PWM & 555 Timer

The Basics of PWM and 555 Timer Circuits

Zachariadis Charalampos & Vrakatselis Christos

Starbound Team
IEEE University of Thessaly SB

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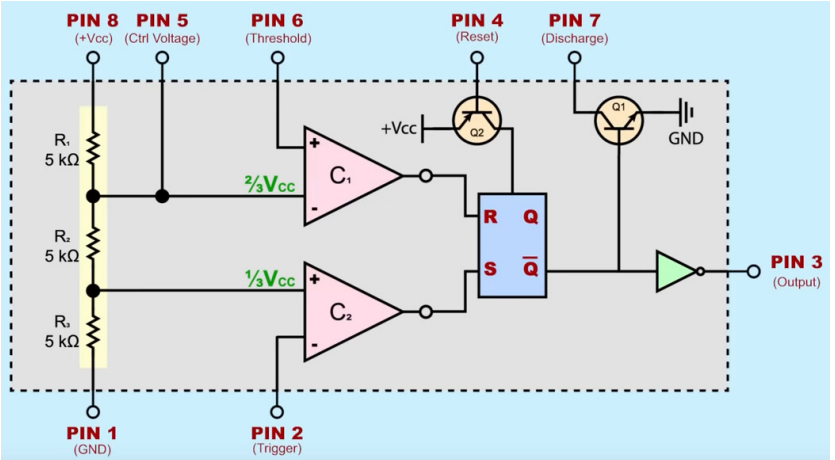
- The circuit may be triggered and reset on falling waveforms, and the output circuit can source or sink up to 200 mA or drive TTL circuits.

Pin Configuration and Functions

No.	Name	Description
1	GND	Ground reference voltage.
2	Trigger	Responsible for transition of the flip-flop from set to reset.
3	Output	Output driven waveform.
4	Reset	Negative pulse applied to this pin to disable or reset the timer (!R1 – Master Reset).
5	Control Voltage	Controls the threshold and trigger levels.
6	Threshold	Compares the voltage applied to the terminal with a reference voltage of 2/3 Vcc.
7	Discharge	Open collector output which discharges a capacitor between intervals.
8	V^+	Supply voltage with respect to GND.



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- On the other side, we can obtain only 500kHz or slightly more.

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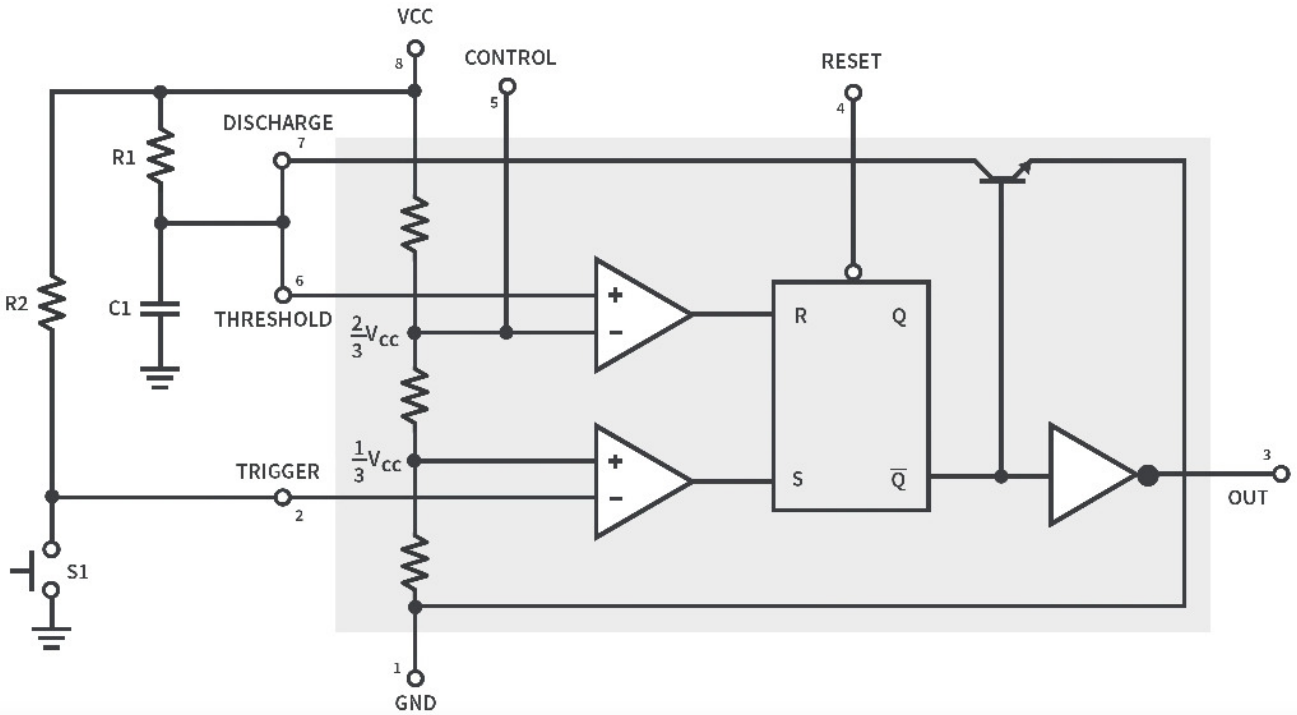
- When a monostable multivibrator is triggered externally, it produces a single output pulse in the unstable state for a short duration and then returns back to the stable state.

Basic Circuit



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- A resistor is connected between VCC and the common node of threshold (6) and discharge pin (7), and a capacitor is connected between the common node and ground. The voltage across the capacitor acts like input for the threshold and discharge pin.

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- The reset pin (4) of the IC is connected to VCC to avoid any accidental resets during the operation.
- The control voltage pin (5) is connected to the ground via a small capacitor to avoid noise when not in use.

Output Configurations

- In the monostable mode of the 555 timer, also known as the "one-shot mode", when we apply a logic LOW to the trigger pin of the timer by closing the switch, the output becomes logic HIGH and holds there for a specific time duration (T).

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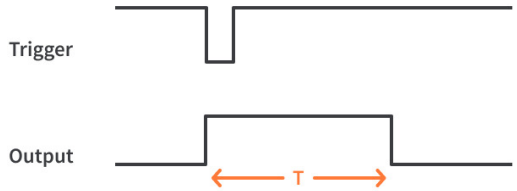
- This time period T is calculated by the following relation:

$$\boxed{T = 1.1 \cdot R \cdot C}$$

where R is in Ohms and C is in Farads.

Output Configurations

- After the time period T, the output again falls back to logic LOW and waits for the next trigger:



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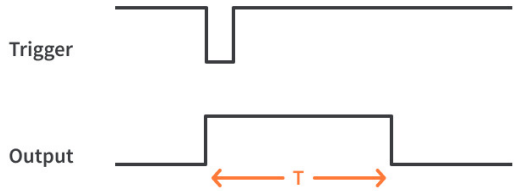
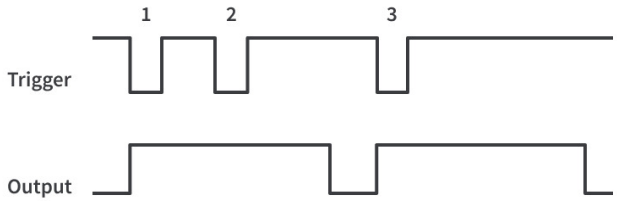


- If another event is triggered during a previous event when the output pulse is high, itll simply not respond to the trigger. As you can see below, we get an output pulse due to the 1st and 3rd trigger pulse but the 2nd trigger pulse is simply ignored:



Internal Operation

Why is this all happening?

To see what's under the hood you should visit the following article in the senction "Internal Operation as a Monostable Multivibrator":

`https://www.circuitbread.com/tutorials/555-timer-2-monostable-multivibrator-configuration`

Basic Applications

- **Debouncing Switches:** When a switch is pressed, it can produce multiple transitions (bounces) before settling, with the monostable mode we can generate a single clean pulse, thus eliminating the noise from the bouncing.

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- **Pulse Shaping:** It can be used to condition or shape pulses in digital circuits. For instance, it can convert a noisy or irregular pulse into a clean, consistent output pulse.
- **Capacitive Touch Sensors:** Monostable mode can be used in touch-sensitive applications where touching a sensor produces a pulse that can trigger other actions.

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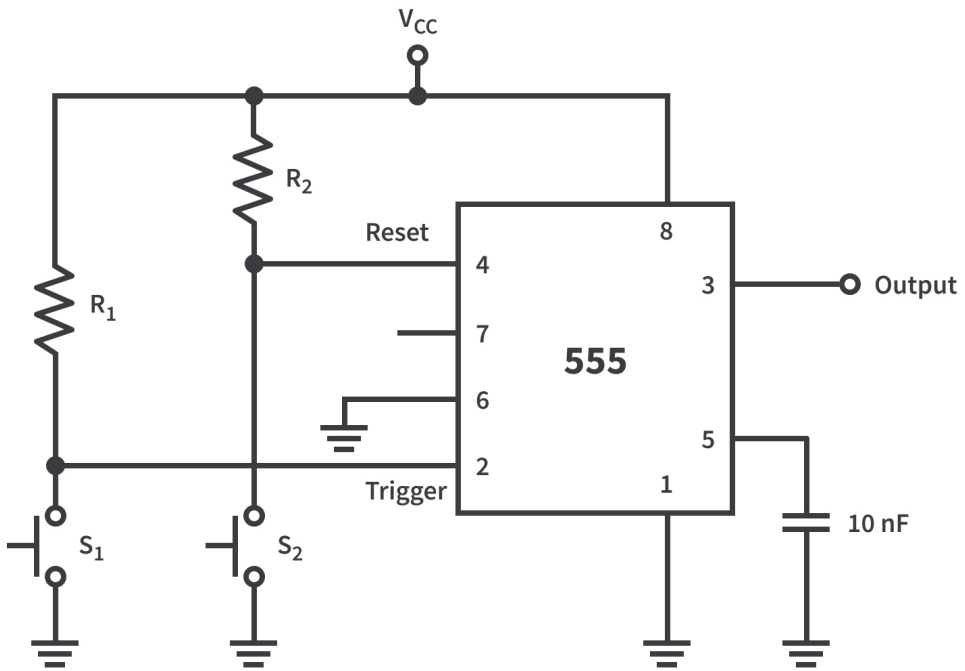
- It's the simplest and least popular mode since it has little applications and you can just replace it with a simpler latching switch which can do the same job.

Basic Circuit



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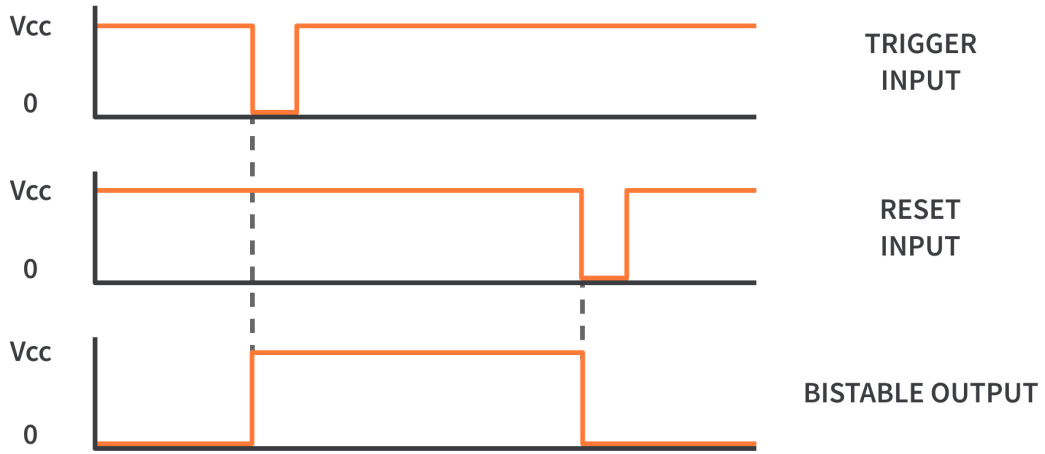
- The threshold pin is grounded in this mode to avoid accidental reset due to the R input of the flip flop.

Output Configurations

- The figure below represents the complete output waveform of the bistable mode of the 555 timers. You can see in the figure that the output switches to HIGH when the trigger is pulled LOW, and the output switches back to LOW when the reset pin is pulled LOW:



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- **Push-button Toggle:** It can create a toggle switch, where a single push-button can turn a device on or off. Each press of the button changes the state of the output.

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- **Simple Memory Element:** It can act as a simple memory element in digital circuits, storing the state of a single bit of information.
- **Frequency Divider (as each mode):** By triggering the 555 timer with a high-frequency signal and adjusting the pulse width, the output will have a lower frequency.

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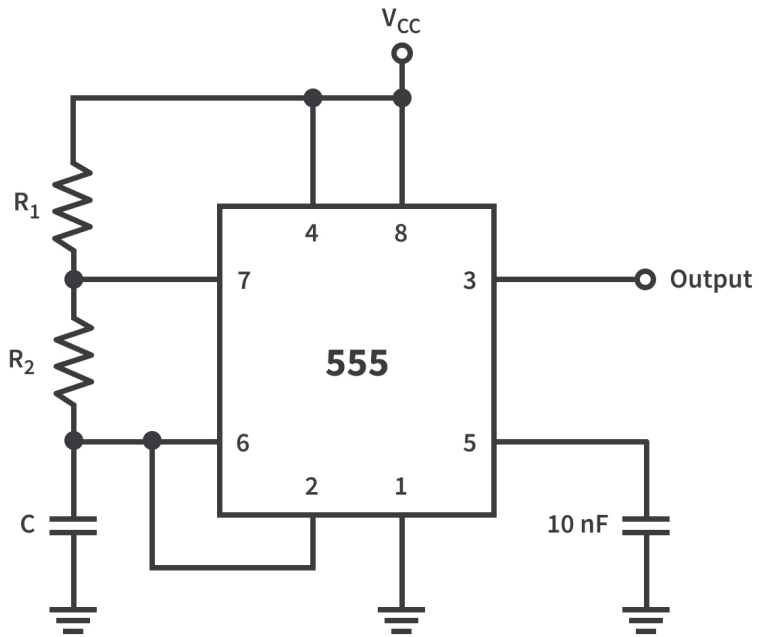
- As we saw in the previously, the monostable and the bistable multivibrator need an external trigger for their operation. But an astable multivibrator is different as it doesn't need any external trigger pulse. It has a built-in automatic triggering to switch between the states.

Basic Circuit



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- The control pin (5) can be used to change the threshold reference voltage of VCC. We can apply external voltage on this pin and the reference voltage can be changed to values other than VCC. However, here well not be changing the reference voltage so the control pin is grounded via a 10nF capacitor.

Output Configurations

- The duration for which the capacitor is charging up to 2/3 V_{cc} us how much we get a logic HIGH at the output for every period. We can calculate it with this formula:

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- It's highly recomented to use high resistances so that the resistance of the BJT transistor doesn't affect the RC calculations. For more details you can check this video .

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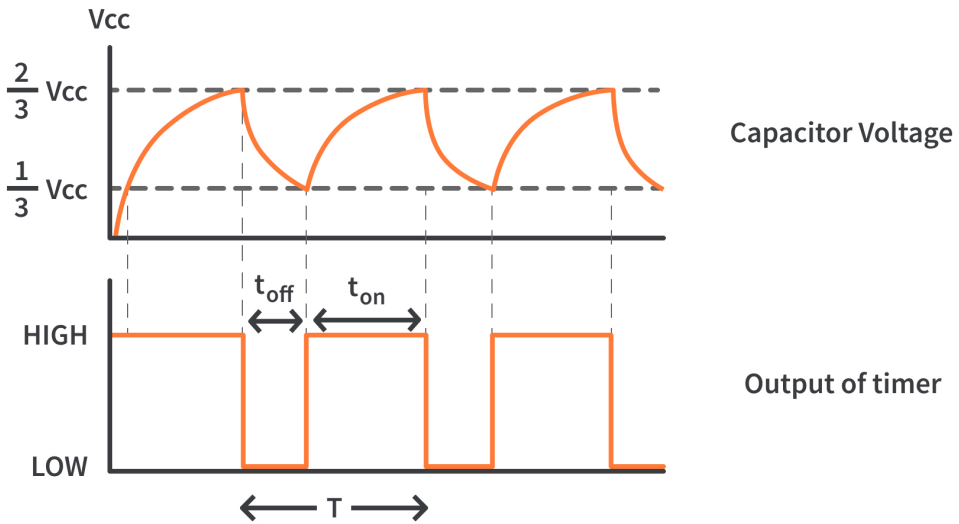
- Below is the complete waveform of the astable mode of the 555 timers along with the voltage across the capacitor:



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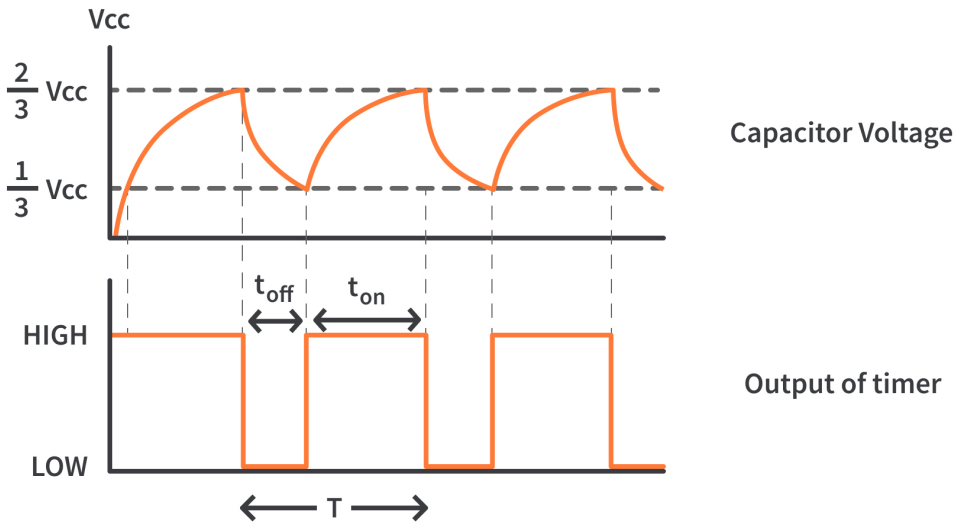

- We the help of the formulas and the image we can easily realise that always: $t_{off} < t_{on}$ and $T_{period} = t_{on} + t_{off}$.

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- **Tone Generation:** It can generate audio tones for various applications, including alarms, sound effects, and simple music instruments.

- https://www.electronics-tutorials.ws/waveforms/555_timer.html
- https://www.ti.com/lit/ds/symlink/lm555.pdf
- https://fulmanski.pl/tutorials/electronics/introduction/555-2/
- https://www.circuitbread.com/tutorials/555-timer-2-monostable-multivibrator-configuration
- https://www.circuitbread.com/tutorials/555-timer-3-bistable-multivibrator-configuration
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Thanks For Your Attention!

Any questions?