Sine_to_Square_Converter -- Overview

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Square to Sine Wave Converter

OBJECTIVES

At the end of this experiment, learner would be able to:

- Design a filter using Opamp
- Understand the concept of signal processing using hardware
- Determine the fundamental frequency of a square wave
- Converter (filter out) square wave to a sine wave
- Use TBS1000B-EDU oscilloscope for signal analysis

EQUIPMENT

To perform this experiment, you would need:

- Opamp μA741 IC
- Signal Generator (AFG3000 Series from Tektronix or equivalent)
- Resistors - 3.3KΩ, 10KΩ, 5.6 KΩ
- Capacitor - 0.01μF
- Oscilloscope (TBS1000B-EDU series from Tektronix or equivalent)
- Connecting wires and breadboard

FILTER DESIGN

- For a second order filter, A_f = 1. 586 and f_c= 5 kHz
  - The passband gain of filter = $A_f = (1+ R_f / R_1)$
  - So R_f / R_1 = 1.568 -1 = 0.568
  - Take R_1 = 10 kΩ then
  - R_f = 5.68 kΩ
- f_c= 5 kHz = 1 / (2πRC)
  - Assume C = 0. 01μF
  - then R = 3.3 kΩ

THEORY

- The low pass filter is the one that allows low frequencies

through the circuit and stops (attenuates) frequencies higher than the cut off frequency.

- The transition from passband (frequencies that are allowed to pass) to stopband (frequencies that are attenuated) happens at a frequency called cut-off frequency.
- At cut-off frequency, the output of the filter is 3dB below the input power. So cut-off frequency is also called as 3dB down frequency.
- The transition from passband to stop band and stopband attenuation varies based on type of filter used (e.g., Butterworth, Bessel, Tschebyscheff) and order of filter (1^{st}, 2^{nd}, etc).
- The roll off (attenuation) of the filter can be given by the formula: roll off = (- 20 * n) dB / decade where n is the order of the filter.
- Filters are applied in radio circuits, TV, Telephone, Radar and Biomedical Equipments.

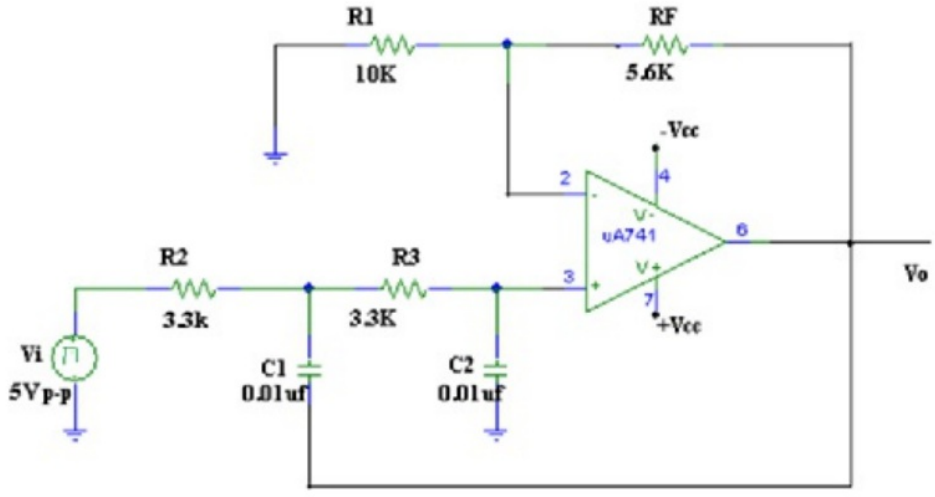
Reference Reading:

- Introduction to Analog and Digital Communication by Simon Haykin.
- Linear Integrated Circuits by D Roy Choudhary

Sine_to_Square_Converter -- Procedures

Step 1

Build the circuit as shown below:



Step 2

- Ensure the value of the circuit components follow the design procedure mentioned in the Overview.
- Parameters given for design of the circuit is:
  - Filter gain A_f = 1.568
  - Cut-off frequency f_c = 5kHz

Step 3

- Set the signal generator output to 2V peak to peak & frequency = 5kHz
- Set the signal type as Square Wave.
- Feed the signal generator output to circuit input.

Step 4

- Observe the output of the filter circuit.
- Measure peak-to-peak voltage of input and output
- Take screenshot of output waveform

Step 5

Question:

- What is shape of the output signal?
- What is the frequency of the output signal?

Step 6

The filtered output represents the fundamental frequency of the square wave