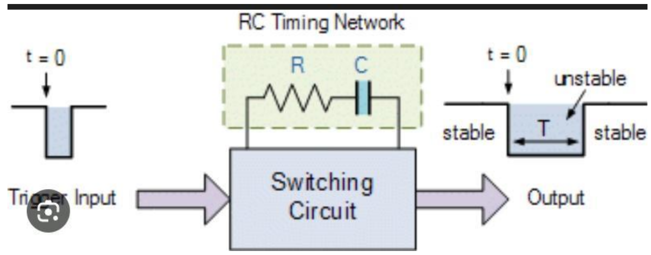
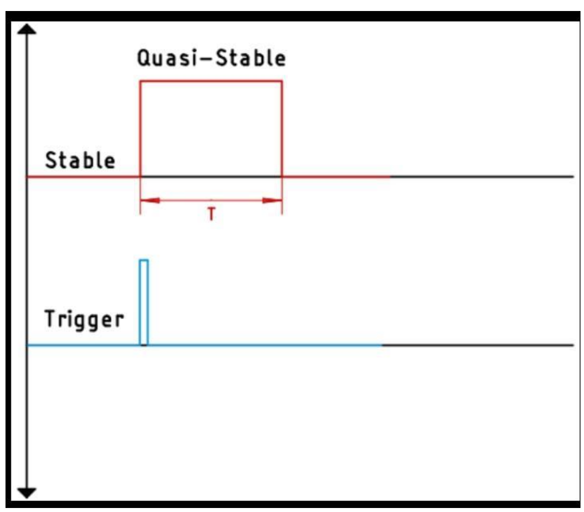
<u>Basic information</u>: *What is the monostable multivibrator?*



A **monostable multivibrator** is also called a single short multivibrator, it has only one stable state and the other state is a quasi-stable state. By stable state in a multivibrator, we mean that at that moment, the output is high or low. Now, when a triggering pulse is applied, the multivibrator changes its output from a stable state to a quasi-stable state. And after a certain time 'T', which is determined by the circuit components, the multivibrator returns to its original stable state automatically. In other words, no external triggering signal is required to induce this reverse transition. The circuit remains in this state until another triggering pulse is applied. These multivibrators are also called one-shot, single cycle, single-step, or **unified multivibrators**. Time ‘T’ after which the circuit returns to its original state is called **gate-width** and hence the multivibrator is also known as the gating circuit or delay circuit. This circuit is used to produce the pulses of variable width at the required moments.



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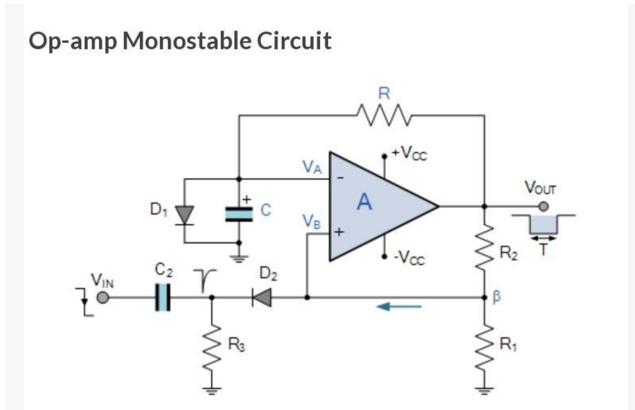
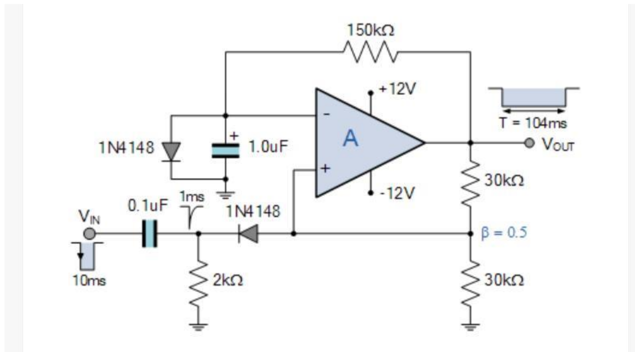
Monostable multivibrator with op-amp

Working:





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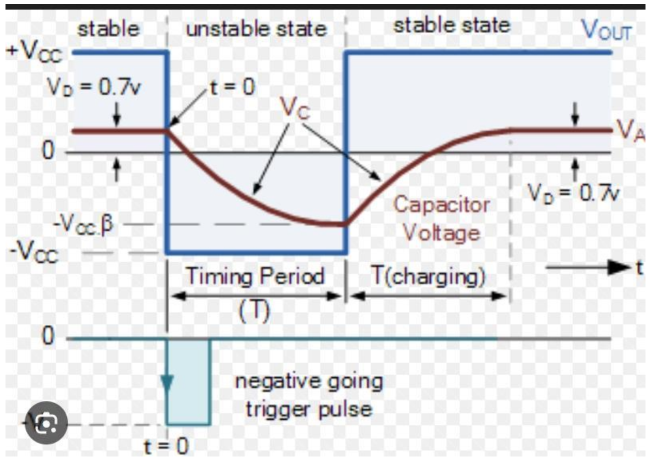
Let's consider the output is at positive saturation voltage or the output of the op-amp is positive, then the voltage at node A will be (R2/(R1+R2)) * Vsat, and whenever the output is at positive saturation voltage, the diode D1 will become forward biased, and the voltage across the capacitor C1 will be the forward voltage drop across the diode. So, at the inverting node, the voltage will be equal to the forward voltage drop across the diode. For this scenario, as the output voltage is greater than the inverting node, the output of the op-amp will be at the positive saturation voltage.

Now we will apply a trigger pulse at node A, and whenever this negative trigger signal has applied, the output at the non-inverting node will be less than the voltage at the inverting node. And the output of the op-amp will switch from the positive saturation voltage to the negative saturation voltage. And the circuit will go into the quasi-stable state.

Now the voltage at the non-inverting node will be equal to -Vsat. As the output voltage is equal to the negative saturation voltage, the diode will become reversed biased and the capacitor will start charging towards the negative saturation voltage. Now whenever the voltage at the inverting node goes below the voltage -Vsat, then once again the output of the op-amp will become positive saturation voltage because, at that time, the non-inverting node will be slightly less than the inverting node. So, the output will switch from negative saturation voltage to positive saturation voltage. And for this time T, only the output will stay on the quasi-stable as soon as the output reaches the positive saturation voltage, the diode will become forward biased and this cycle will continue. So this is the basic working principle of the monostable multivibrator.



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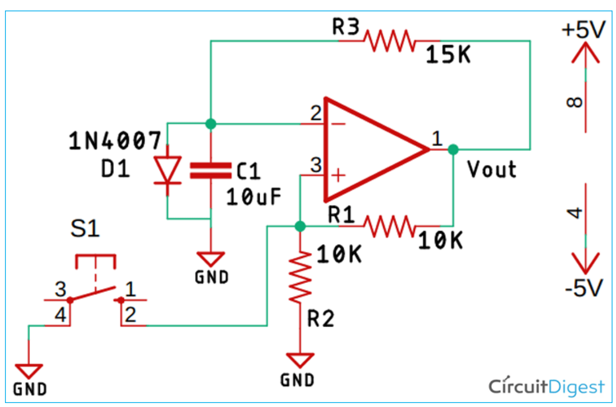
Op-amp Monostable Multivibrator using Op-Amp derivation



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In this circuit also, the period ‘T’ is determined by the values of the resistor R3, the capacitor C1, and the values of the feedback resistors, and for the given circuit, the time-period can be calculated by-

T = RC * logn (1 + (R2 / R1))

With the formula, sorted outlets design a monostable multivibrator that has a time-period of 100ms. For simplicity, we are going to be using two 10K resistors for R1 and R2. By doing so, the expression becomes-

T = RC * logn (1 + 1)
T = RC * logn (2)

If we were to put these values on the calculator and calculate the values, it becomes 0.693RC and for the capacitor, we are going to use a 10uF capacitor.

T = 0.693 RC
C = 10 uF
R = 15 k
Now, as we have completed the calculations, we can move on to the building and testing the circuit.

Components Required

As this is a very simple monostable multivibrator circuit, the component requirements for this project are very simple, and you can get those from your local hobby store. The list of components is given below.

- LM358 Op-amp IC - 1
- 10K Resistors - 3
- 4.7K Resistor - 1
- 0.1uF Capacitor - 2
- 1N4007 Diode - 4
- 1000uF, 25V Capacitors - 2
- 4.5V - 0 - 4.5V Transformer - 1
- AC Cable - 1
- Breadboard - 1
- Connecting Wires

Advantages and limitations

Advantages:

1. **Precise Timing**: The pulse width is accurately controlled by the values of R and C, making it highly reliable in timing applications.
2. **Simple Design**:Requires only a few components, making it easy to design and implement in various circuits.
3. **Versatile Applications**:Can be used for pulse shaping, delay circuits, event counting, and more in digital systems.

Disadvantages:

1. **Sensitive to Noise**:The circuit can be triggered unintentionally by noise, which may result in unwanted output pulses.
2. **Limited Pulse Width Range**:The pulse width is limited by the chosen values of the resistor and capacitor, which might not cover a wide range of timings without using very large or very small components.
3. **Temperature Dependence**:The values of R and C may drift with temperature, affecting the accuracy of the pulse width over time.

Limitations:

1. **Trigger Requirements**:The trigger pulse must be shorter than the generated pulse width to avoid malfunction.
2. **Component Tolerances**:The accuracy of the circuit depends heavily on the tolerances of the resistor and capacitor used, which can introduce error in critical timing applications.
3. **Limited Frequency Response**:The circuit cannot respond effectively to very fast or very slow trigger signals due to limitations in the RC time constant.

Referencee

Websites:

- https://circuitdigest.com/electronic-circuits/how-to-design-a-simple-monostable-multivibrator-circuit-using-op-amp

- https://www.electronics-tutorials.ws/opamp/op-amp-monostable.html

Books:

- “Op-Amps and Linear Integrated Circuits" by Ramakant A. Gayakwad**
- “Microelectronic Circuits" by Adel S. Sedra and Kenneth C. Smith
- "Pulse, Digital and Switching Waveforms" by Jacob Millman and Herbert Taub**