MEASUREMENTS AND INSTRUMENTATIONS (ECC 201)

ASSIGNMENT-1

2-Digit Counter Circuit using CD4033 and NE555 Timer IC

NAME - Anjana Gupta

ADMISSION No.- 22JE0122

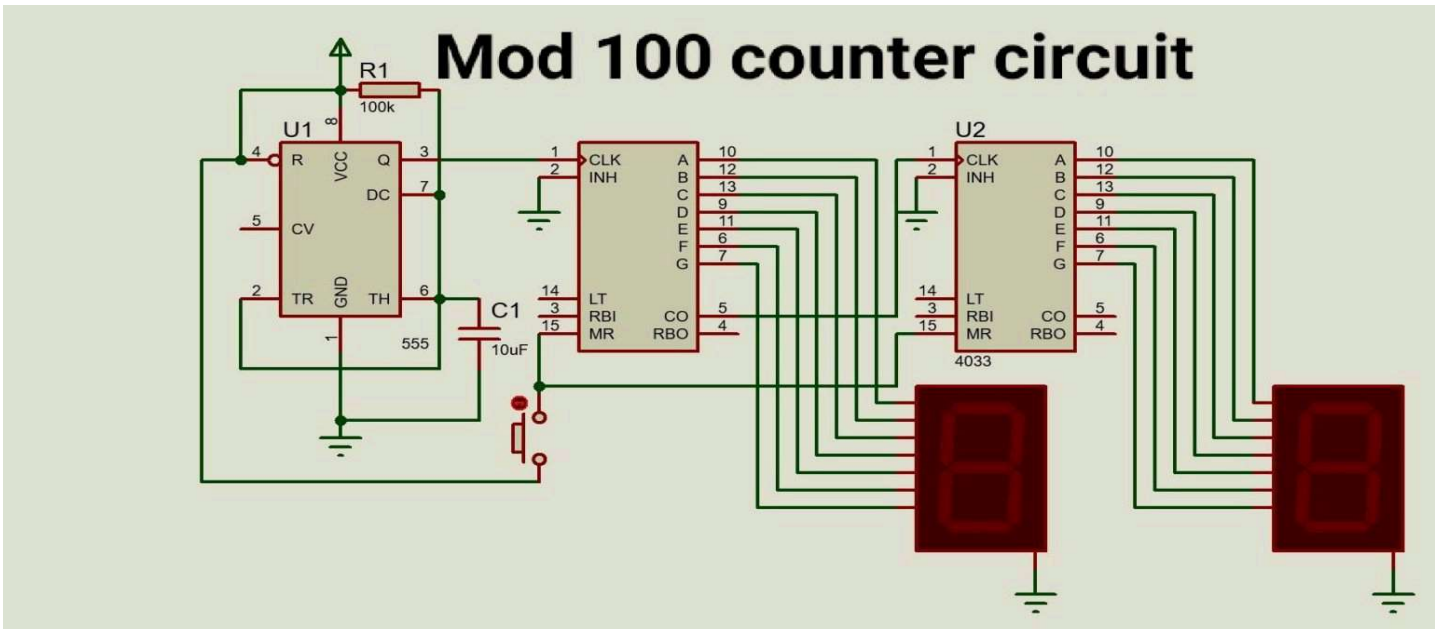
INTRODUCTION:

The primary objective of this project is to design and construct a mod-100 counter circuit capable of sequentially counting from 0 to 99. Achieving this involves coordinating the timing signals from the 555 timer with the counting logic of the CD4033 IC, ensuring accurate and synchronized counting operations. The utilization of a 7-segment display enhances the project's visual appeal, providing real-time feedback of the counting process.

COMPONENTS REQUIRED:

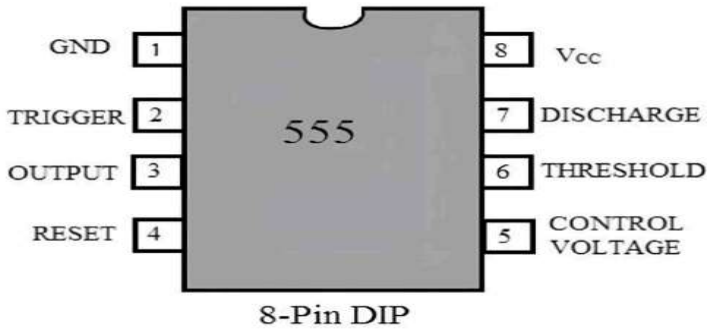
- 555 timer – 1
- CD4033 counter IC – 2
- Seven segment display (common cathode) – 2
- Push-button – 1
- 10uf Capacitor – 1
- 100k resistor – 1
- 5V power supply

CIRCUIT DIAGRAM:



COMPONENTS DETAILS:

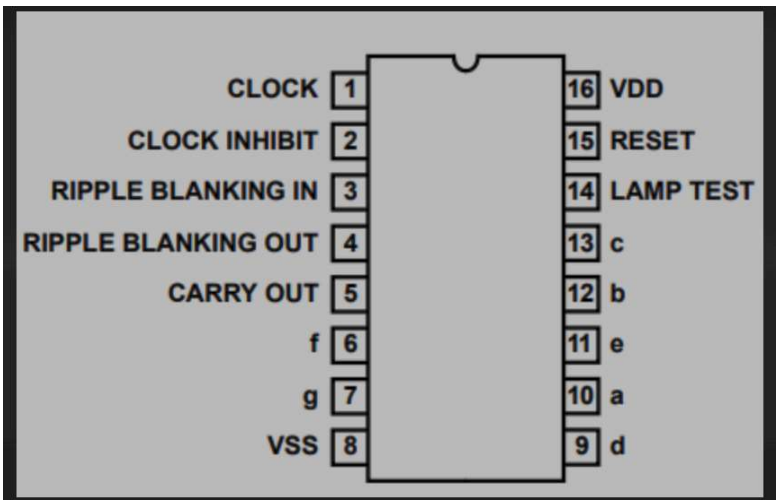
- NE 555 IC:
  The NE555 is a highly versatile timer IC renowned for its ability to generate precise time delays and square waveforms. The NE555 operates in three primary modes: astable, monostable, and bistable, each serving specific timing functions.



NE555 Pin Specifications:

1. **Ground (GND, Pin 1)**: This pin is connected to the ground and serves as the reference point for the IC's internal circuitry and external components.
2. **Trigger (TRIG, Pin 2)**: This pin is used to trigger the timer and start the timing process when its voltage falls below one-third of the supply voltage (Vcc).
3. **Output (OUT, Pin 3)**: The output pin provides the timer's timed pulses or waveform based on its configuration mode (astable, monostable, or bistable).
4. **Reset (RESET, Pin 4)**: This pin is used to reset the timer and interrupt its timing process. When connected to Vcc (high logic level), it disables the timer and resets its internal state.
5. **Control Voltage (CV, Pin 5)**: This pin allows external control of the timing characteristics of the IC, such as threshold and trigger levels.
6. **Threshold (THRESH, Pin 6)**: This pin is used in conjunction with the Trigger pin to control the timing cycle of the IC. When the voltage at this pin exceeds two-thirds of Vcc, it resets the timer and ends the timing cycle.
7. **Discharge (DISCHARGE, Pin 7)**: This pin is connected internally to the open collector of a transistor that discharges the timing capacitor during specific phases of the timing cycle. It is used in astable and monostable modes to discharge the timing capacitor.
8. **Supply Voltage (Vcc, Pin 8)**: This pin is connected to the positive supply voltage, typically ranging from 4.5V to 15V DC, depending on the specific NE555 variant and application requirements.

- **IC CD4033:**

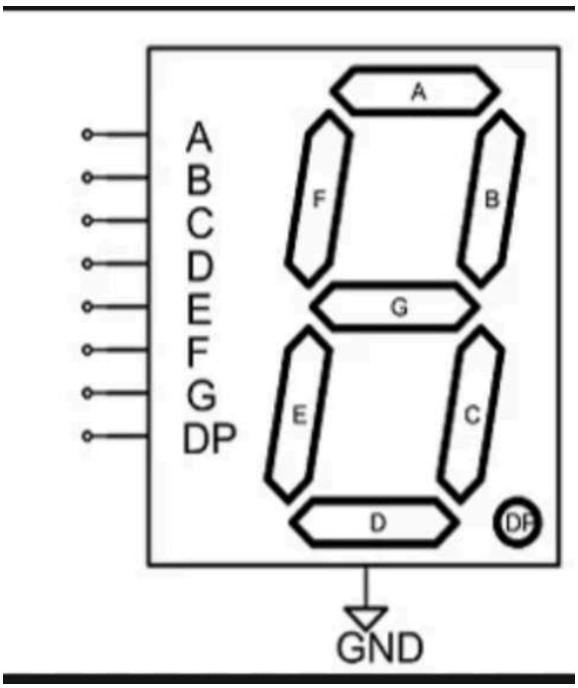


The CD4033 is a CMOS (Complementary Metal-Oxide-Semiconductor) integrated circuit (IC) that functions as a decade counter with a built-in 7-segment decoder.

CD4033 Pin Specifications:

Pin#1: It's the clock input pinout of the IC, which is assigned for accepting positive clock signals or the pulses which need to be checked or counted.
Pin#2: It's the clock inhibit pinout of the IC, As the name refers to, this pinout could be used for inhibiting the IC from responding to the input pulses by configuring this pinout to the positive supply or the Vdd.
Pin#3/#4: These are the Ripple blanking IN and Ripple blanking OUT pinouts of the IC, which provides the user with the option of either allowing the non-significant zeros to be displayed or to be left out from the connected digital displays.
Pin#5: It's the carryout pinout of the IC, it sends a high logic output after every 10 legit clocks at the clock pin#1 of the IC.
Pin#6,7,9,10,11,12,13: All these pinouts are the outputs of the IC which are configured with the discussed 7 segment digital display module.
Pin#14: It's the "lamp test" pinout of the IC. As the name signifies it is used for testing the connected digital displays in terms of illumination level.
Pin#15: It's the reset input of the IC, a high logic or applying the supply voltage to this pin resets the IC completely, resulting in clearing all the data from the display and restoring it to zero.
Pin#16: is the Vdd or the supply input of the IC.

- **SEVEN SEGMENT DISPLAY:**



A 7-segment display is a common type of electronic display device used to represent numerical digits and some alphabets through the illumination of seven individual segments

arranged in a figure-eight pattern. By selectively activating specific segments, numbers ranging from 0 to 9 and certain alphabets such as A-F can be displayed.
The pin configuration of a 7-segment display depends on whether it is common anode or common cathode.

Common Anode 7-Segment Display:
Typically has 8 pins:

- 7 pins labeled as segments a-g, each corresponding to one of the illuminated segments in the display.
- 1 common pin (often labeled as "COM" or "CA") connected to the positive voltage source (+Vcc). When a segment is connected to ground (logic LOW), it illuminates due to the common anode being at a higher potential.

Common Cathode 7-Segment Display:
Also typically has 8 pins:

- 7 pins labeled as segments a-g, corresponding to the illuminated segments in the display.
- 1 common pin (often labeled as "COM" or "CC") connected to ground (GND). When a segment is connected to the positive voltage source (+Vcc) through a current-limiting resistor, it illuminates due to the common cathode being at a lower potential.

CALCULATION:

When connected as an astable multivibrator, the output from the 555 Oscillator will continue indefinitely charging and discharging between 2/3Vcc and 1/3Vcc until the power supply is removed.

Calculate Charging Time (t1):

- Charging Time (t1) = 0.693 * R * C
- t1 = 0.693 * 100kΩ * 10μF≈ 6.93 milliseconds (ms)

Calculate Discharging Time (t2):

- Discharging Time (t2) = 0.693 * R * C
- t2 = 0.693 * 100kΩ * 10μF≈ 6.93 milliseconds (ms)

Calculate Total Period (T):

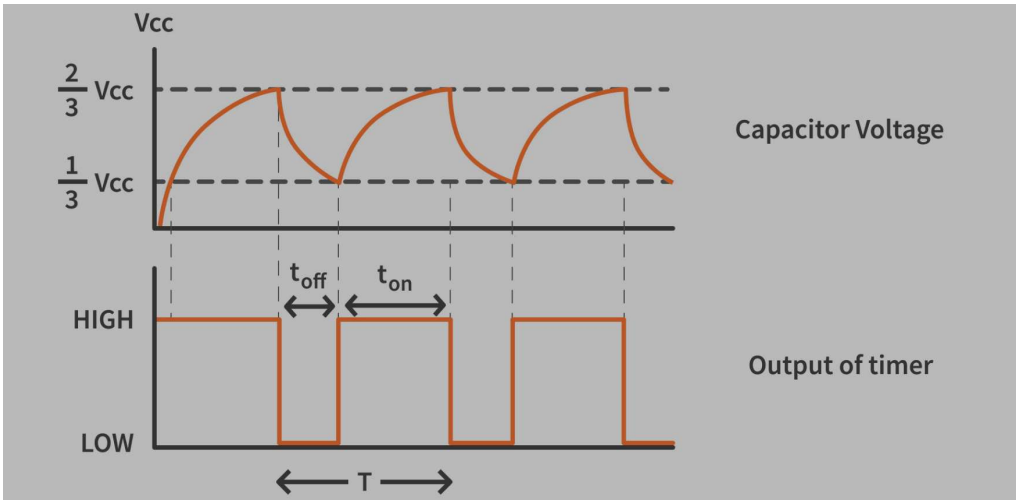
- Total Period (T) = Charging Time (t1) + Discharging Time (t2)≈ 13.86 milliseconds (ms)

Calculate Clock Frequency (f):

- Clock Frequency (f) = 1 / T
- f = 1 / 0.01386 seconds (s)≈ 72.12 Hz

Calculate Duty Cycle (D):

- Duty Cycle (D) = (t1 / T) * 100%
- D = (6.93 ms / 13.86 ms) * 100% ≈ 50%



WORKING PROCEDURE:

- The 555 timer (U1) is configured as an astable multivibrator which creates a continuous pulse train at its output (pin 3). This pulse train provides a clock signal for the CD4033 decade counter ICs (U2 and U3).
- The CD4033 decade counter ICs (U2 and U3) are wired in cascade to count from 00 to 99.
- When the circuit is first powered on, or the reset (RBO) input of the first CD4033 (U2) is pulsed low, the counter resets to 00.
- Each pulse from the clock signal (pin 3 of U1) increments the count on the first counter (U2) by 1.
- The output from the first counter (U2) is connected to the clock input (pin 1) of the second counter (U3).
- The first counter (U2) will continue to increment until it reaches a count of 10 (represented as 0000 in binary on the IC). When this happens, the output (pin 13 of U2) goes high and triggers the second counter (U3) to increment by 1.
- The second counter (U3) will then continue to increment until it reaches a count of 10. When this happens, the output (pin 13 of U3) goes high and resets the first counter (U2) to 00 and increments its own count by 1. This creates the counting sequence from 00 to 99.

Design Limitation/Assumptions :

- The design is limited to counting from 00 to 99. It does not incorporate mechanisms for counting beyond this range or for counting in different numeral systems.
- The circuit assumes a stable +5V power supply. Variations or fluctuations in the power supply voltage could affect the performance of the circuit.
- The design assumes ideal characteristics of the electronic components, such as perfect functionality, negligible propagation delays, and consistent performance across temperature and voltage variations.

- The design does not incorporate error detection or correction mechanisms. Any errors in counting or display would not be automatically corrected by the system.

CONCLUSION:

The successful completion of the 2-digit counter circuit project using the 555 timer, CD4033 counter ICs, common cathode 7-segment displays, and supporting components marks a significant achievement in digital electronics and circuit design. Through this project, several key concepts and practical skills were explored and applied, leading to a functional counting system capable of displaying numbers from 00 to 99.