#### Lab 3 - First and second order filtering of high frequency noise

#### Aim

The experiment demonstrates techniques to filter a noisy electrical signal.

#### Introduction

A noisy signal will be generated by adding a high frequency signal to a "clean" signal using a summing amplifier.

Hardware filtering of the noisy signal will be tested using a number of active filters (first order a second order).

Software filtering is achieved by means of capturing the signal to obtain the raw data which can be filtered then using a number of software tools.

Note: You must include all circuit diagrams in your report.

### Hardware filtering of noise

Signal filtering performs an important function in some electronic circuits, simple passive RC and RLC filter circuits are limited and so active filters are generally preferred. The goal of part 1 of the practical is to produce a noisy signal which will be filtered using both a first and second order active filter.

For this lab we need to:

- 1. Generate a approximate model of high frequency noise
- 2. Add the noise to a clean signal
- 3. Filter out the noise.

#### Task 1: Generate a high frequency signal to approximate noise

Set the function generator to produce a sine wave of frequency 5 kHz and 5 Vpp

#### Task 2: Generate a clean signal

Set the second function generator to produce noise signal of 50 mVpp

## Task 3: Add the noise to the signal

Using a summing amplifier design and implement the addition of the noise to the clean signal to produce a noisy signal.

**Note:** Design the summing amplifier using standard *inverting* operational amplifier configuration i.e.the output voltage will be inverted. To re-invert the signal add a single input inverting adder with a gain of one to your circuit.

#### Task 4: Test the circuit

Produce representative graphs of

- 1. The clean signal
- 2. The noise signal
- 3. The noisy signal

If you have completed the above Task 5 in the in-person lab, please include this in your report and skip to Task 6. If you have not fully completed Task 5, use the Multisim results.

# Task 5: Filter of the noisy signal using a second order band pass filter

- Decide on the appropriate cut-off frequency
- Design the filter using https://filterlab.microchip.com/

Use the software to design the second order filter bandpass.

• Implement and test the circuit in Multisim.

**Note:** the noise signal can be generated by using the Thermal Noise voltage source.

# Task 6: Filter of the noisy signal using a fourth order band pass filter

- Decide on the appropriate cut-off frequency
- Design the filter using https://filterlab.microchip.com/
  Use the software to design the fourth order filter bandpass.
  - Implement and test the circuit in Multisim

# **Data for Report:**

- 1. Show the two input signals
- 2. Show the input signal and noisy signal
- 3. Show noisy signal and output from 2<sup>nd</sup> order filter
- 4. Show output from 2<sup>nd</sup> order filter and 4<sup>th</sup> order filter