Cycle Initial en Technologies de l'Information de Saint-Étienne

SECOND ORDER ACTIVE FILTER TOPOLOGY

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1. Abstract

The goal of this report is to introduce ourselves to different second order active filter topologies. In this case we'll be studying the Sallen-Key and Multiple Feedback filters in an effort to understand and manipulate the effects of damping and resonance on these kinds of filters.

2. Sallen-Key Low-Pass Filter

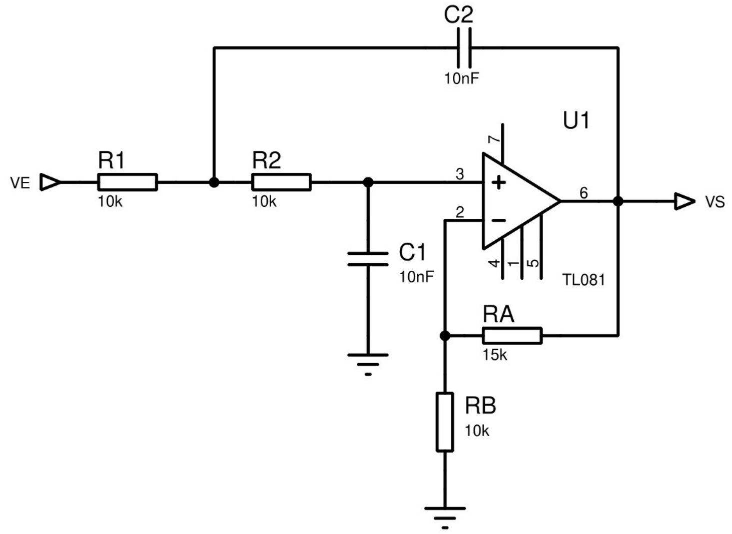
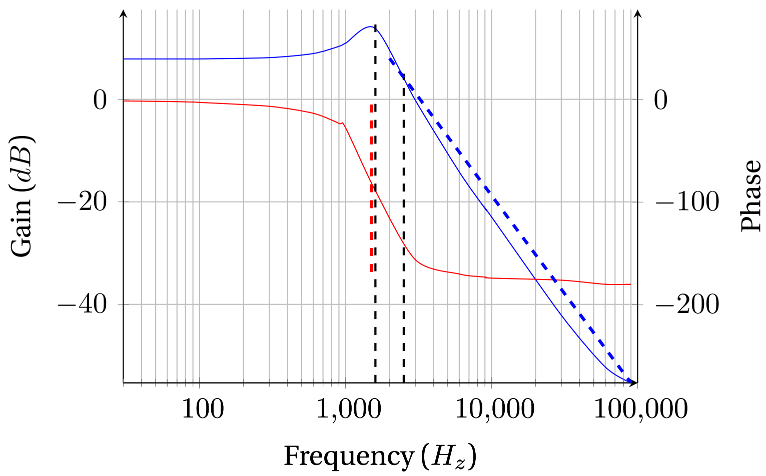


Figure 2.1. Sallen-Key Low-Pass Filter

2.1. Study in sinusoidal regime



Using the formulas provided in the preparation of the experiment we quickly calculate the damping coefficient $m = 0.25$ as well as the constant gain factor $K = 2.5$

Judging by the Bode diagram we can accurately measure a cut-off frequency at about $2500\ H_z$ as well as a resonance frequency at $1600\ H_z$ which maxes out at the curve's maximal gain $17.5\ dB$, as well as a $-40\ dB/dec$ slope.

On this non-unity-gain filter we notice that due to the damping factor being inferior to 1 a peak of high gain manifests itself highlighting the resonance which can later be used for signal processing.

2.2. Study in impulsive regime

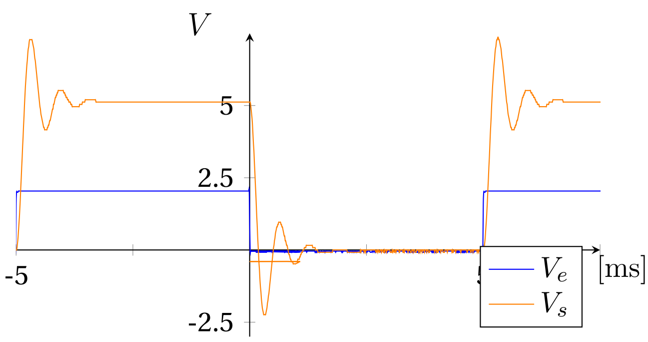


Figure 2.2. Chronograms of V_s and V_e

To study the signal response we'll be choosing a frequency of $100\ H_z$ allowing us to clearly see the damped oscillations as the frequency goes below the resonance.

This being done we can then measure the rise at about $124\ \mu s$, which can be considered slow . However the observed values correspond to our expectations since the damping coefficient remains lesser than 1, responsible for the damped oscillations.

3. Multiple Feedback High-Pass Filter

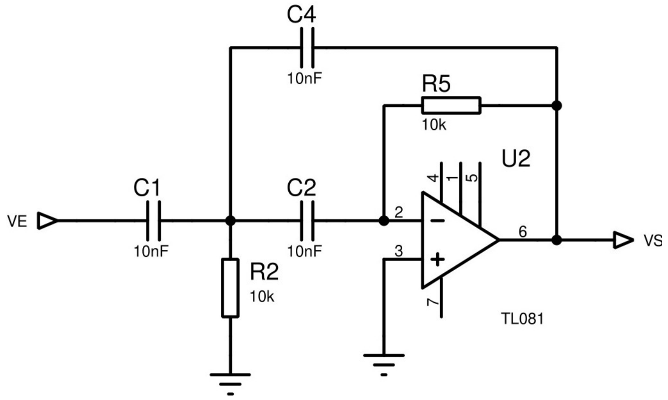
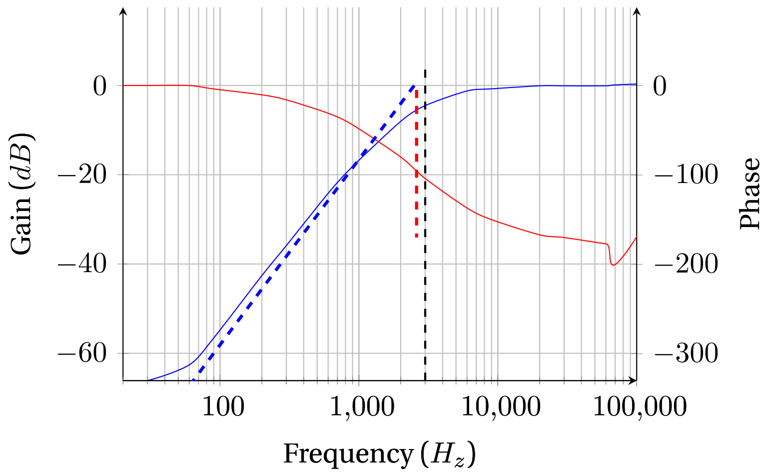


Figure 3.1. Multiple Feedback High-Pass Filter

3.1. Study in sinusoidal regime



Using the formulas provided in the preparation of the experiment we quickly calculate the damping coefficient $m = 1$ as well as the cut-off frequency at $f_0 = 2321\ Hz$

Judging by the Bode diagram we can accurately measure a cut-off frequency at about $2500\ H_z$ from which point rearwards the gain slope is at $40\ dB/dec$. All of which correspond to the expected values. Unlike last study, the damping coefficient is equal to 1 therefore the cut-off frequency is much clear and no resonance is expected.

We can notice a second higher cut-off frequency at about $1300\ H_z$ this is due to the limitation of the operational amplifier which can no longer properly process the rapid input changes.

3.2. Study in impulsive regime

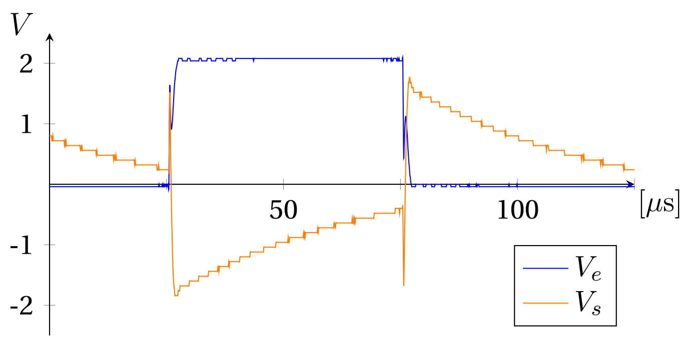


Figure 3.2. Chronograms of V_s and V_e

To study the signal response we'll be choosing a frequency of $10\ KH_z$ allowing us to clearly see the exponential decay as the frequency goes above cut-off.

This being done we can then measure the rise at about $707\ ns$.

The observed values correspond to our expectations since the damping coefficient remains equal to 1, responsible for the exponential decay curve.