Generation of PAM Signals and Reconstruction

1 Objective

- Generation of PAM Signals.
- Reconstruction/demodulation of the PAM signals.

2 Theory Overview

Pulse modulation is the process of changing a binary pulse signal to represent the information to be transmitted. Pulse-amplitude modulation (PAM) is the simplest and the most basic form of pulse modulation. In PAM, the amplitudes of regularly spaced pulses are varied in proportion to the corresponding sample values of a continuous message signal. Figure 1 shows an analog modulating signal and the waveform produced by a PAM modulator [1]. The PAM signal shown in Figure 1 is a series of constant-width pulses whose amplitudes vary in accordance with the analog signal. The pulses are usually narrow compared to the period of sampling; this means that the duty cycle is low. Note that the modulating signal is strictly positive. The corresponding output of the modulator is known as the *single-polarity* PAM signal.

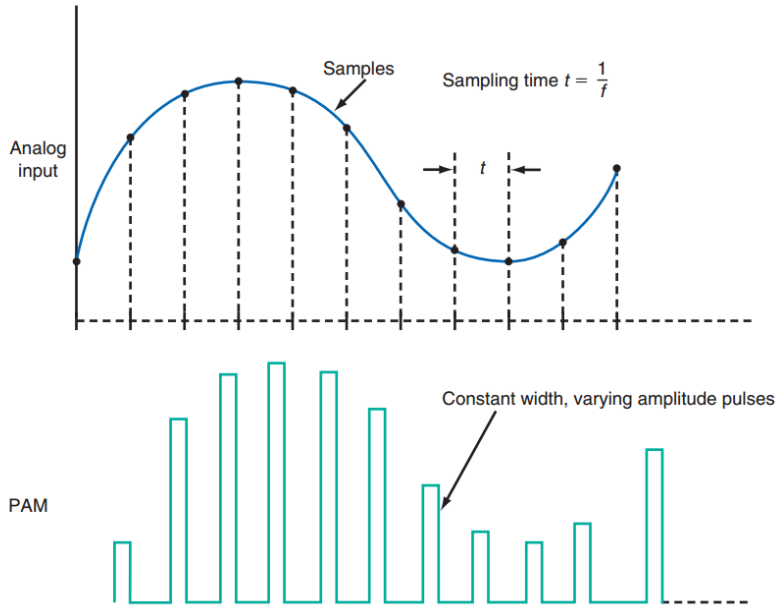

Figure 1: Modulating signal and PAM signal

3 Circuit and Its Working Principle

The circuit diagram for PAM generation and reconstruction is shown in Figure 2. The modulator circuit comprises of two parts: *amplifier* (transistor Q1) and *switch* (transistor Q2). The purpose of the amplifier stage is to convert the message signal into a non-negative signal as depicted in Figure 1. The switching is controlled by the pulse signal. At the collector of Q2, we get a series of pulses whose amplitudes are proportional to the message signal. The resulting output is the desired PAM signal. Note that the (sampling) frequency of the pulse signal must satisfy the Nyquist condition.

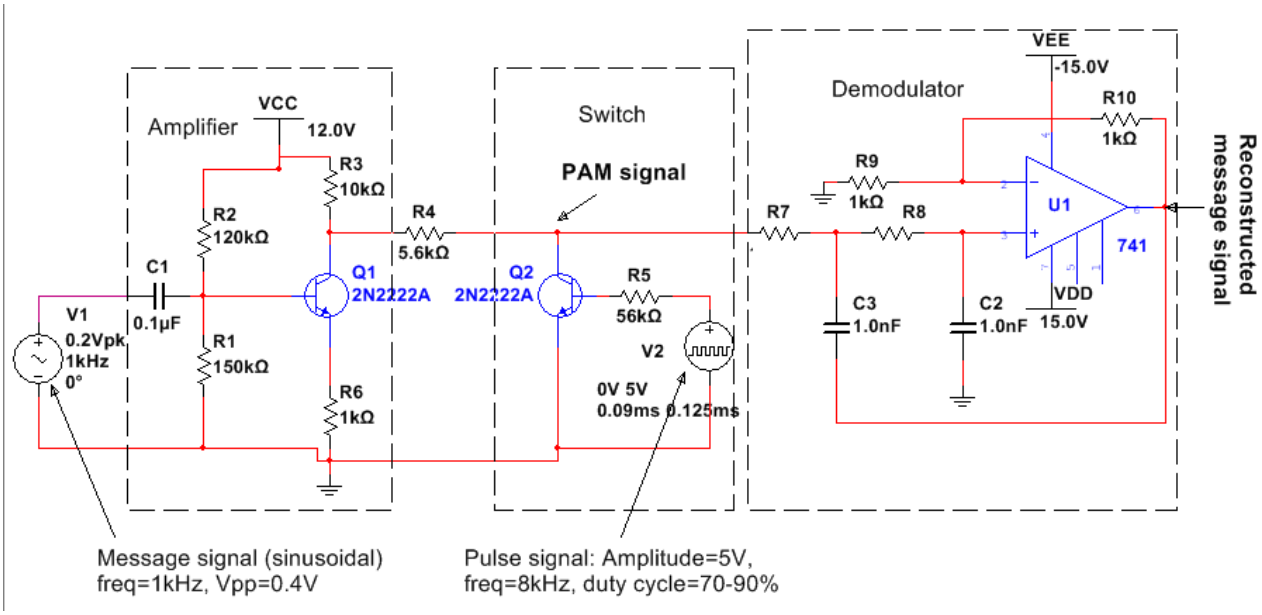

Figure 2: Circuit diagram

The reconstruction of the PAM is accomplished by the 2nd order Butterworth low-pass filter based on IC741 OP-AMP as shown in Figure 2.

4 Lab Procedures

Perform the following steps:

- Implement the circuit for the amplifier stage as shown in Figure 2.
- Apply a sinusoidal message signal of frequency= 1kHz, Vpp=0.4V.
- Observe the output of the amplifier stage i.e. at the collector of Q1. Plot this output along with the message signal.
- Connect the switching circuit.
- Apply a pulse signal of frequency= 8kHz, amplitude= 5V and duty cycle between 70-90 %.
- Observe the PAM signal at the collector of Q2. Plot it along with the message signal.

- Connect the demodulator circuit.
- Design the Butterworth filter, compute the cut-off frequency and justify it.
- Observe the reconstructed message signal. Compare it with the original message signal.

Questions

1. Explain the purpose of the amplifier stage in the modulator circuit.
2. Justify the use of higher duty cycle for the pulse signal.

References

[1] Louis E. Frenzel Jr, *Principles of Electronic Communication Systems*, McGraw Hill Education, 4th edition