

Signal Modulation Techniques

<https://esim.fossee.in/circuit-simulation-project>

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Title of the circuit : Signal Modulation Techniques (PWM,PAM & PPM)

Problem Statement : Evaluate the effectiveness of signal modulation techniques in improving data transmission quality and efficiency in communication systems.

Theory/Description :

Signal modulation is a method by which certain properties of a carrier signal such as amplitude, width, or position are varied to encode information. This process allows for efficient data transmission by converting signals into a format suitable for communication channels, ensuring clarity upon reception. Techniques like Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), and Pulse Position Modulation (PPM) each offer distinct ways to encode data. While PAM adjusts pulse amplitude, PWM modulates pulse width, and PPM shifts pulse position, enabling effective data transfer over varied distances. These methods increase transmission efficiency, reduce noise, and enhance signal quality, essential for applications ranging from radio broadcasting to digital data systems. Modulation, by optimizing bandwidth and power, plays a critical role in maintaining signal integrity and reducing interference, which is vital for reliable communication in high-congestion environments.

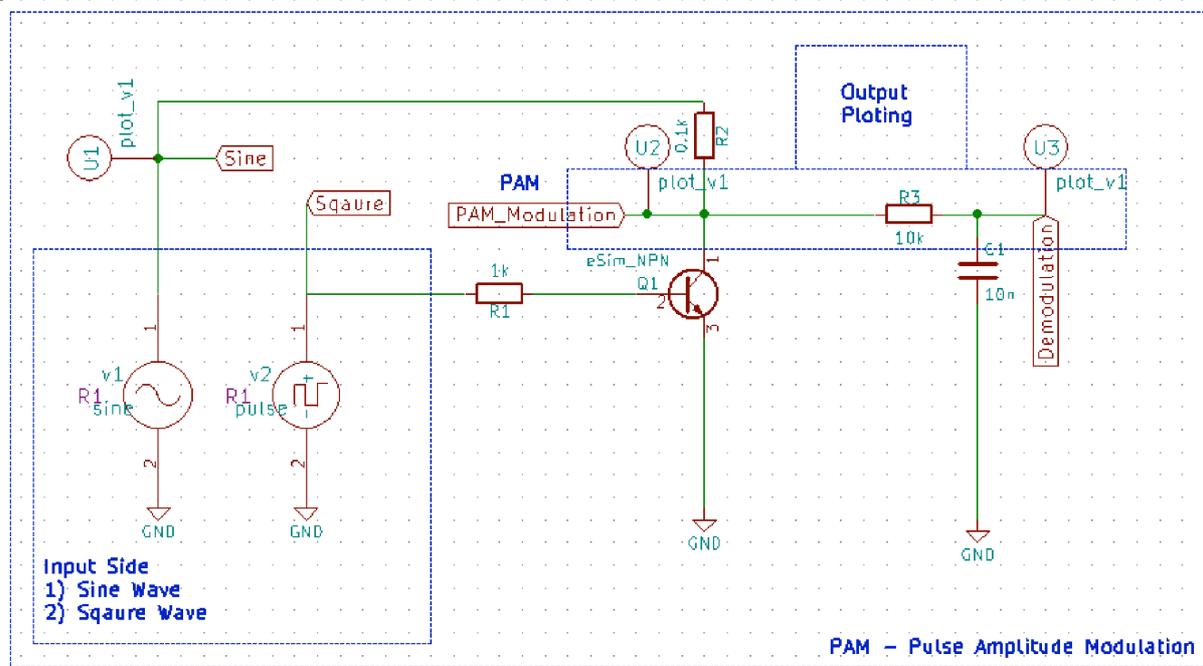
Techniques Covered:

- A) Pulse Amplitude Modulation (PAM)
- B) Pulse Width Modulation (PWM)
- C) Pulse Position Modulation (PPM)

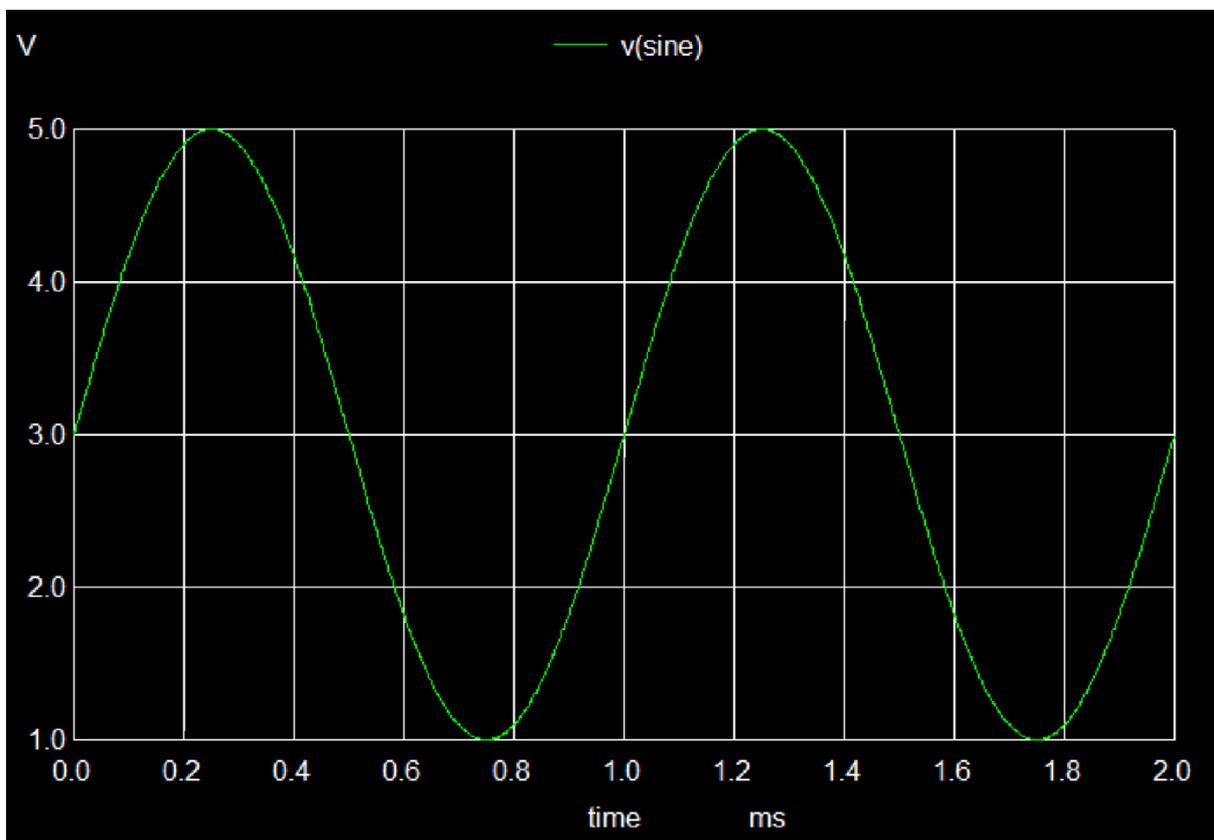
Methodology: Each modulation technique is designed, visually drawn, and simulated to illustrate its unique characteristics and performance using eSim.

A) Pulse Amplitude Modulation (PAM): In PAM, the amplitude of the carrier pulse varies in accordance with the information signal. This technique is simple to implement and allows multiple signals to share the same transmission medium. However, PAM is more susceptible to noise, which can affect signal clarity, especially over longer distances.

Circuit Diagram(s) :

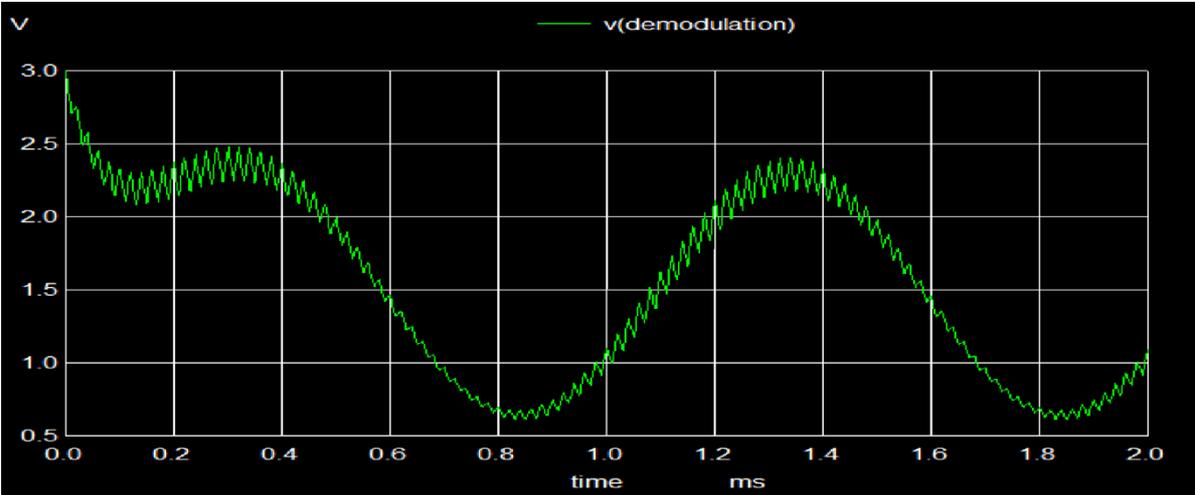
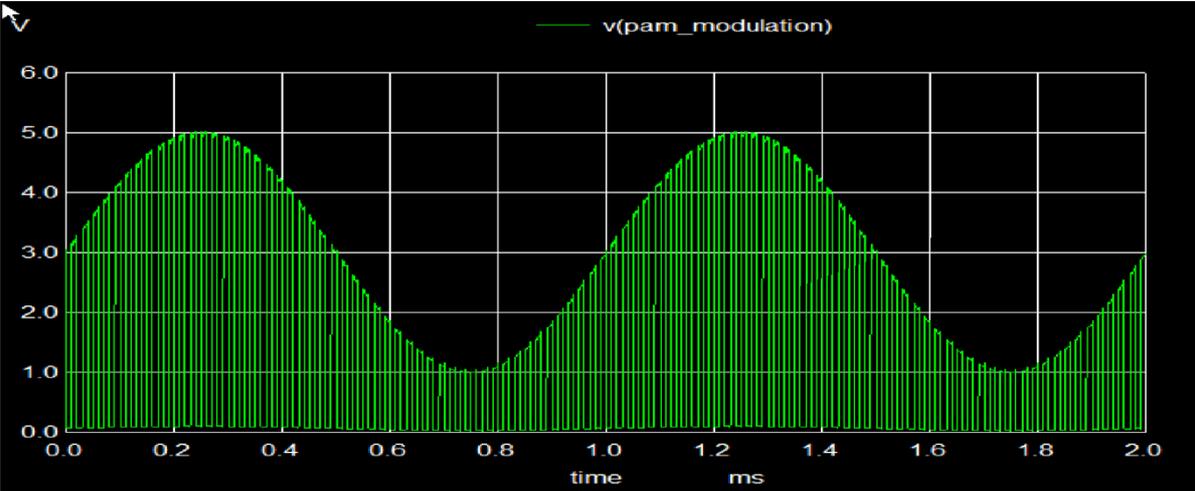


Input Waveform :

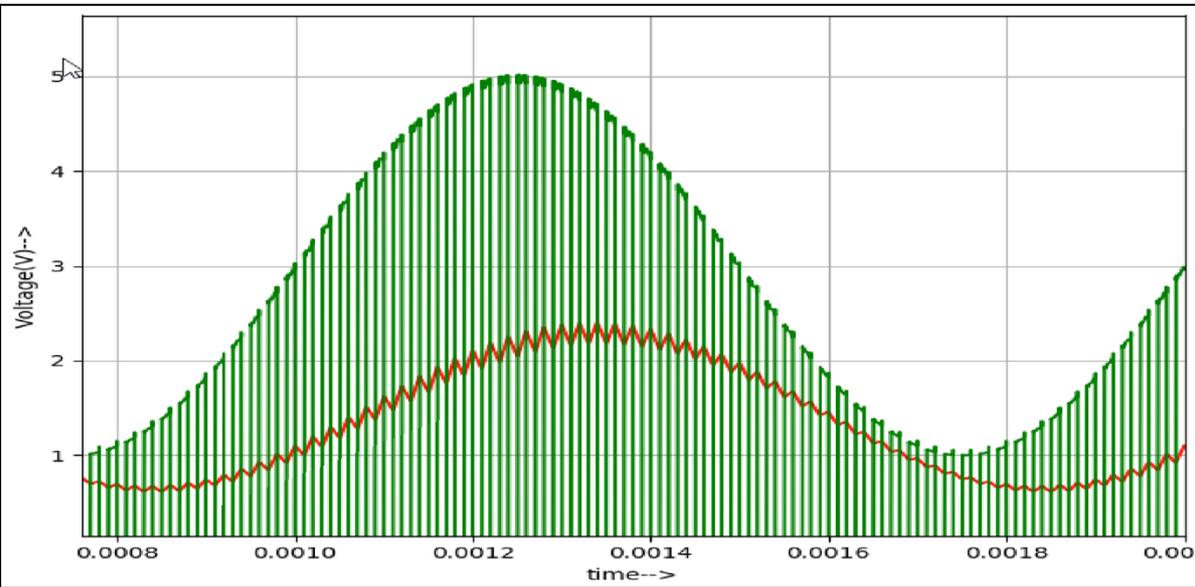


Output Waveform :

1) Ngspice

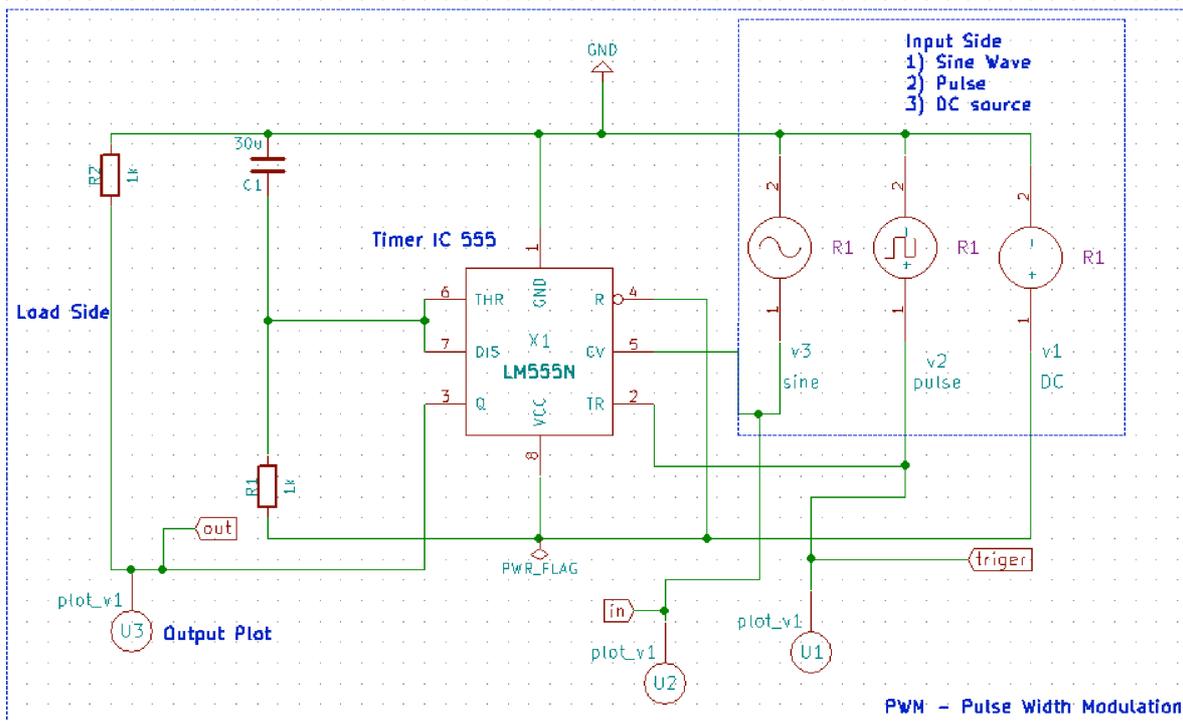


2) Python Plot window

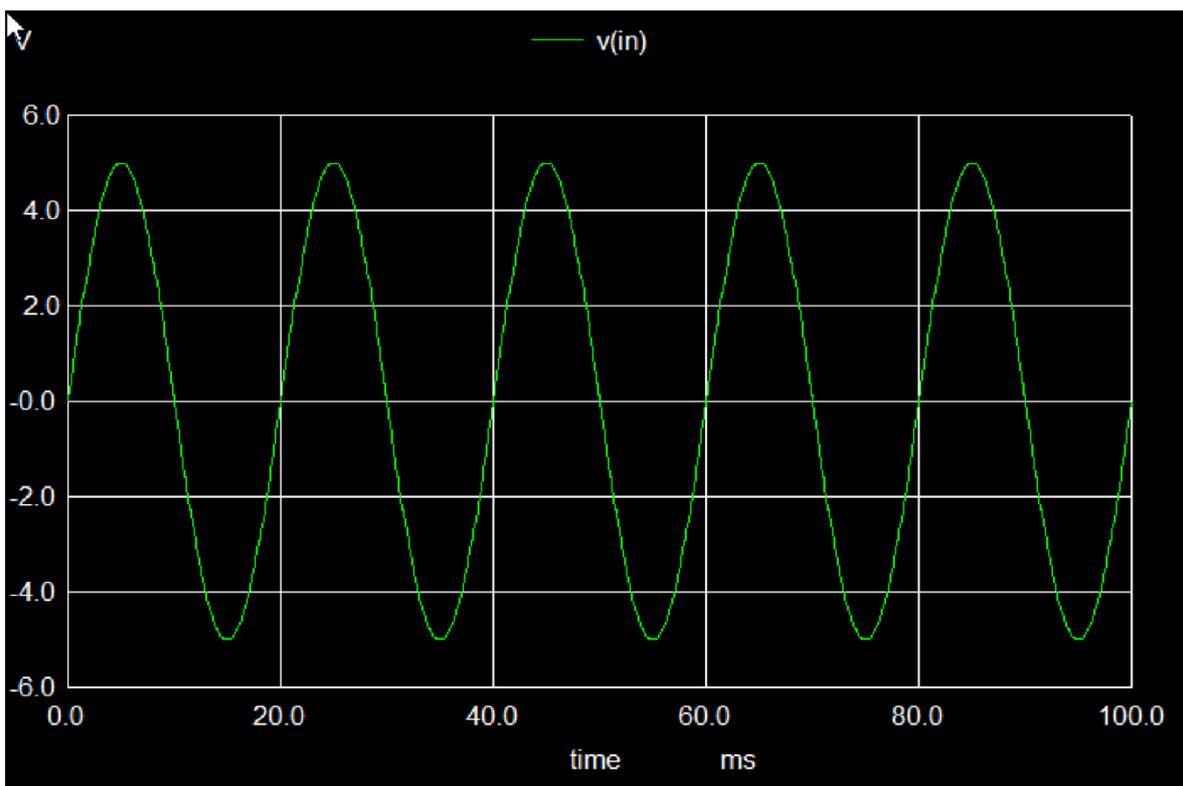


B) Pulse Width Modulation (PWM): With PWM, the width (or duration) of each pulse is modulated based on the information signal. This method offers high noise immunity and is commonly used in power control systems and audio signal transmission, where maintaining signal integrity is critical

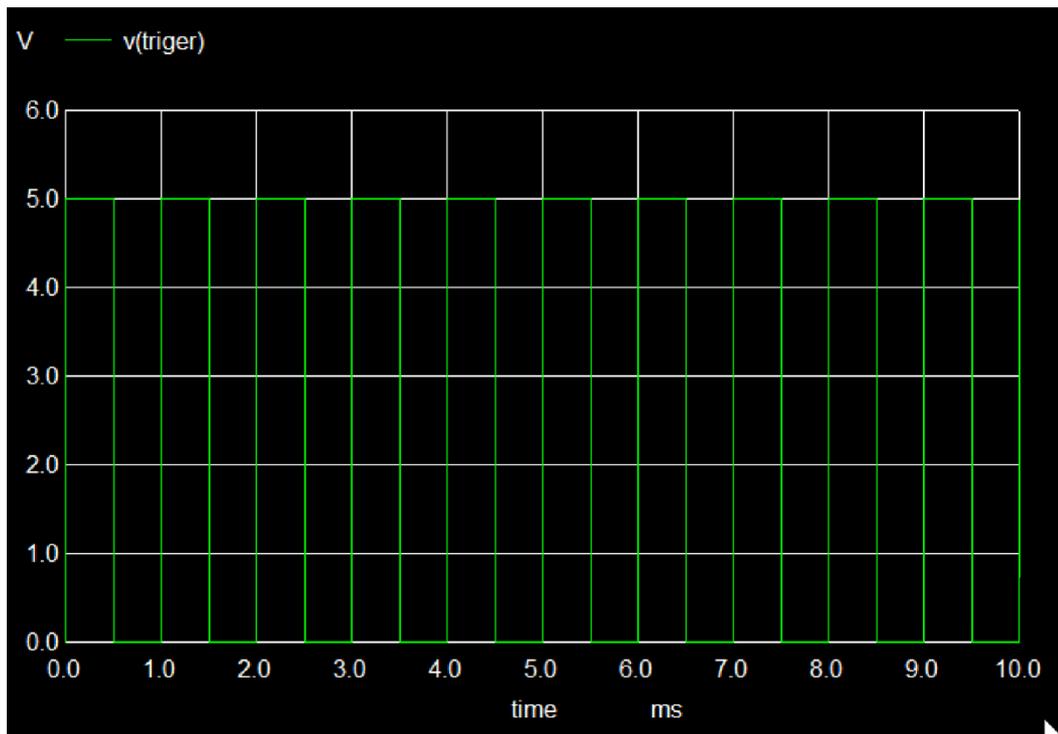
Circuit Diagram :



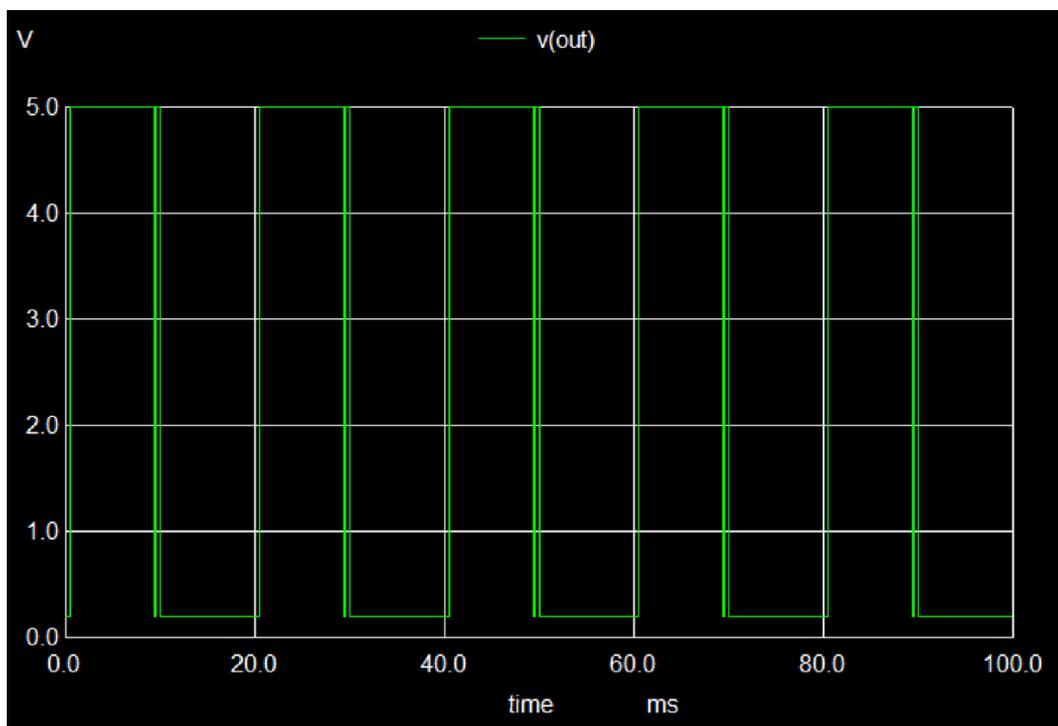
Input Waveform :



Trigger Waveform :

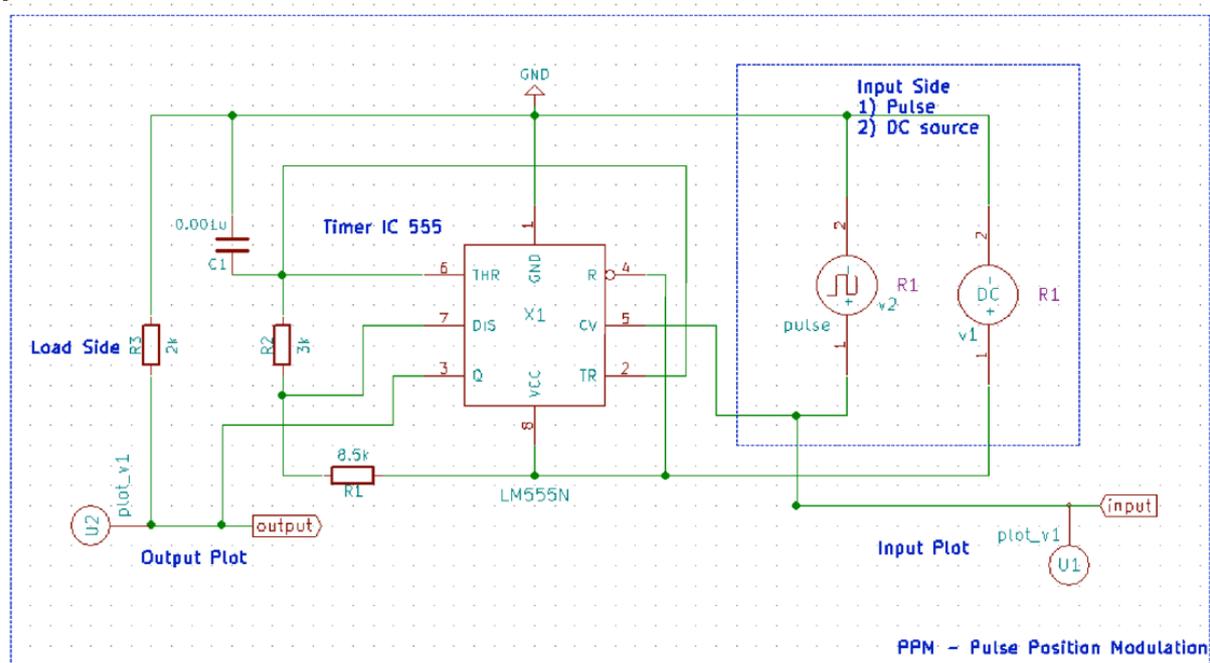


Output Waveform :

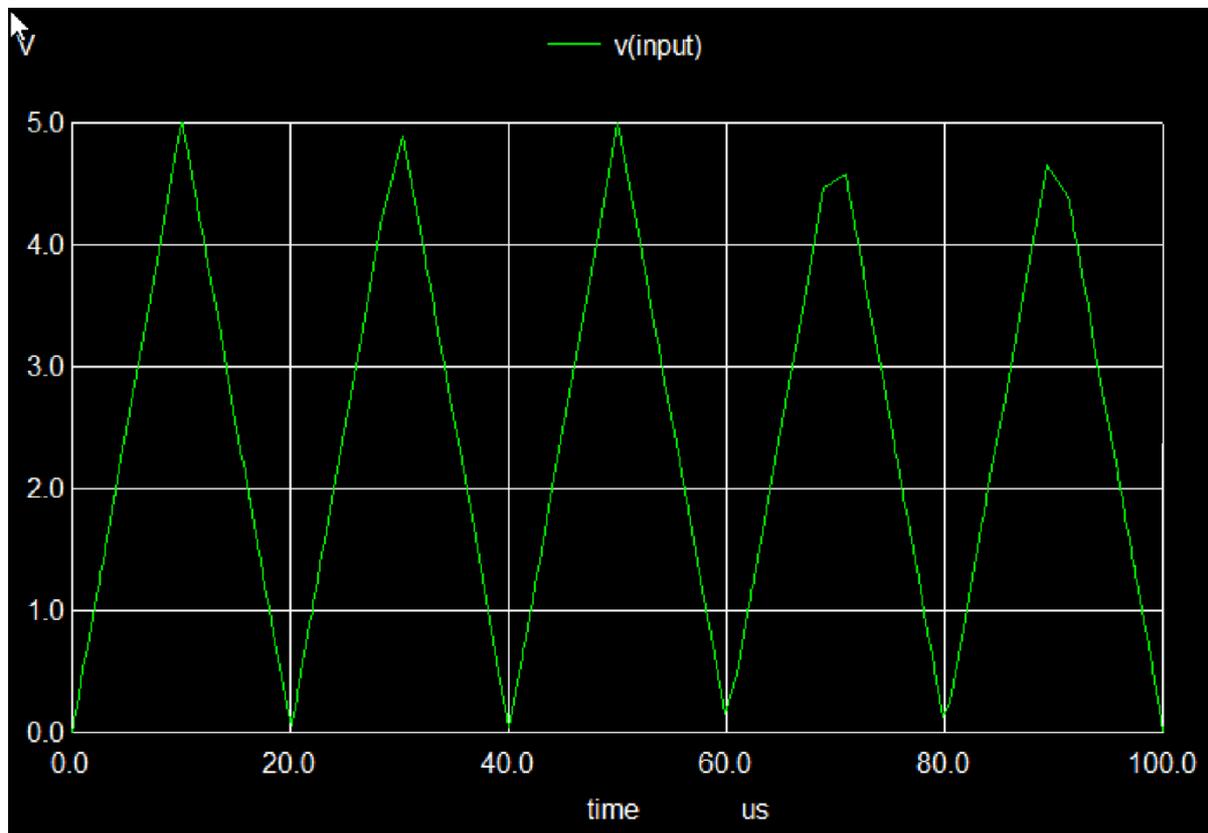


C) Pulse Position Modulation (PPM): In PPM, the position of each pulse is varied relative to the reference position according to the information signal. PPM provides better noise immunity than PAM and is well-suited for optical communication systems where signal clarity is essential over significant distances.

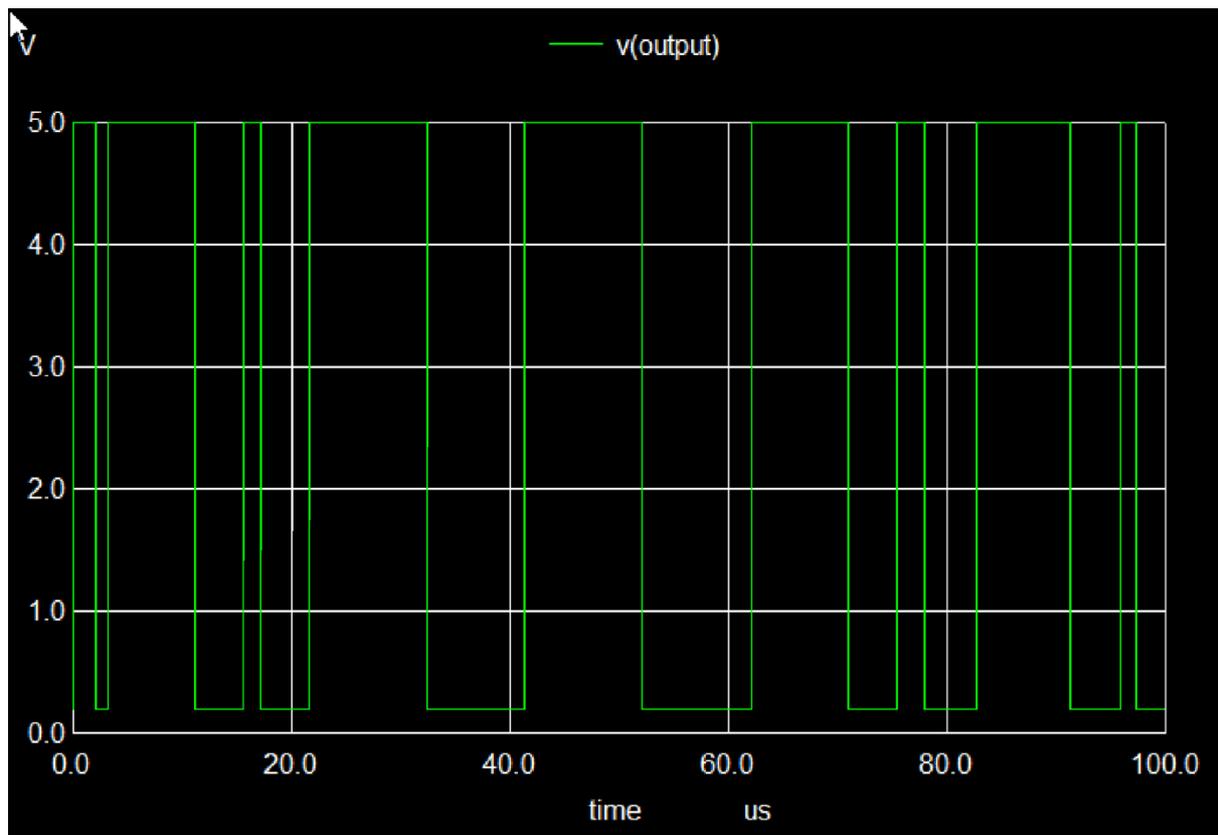
Circuit Diagram :



Input Waveform



Output Waveform :



Source/Reference(s) :

Sacko, Diouba, and A. A. Kéïta. "Techniques of modulation: pulse amplitude modulation, pulse width modulation, pulse position modulation." *Int. J. Eng. Adv. Technol* 7.9 (2017).

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- Title of the paper: Techniques of Modulation: Pulse Amplitude Modulation, Pulse Width Modulation, Pulse Position Modulation
 - Author(s): Diouba Sacko, Alpha Amadou Kéïta
 - Name of the journal/publication: International Journal of Engineering and Advanced Technology (IJEAT)
 - Chapter volume pages: ISSN: 2249-8958 (Online), Volume-7 Issue-2, December 2017
 - Link:
<https://www.ijeat.org/wp-content/uploads/papers/v7i2/B5251127217.pdf>