Department of Electronics and Electrical Communication Engineering, IIT Kharagpur

Experiment 2: Switching Modulator

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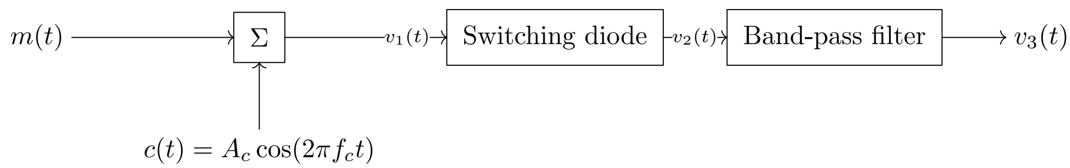
1 Introduction

1.1 Task 1

We want to a transmit a message signal $m(t)$ using a carrier signal $c(t)$. We set up the following to generate the final modulated signal, and the following block diagram represents it:



Here

$$v_1(t) = m(t) + A_c \cos(2\pi f_c t)$$

where $A_c > |m(t)|$
The signal $v_3(t)$ is the final modulated signal.

Here for $c(t)$: $A_c = 3V$ i.e. $6V_{pp}$ and $f_c = 8kHz$
And for $m(t)$: $A_c = 1V$ i.e. $2V_{pp}$ and $f_m = 1kHz$

1.2 Task 2

To demodulate and find out the original signal, we will design an envelope detector, with respect to the carrier and the message frequencies. Further we will pass the output through an appropriate low pass filter to smoothen output

2 Instruments and Materials Used

1. RIGOL Signal Generator
2. ScientiFIC SMO10C Digital Signal Oscilloscope
3. +12V, -12V DC source and ground
4. Resistors
5. Capacitors
6. Diodes
7. Breadboard
8. Connecting wires

3 Theory

Due to the diode:

$$v_2(t) = \begin{cases} v_1(t), & \text{if } c(t) > 0 \\ 0, & \text{if } c(t) < 0 \end{cases} \tag{1}$$

which means that the expression can be represented as:

$$v_2(t) = v_1(t)x(t) \tag{2}$$

where $x(t)$ is a square wave which follows $\cos(2\pi f_c t)$

The Fourier decomposition can be written as

$$x(t) = \frac{1}{2} + \frac{2}{\pi}\sum_{n=1}^{\infty}\left(\frac{(-1)^{n-1}}{2n-1}\cos(2\pi(2n-1)f_c t)\right) \tag{3}$$

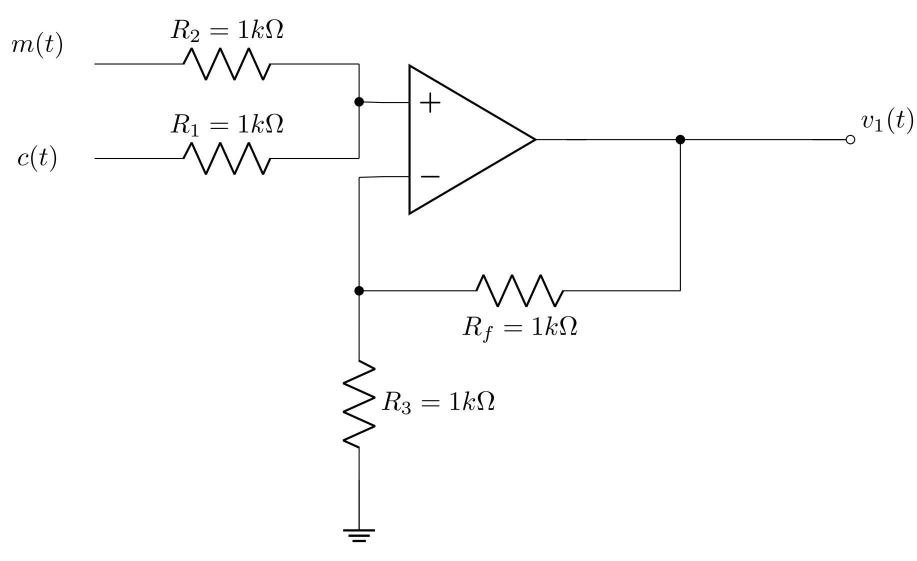
4 Calculations and Circuit Diagrams

4.1 Task 1: Modulating circuit

For the adder, since we require $v_1(t) = m(t) + A_c\cos(2\pi f_c t)$, we use the op-amp as an adder with

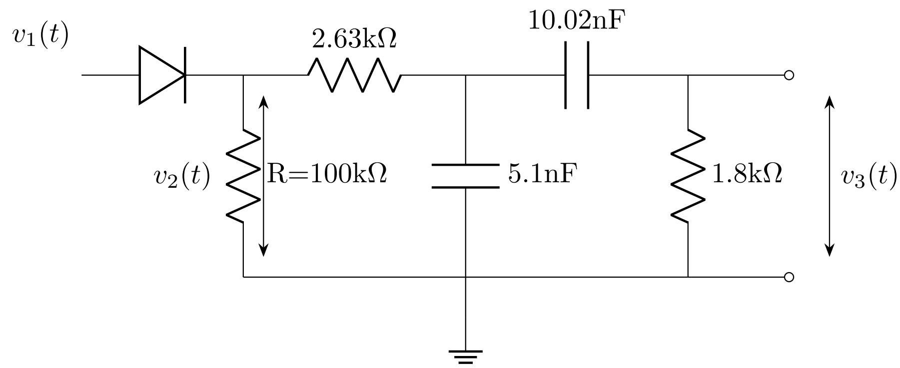
$$R_1 = R_2 = R_3 = R_f = 1k\Omega$$

Figure 1: Required circuit for addition



After the added signal $v_1(t)$ we design the following band pass filter:

Figure 2: Band pass filter to remove higher frequencies



where $f_L = 4.4kHz$ and $f_H = 12.5kHz$, such that unwanted high frequency do not result in power wastage