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

COMPUTER AIDED DESIGN

LABORATORY

Instruction for the laboratory exercise

Multisim: Use of virtual instruments

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1. The aim of exercise

- Using virtual instruments in Multisim,
- Analysis and synthesis signals,
- Filtering and a Fourier analysis of selected signals.

2. Analysis and synthesis square-wave signal

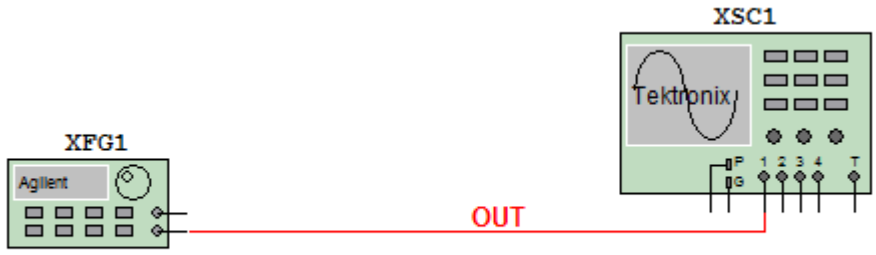

Fig.1. Measuring system connection

a) Square-wave signal analysis

- insert object Agilent Function Generator,
- set the parameters of the square wave signal $1V_{pp}$, 1kHz (the teacher can give other signal parameters),
- draw line (connection) from the output of the generator and call it OUT,
- insert object Tektronix Oscilloscope and connect OUT signal to Channel 1,
- using the oscilloscope make a Fourier analysis, read the harmonic frequencies,
- make the Fourier analysis of the signal using *Simulate* > *Analyses* > *Fourier analysis*,
- read the amplitude and phase of the signal for the first 10 harmonics.
- compare results with your readings from oscilloscope in FFT mode.

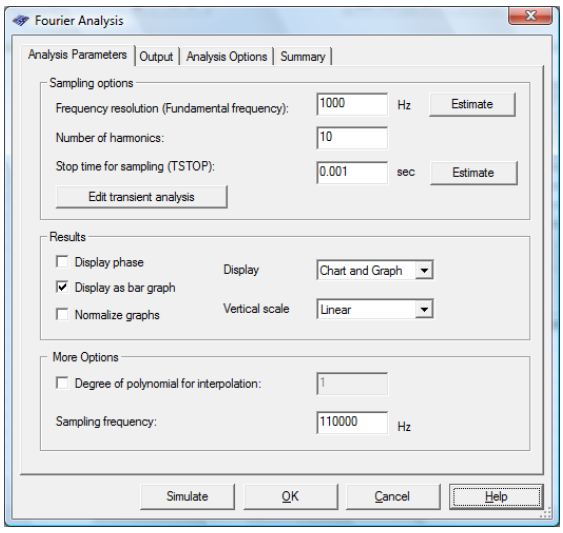

Fig.2. Fourier Analysis settings

b) Synthesis of square-wave signal from harmonics

- design inverting adder circuit for the first five odd harmonics (a sample configuration is shown in Fig.3),
- enter the parameters of harmonics previously read in point a),
- observe the signal on the oscilloscope,
- make a Fourier analysis to validate the parameters of the components,
- to improve the signal shape it can be added the next harmonics - even and odd (ask the teacher for details).

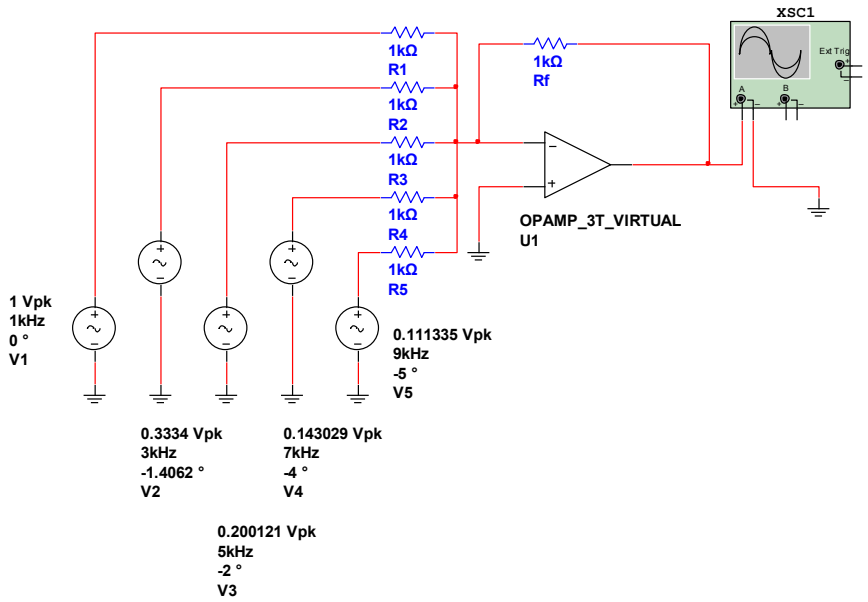

Fig.3. Example of an adder with attached sources and oscilloscope

3. Filtering out selected harmonics of the square-wave signal

a) Cutting off the higher harmonics

- design a low-pass filter to cut-off higher harmonics from created signal, it should remain only the basic one,
- decide **yourself** what type of filter, the filter slope and its configuration,
- to design filter you use the online filter design page: **https://tools.analog.com/en/filterwizard/**
- perform the AC and Time analysis to show the performance of the filters,
- calculate the *Total Harmonic Distortion* (*THD*) from equation (use Calc or Excel):

$$THD = \frac{\sqrt{H_2^2 + H_3^2 + H_4^2 + \cdots H_k^2}}{\sqrt{H_1^2 + H_2^2 + H_3^2 + H_4^2 + \cdots H_k^2}} \cdot 100\%$$

- insert object *Distortion Analyser* and measure THD,
- make a Fourier analysis, read calculated THD and compare results.

4. Tasks for students to do homework (obligatory)

- Perform analysis and synthesis of triangular signal (f = 1kHz), use 5 harmonics,
- Use low-pas filter to get main harmonic,
- Calculate and measure the total nonlinear harmonic distortion nonlinear *THD* for created signal.

5. Additional tasks

- Based on signal from circuit in Fig.3. design and use a band-pass filter to extract the 3-th harmonic.

6. Report

It should contain:

- all schemes of simulated circuits,
- simulation results,
- answers to the questions contained in the manual,
- conclusions.