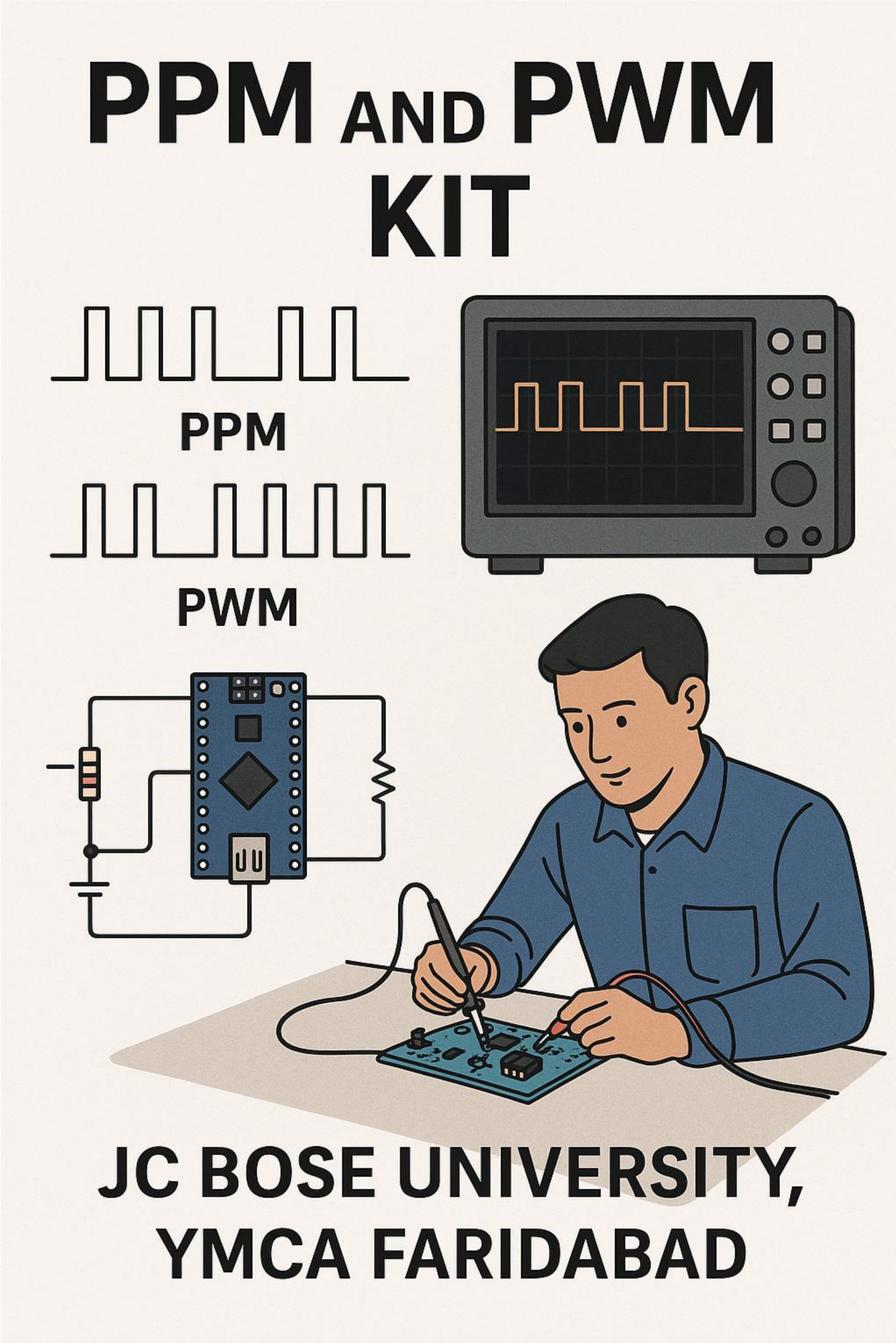

Under guidance of

Ms. Kusum Arora

Contents

CERTIFICATE

This is to certify that the following students have successfully completed the project titled: "Design and Implementation of a PPM and PWM Kit using 555 Timer IC" under the guidance of the Department of Electronics Engineering.

Team Members:

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The project demonstrates the application of Pulse Position Modulation (PPM) and Pulse Width Modulation (PWM) using the versatile 555 Timer IC, showcasing their understanding of analog signal generation and modulation techniques in practical electronics.

Date: 22nd May 2025

Head of the Department	Mini-project Coordinator	Project Supervisor

ABSTRACT

This project focuses on the design and development of a PPM and PWM Kit aimed at demonstrating the principles of Pulse Position Modulation (PPM) and Pulse Width Modulation (PWM) using fundamental electronic components. The kit integrates a step-down transformer (220V to 20V) to provide the necessary power supply, along with a function generator based on the IC 8038 to produce base waveforms. The core modulation functions are implemented using the 555 Timer IC, configured appropriately to generate both PPM and PWM signals.

To ensure signal stability and proper interfacing, operational amplifiers are used as buffers, enhancing the system's performance and reliability. The kit serves as a practical educational tool for understanding time-domain modulation techniques and the working of essential components like timers, waveform generators, and op-amps.

This modular and easy-to-use kit is ideal for laboratory demonstrations and academic learning, especially for students in electronics and communication engineering.

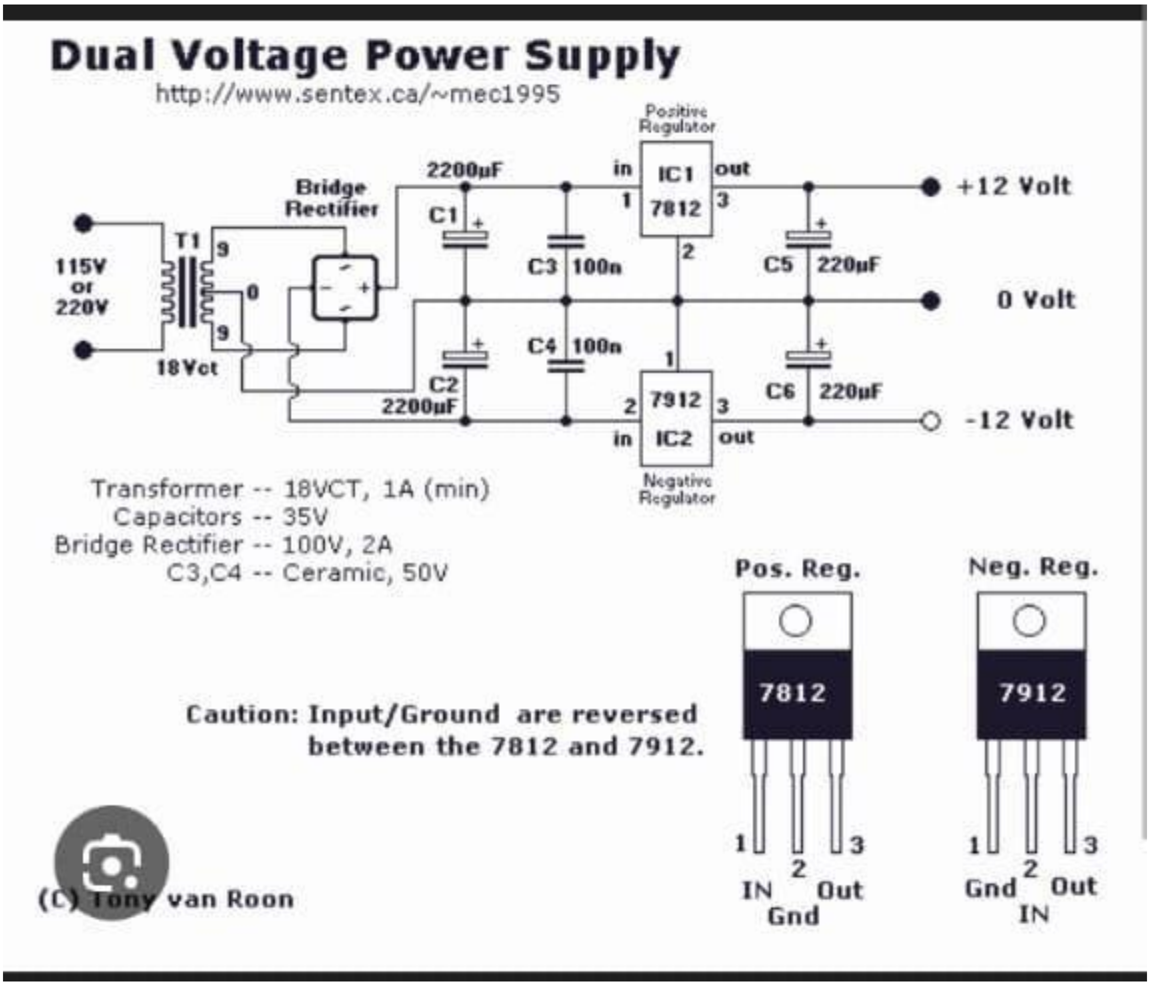
Components Briefing

1. Power Supply

This circuit provides a regulated ±12V dual power supply using two linear voltage regulator ICs: 7812 for +12V and 7912 for –12V. The input is derived from a center-tapped step-down transformer (220V to 20-0-20V) connected to a bridge rectifier, which converts AC to DC. The positive rail is filtered using capacitors and regulated through the 7812, while the negative rail is regulated via the 7912.

This setup is ideal for powering op-amp circuits and other analog components that require symmetrical dual voltage.

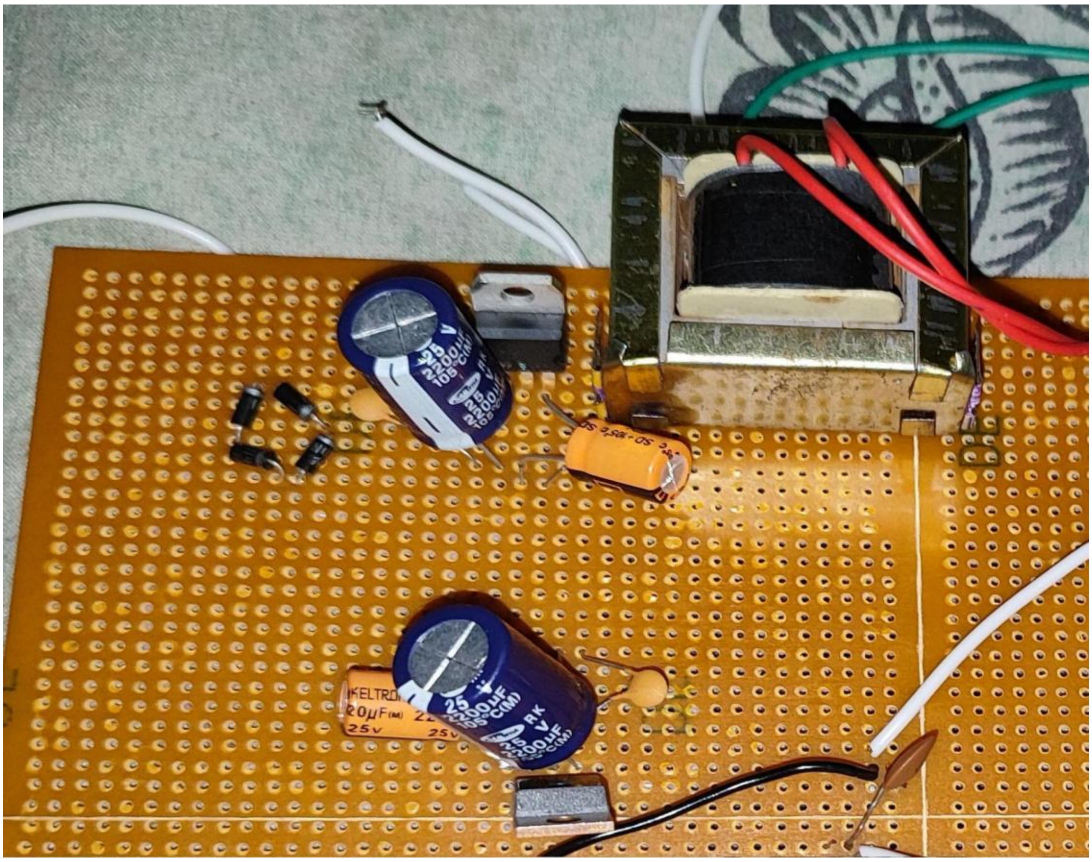
—> Circuit Diagram



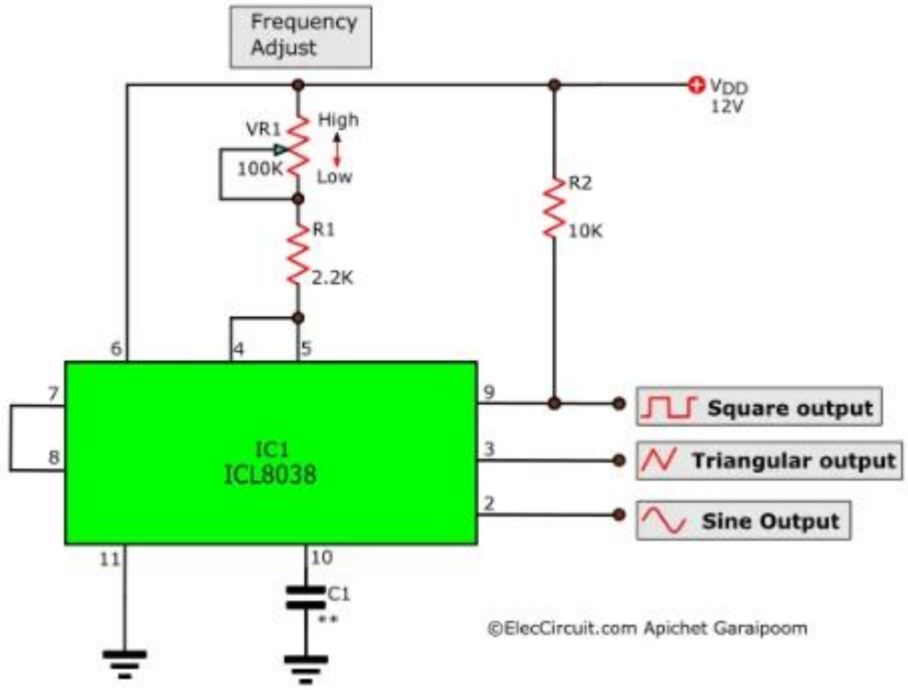
—> Working of Dual Power Supply (+12V / –12V):

The power supply uses a center-tapped step-down transformer to convert 220V AC to 20-0-20V AC. This AC voltage is then passed through a bridge rectifier, which converts it into unregulated DC voltage. The output from the rectifier is filtered using electrolytic capacitors to smooth the ripple.

The positive voltage is regulated using the 7812 voltage regulator, which provides a stable +12V output, while the 7912 regulator provides a –12V output from the negative half of the rectified voltage. Together, these provide a clean and stable ±12V dual supply, suitable for powering analog circuits like op-amps and signal processing modules.



2. Function Generator Using 8038 IC

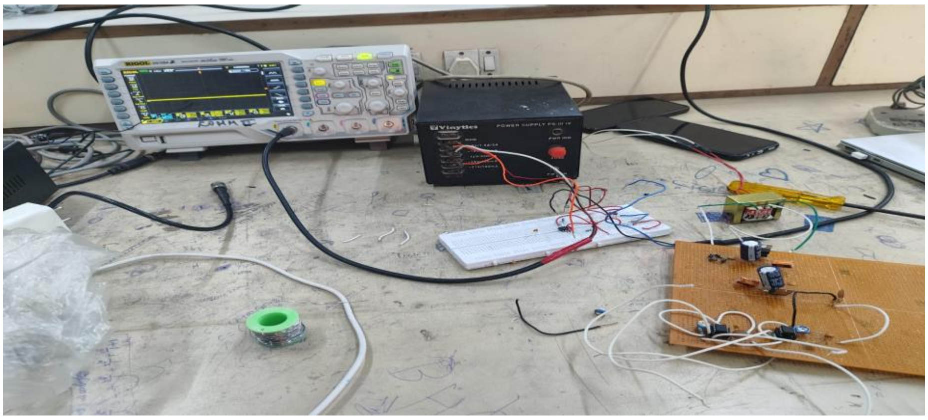


—> IC 8038

The IC 8038 is a precision waveform generator capable of producing sine, square, triangular, sawtooth, and pulse waveforms with high accuracy and stability. It operates over a wide frequency range (typically from 0.001 Hz to 300 kHz) and is ideal for use in function generators, modulators, and waveform synthesizers.

The frequency of oscillation is controlled by external resistors and capacitors, and waveform symmetry can be adjusted via control pins. The IC provides separate outputs for sine, triangle, and square waves, making it versatile for various analog signal applications.

It is particularly useful in projects requiring stable signal sources, such as your PPM and PWM kit.



—> Internal Structure of 8038

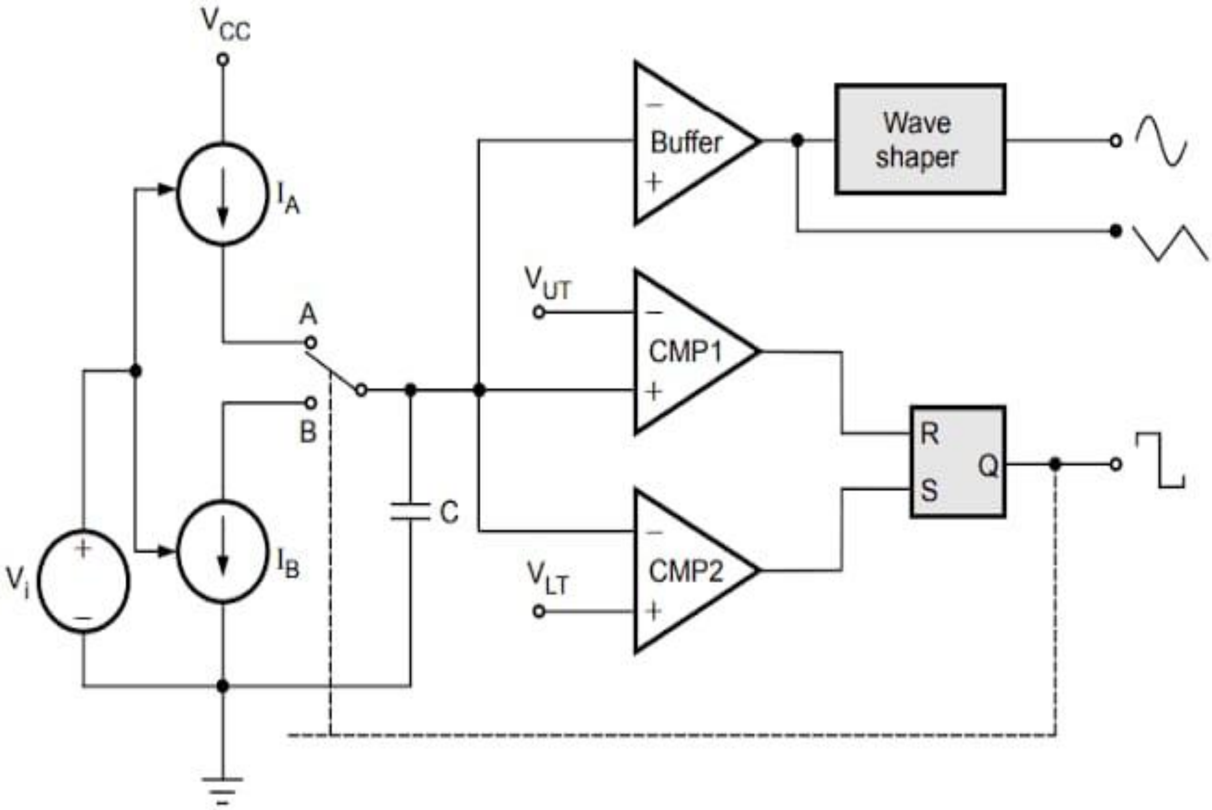


Fig. 5.16.1 Simplified block diagram of ICL 8038 function generator

—> Working of 8038 IC

The 8038 waveform generator IC works by charging and discharging a capacitor using internal current sources. This generates a triangular waveform, which is then internally converted into sine and square waves using shaping and comparator circuits.

By adjusting the external resistors and capacitor connected to the IC, you can control the frequency and duty cycle of the output waveforms. The IC provides separate output pins for sine, square, and triangle waves, making it ideal for use in signal generation and testing circuits.

It offers high frequency stability and low distortion, making it reliable for analog waveform generation in lab kits and modulation systems.

Frequency for 8038 is given by

f=0.15/RC

Where:F = Output frequency in Hz, R=External resistor (in ohms), C = Timing capacitor (in farads)

3. PWM and PPM using 555 timer IC

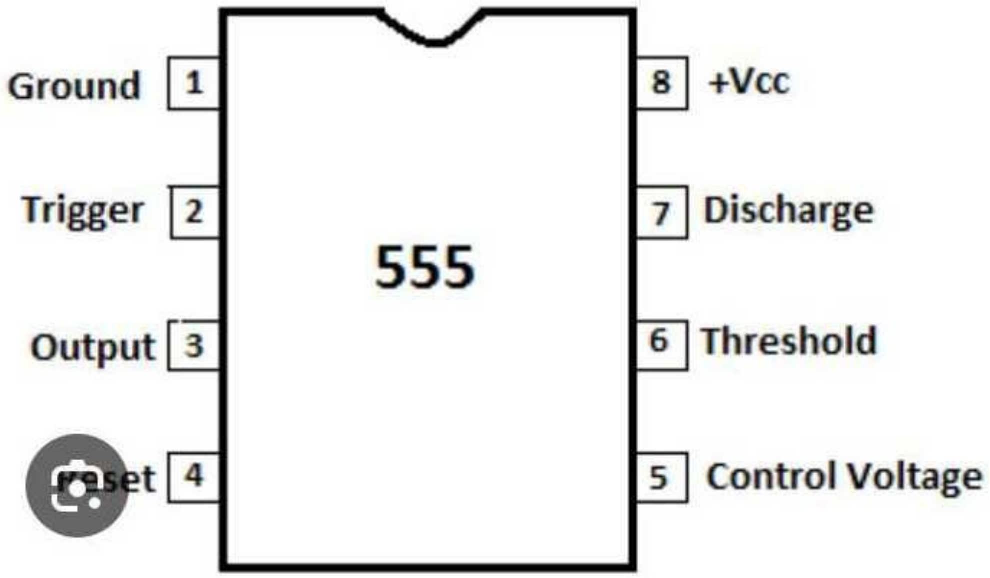
—>555 Timer IC

The 555 Timer IC is one of the most widely used integrated circuits in electronics. It operates in three modes: astable, monostable, and bistable, making it versatile for various timing and pulse generation applications.

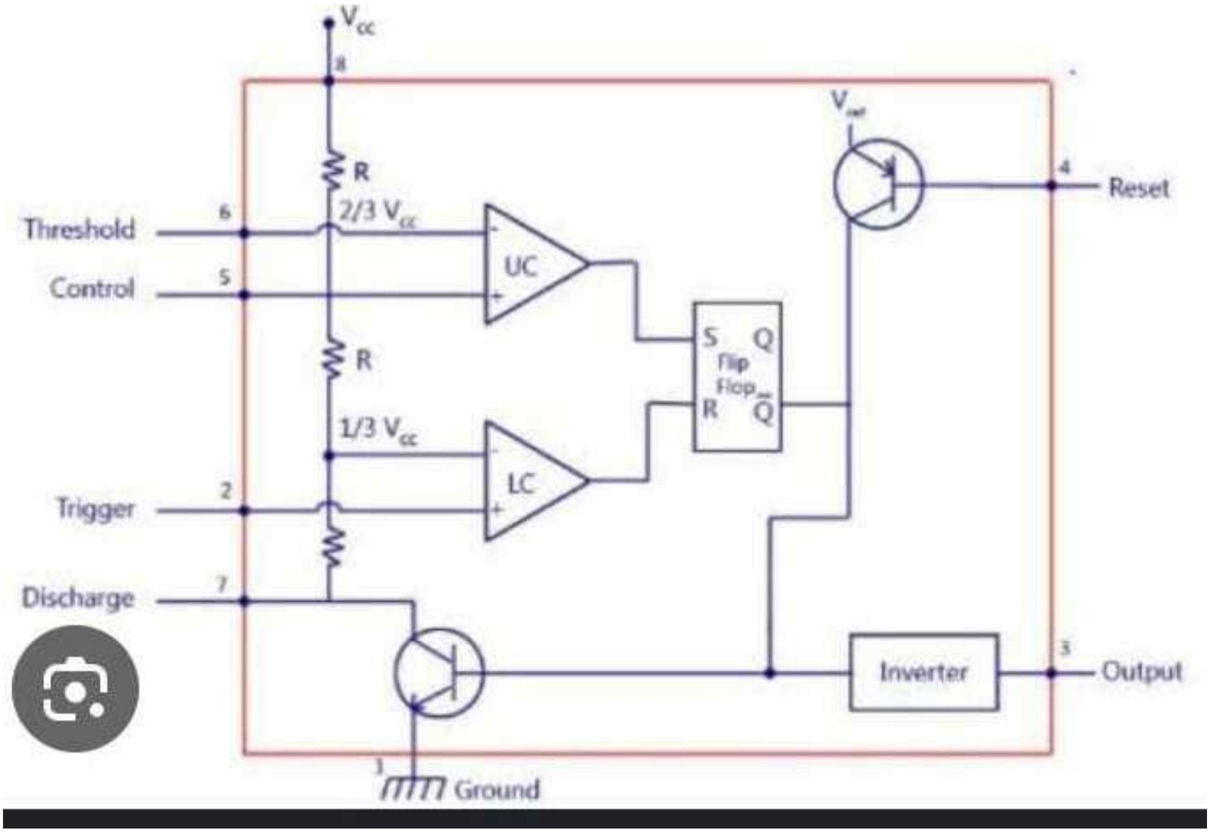
In astable mode, it functions as an oscillator, generating continuous square wave pulses—ideal for use in PWM (Pulse Width Modulation) and PPM (Pulse Position Modulation) circuits. In monostable mode, it produces a single output pulse when triggered.

The 555 timer is easy to configure using external resistors and a capacitor, and it's known for its reliability, low cost, and wide operating voltage range (typically 4.5V to 15V).

Pin Diagram of 555 :



Internal Diagram of 555



—>Working of 555 Timer IC:

The **555 Timer IC** operates by comparing voltages using two internal **comparators**, a **flip-flop**, and a **discharge transistor**. It uses a voltage divider with three 5kΩ resistors to set reference levels at **1/3 and 2/3 of the supply voltage**.

- In **astable mode**, the external **resistors and capacitor** determine the charging and discharging cycles of the capacitor, producing a continuous square wave (used in PWM/PPM).
- The **capacitor charges and discharges** through the resistors, causing the output to toggle between high and low, creating a **timing pulse or oscillation**.
- In **monostable mode**, the 555 outputs a single pulse of fixed duration when triggered, ideal for one-shot applications.

The discharge pin helps control the timing capacitor, and the output pin delivers the generated pulse signal.

Square Wave Generation using 555 Timer (Astable Mode):

In **astable mode**, the 555 timer continuously switches between HIGH and LOW states, producing a **square wave** at the output. This is achieved through the **charging and discharging of a capacitor (C)** via two resistors (**R1** and **R2**) connected to the timer.

Working Steps:

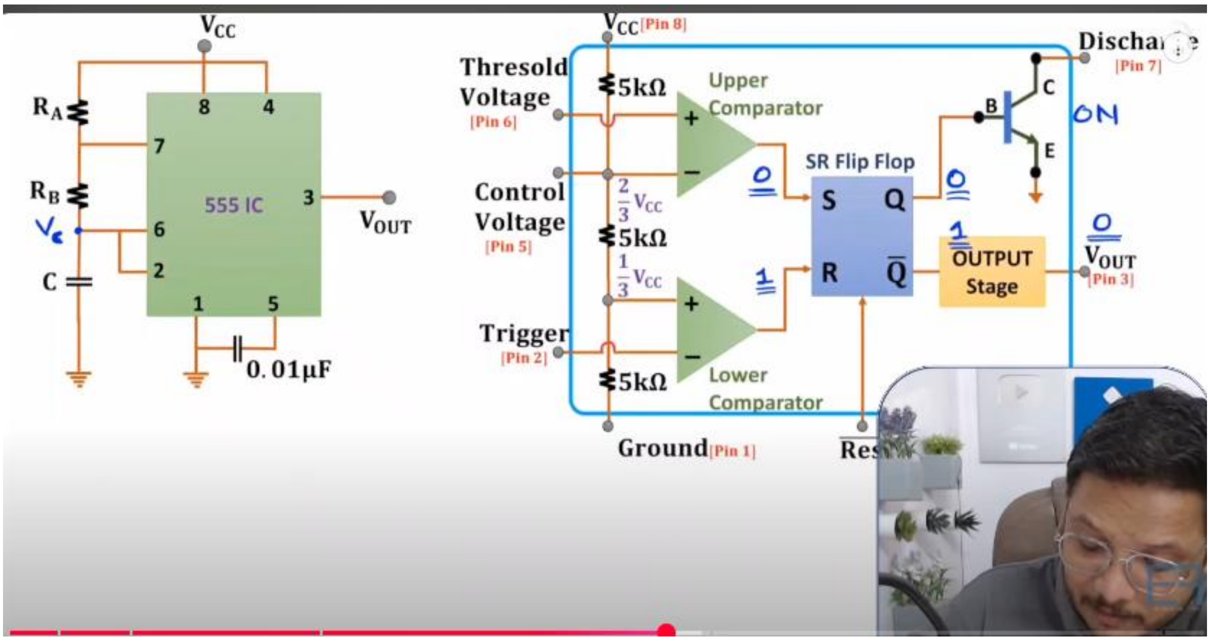
1. **Charging Phase:**
   - The capacitor **charges** through **R1 and R2**.
   - When the capacitor voltage reaches **2/3 of the supply voltage (Vcc)**, the internal comparator **resets the flip-flop**, and the output goes **LOW**.
1. **Discharging Phase:**
   - The discharge transistor inside the 555 turns on, and the capacitor **discharges through R2 only**.
   - When the voltage drops to **1/3 of Vcc**, the second comparator **sets the flip-flop**, and the output goes **HIGH** again.
1. **This cycle repeats**, generating a continuous **square wave** at the output (pin 3).

Frequency and Duty Cycle:

- **Frequency (f)** = 1.44 / [(R1 + 2R2) × C]
- The **duty cycle** depends on the values of R1 and R2.

By adjusting **R1, R2, and C**, you can control the **frequency and pulse width** of the square wave.

Video Link for Square wave :https://youtu.be/XeBJbj5ylt4?si=gmdr_1EDfEMyn6Dr



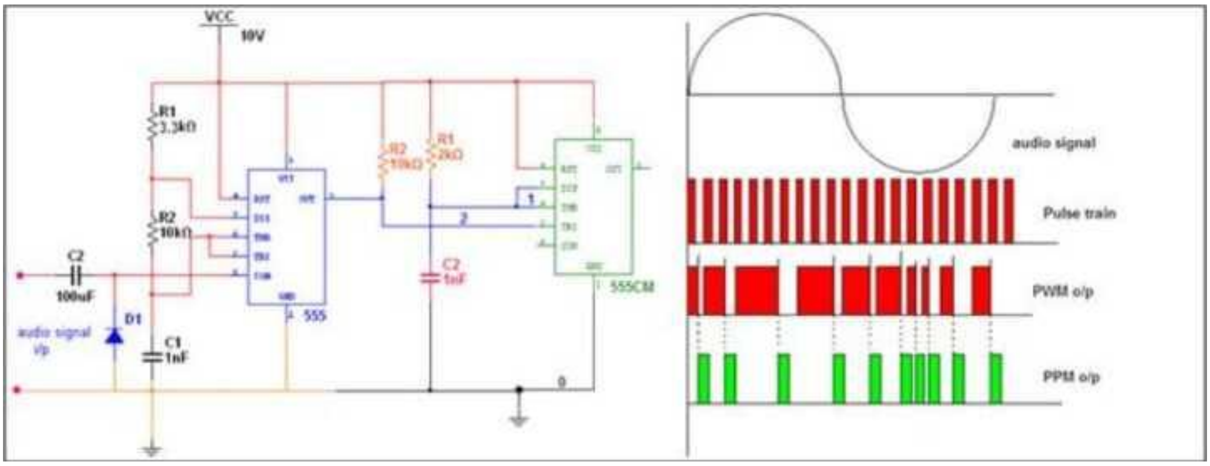
5. PWM using 555 Timer IC

The **555 Timer IC** can generate **PWM signals** by operating in a **modified astable mode**, where the **duty cycle** (ON/OFF time) of the square wave can be controlled **independently of frequency**.

Basic Concept:
In PWM, the **width of the output pulse** is varied while keeping the frequency constant. This is useful for controlling the power delivered to devices like motors, LEDs, etc.

Working Principle:

- A capacitor charges and discharges between **1/3 and 2/3 of the supply voltage**, similar to normal astable mode.
- To control the **duty cycle**, two **diodes** are placed in opposite directions with separate resistors for charging and discharging paths.
- By varying one resistor (typically using a **potentiometer**), you can change how long the output stays **HIGH vs. LOW**—i.e., **pulse width**.



Applications of PWM (Pulse Width Modulation):

Motor Speed Control

- PWM controls the average voltage supplied to **DC motors**, allowing precise speed regulation without energy loss.

LED Dimming

- By varying the duty cycle, PWM adjusts the **brightness of LEDs** smoothly and efficiently.

Audio Signal Generation

- Used in **digital audio** to reproduce analog waveforms or create sound in embedded systems.

Power Control

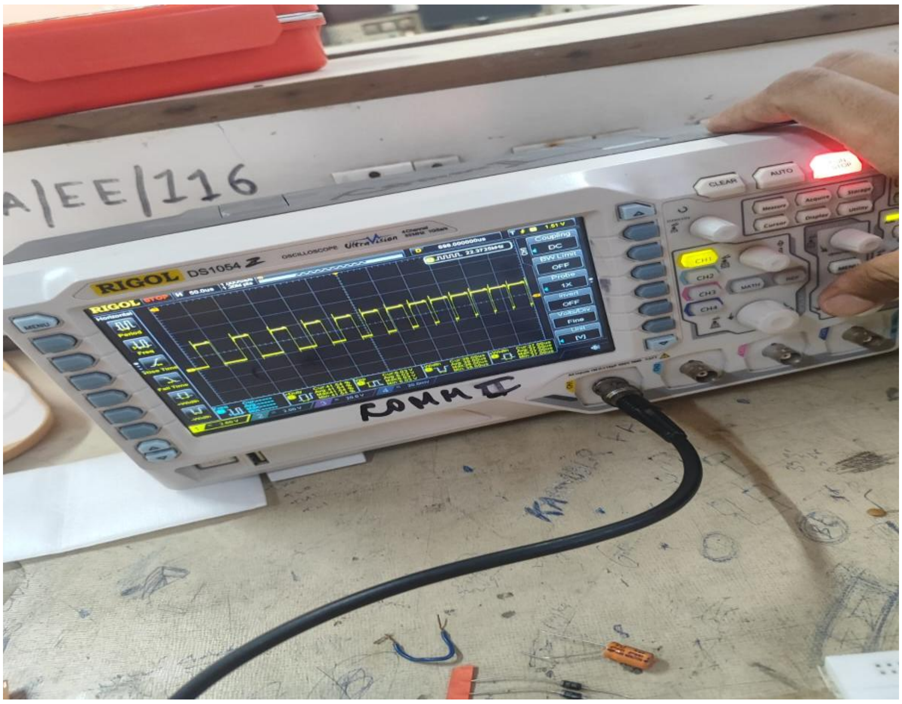
- PWM is used in **power supplies and converters** to regulate output voltage efficiently (e.g., in SMPS).

Communication Systems

- Serves as a **modulation technique** for transmitting data in digital communication.

Microcontroller-Based Systems

- PWM is used in **servo motor control**, tone generation, and more, using built-in timers.



PPM USING 555 Timer IC

Pulse Position Modulation (PPM) can be generated using the 555 Timer IC by first producing a series of reference pulses (usually from a monostable or astable configuration), and then shifting the position of each pulse based on the amplitude of an input signal.

In a typical setup:

- A pulse train is generated using an astable multivibrator (often with another 555 timer or a function generator like the 8038).
- This pulse train is fed to a monostable 555 timer, which triggers an output pulse each time it receives an input.
- The position (timing delay) of this output pulse is modulated based on an analog input, typically through a control voltage that alters the timing capacitor's charge rate.

This results in a series of pulses where the position (timing) of each pulse encodes the information, not the width or amplitude.

—>Application of PPM

Remote Control Systems

- **Used in RC aircraft and drones for transmitting control signals (e.g., servo positioning).**

Optical Communication

- **Applied in fiber optic systems due to its high noise immunity.**

Telemetry Systems

- **Ideal for transmitting sensor data over long distances with minimal distortion.**

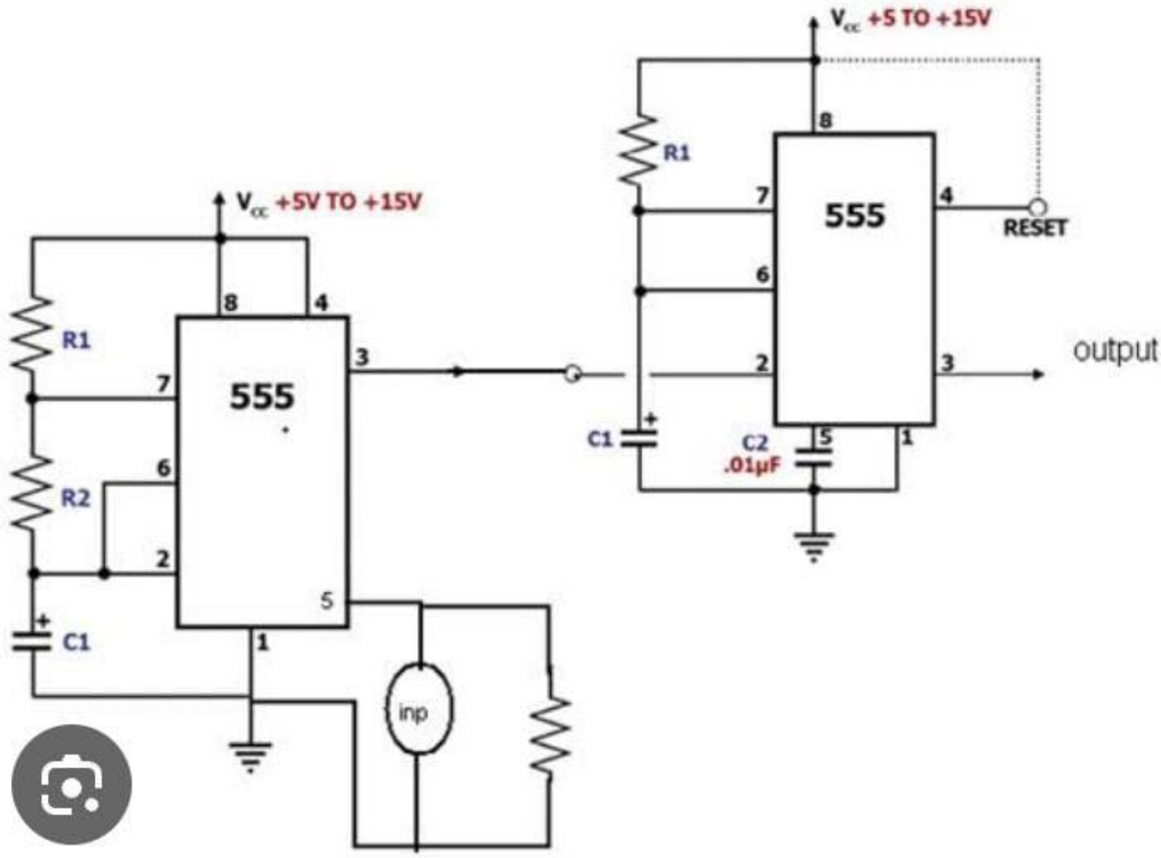
Satellite and Space Communication

- **Preferred in spacecraft communication for efficient and reliable data transmission.**

Digital Data Transmission

- **Used in wireless and infrared communication protocols for encoding digital signals.**

—> Circuit Diagram



—>Waveform of PPM