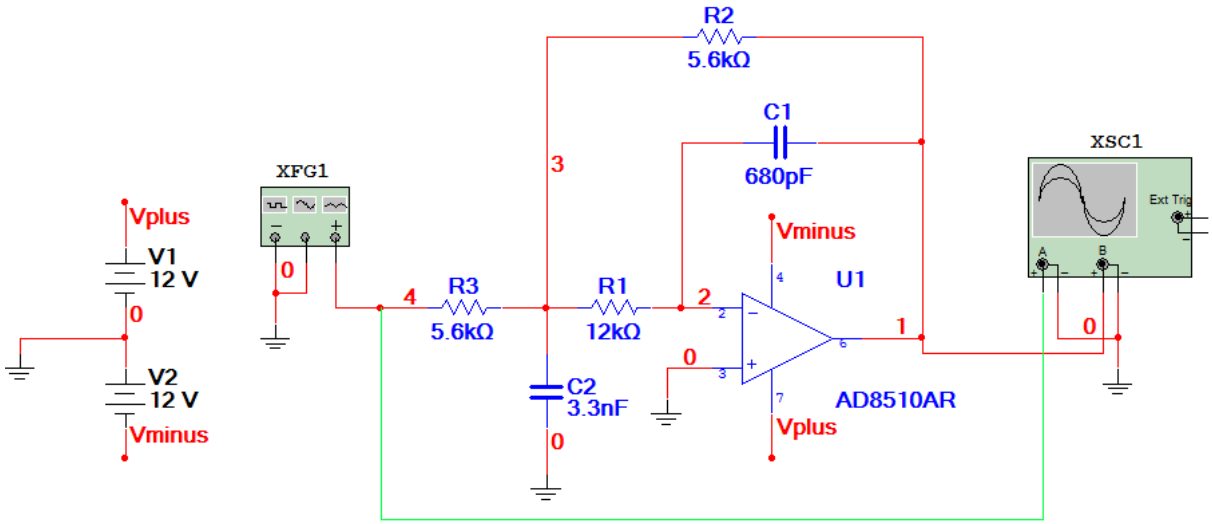

Fig.1. Example of active filter with attached power sources
and the generator and the oscilloscope.

a) Edit the designed filter circuit

- draw the circuit of designed filter in the *NI Multisim 10* program,
- set the tolerance for passive components:
  - capacitors 10%,
  - resistors E12 - tolerance of 10%, temp. co. 1000 ppm/°C (for carbon resistor),
  - resistors E48 - tolerance of 0.5%, temp. co. 50 ppm /° C (for metallic resistor),
- connect the power supply for operational amplifier (example in Fig.1).
- the output of the function generator XFG (filter input) connect to the first input of the oscilloscope XSC (channel A) and an output of the filter connect to the second input oscilloscope XSC (channel B),
- for on-screen virtual oscilloscope waveforms each have different colors, you need to change the colors of their connections (for combined right-click and choose *Segment Color* ...),
- start an interactive simulation and observe output signal at different frequencies (Fig. 2),
- changing the frequency of the generated signal find the cutoff frequency of the filter (output signal decrease by 3 dB).

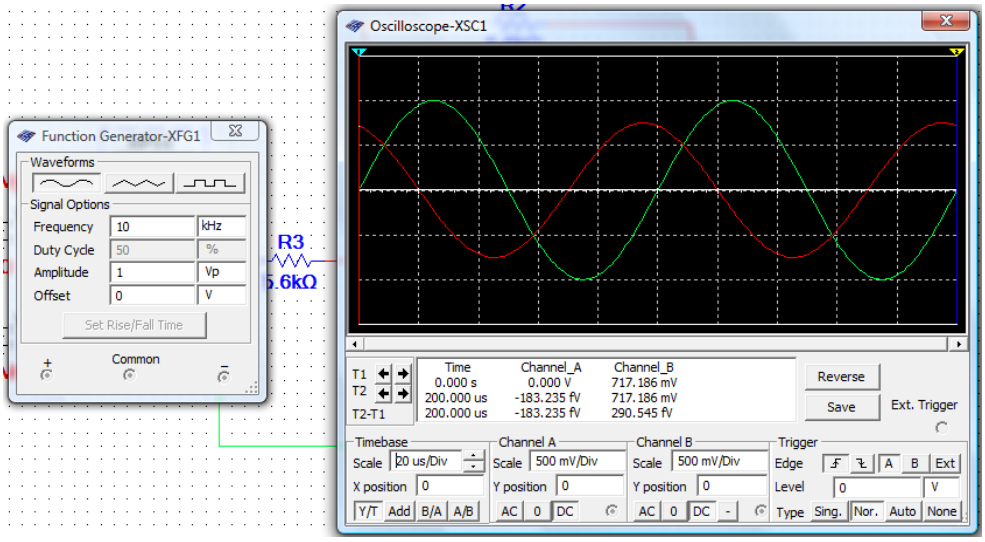

Fig.2. Windows of virtual generator and oscilloscope in NI Multisim.

b) Analysis of the filter

- perform the AC analysis (*AC Sweep* analysis),
- using a parametric analysis (*Parameter Sweep*) examine the influence of various passive elements on filter characteristics (perform the parametric analysis with the analysis of frequency),
- determine the range of the changes of the filter cut-off frequency caused by temperature changes (temperature changes from -20°C to 120°C), make the *Temperature Sweep* analysis,
- determine the range of the changes the filter cutoff frequency for different tolerance of used components - make the *Worst Case* analysis. In *Analysis Parameters* window, take the *Collatig Function* tab and in the *Frequency* field, type the cut-off frequency of the filter,
- the last two points made setting resistor values of the E12 series (carbon resistors) and E48 (metalized resistors).

3. Design and analyze of active filters

Open the online filter design page: **https://tools.analog.com/en/filterwizard/**

a) Design an active filter for audio frequencies with the following parameters:
   - band-pass,
   - gain: 1 V/V,
   - filter order: 4.
   - filter response: Butterworth
   - select multiple-feedback (MFB) circuit implementation
   - design the filter, assuming the values of E12 series resistors (1%) and capacitors from the E48 series (5%).

b) Perform frequency analysis of the tested filter (AC Sweep analysis),

c) Compare the determined characteristics with the design assumptions.

4. Tasks for students to do homework (obligatory)

- Open the online filter design page: **https://tools.analog.com/en/filterwizard/**
- Design a filter in the implementation of Sallen-Key for audio frequencies,
- Use 'real' generator and oscilloscope to observe signals,
- Perform frequency analysis of the tested filter (AC Sweep analysis),
- Compare the determined characteristics with the design assumptions,
- Compare the filter parameters in both embodiments of the arrangement (MFB and Sallen-Key),
- Create BOM of your filter.

5. Additional tasks

- Design audio band-pass filter in Micro-Cap, parameters are the same as in the exercise, you can select the filter type Sallen-Key or multiple-feedback (MFB),
- Compare results from Multisim and Micro-Cap.

Report

Should contain:

Åall schemes of simulated systems,
Åsimulation results,
Åanswers to the questions contained in the manual,
Åconclusions.