Electronics Starter Kit

Learn | Experiment | Fun

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https://github.com/hatchnhack/Electronics-Starter-Kit

First release, September 2020

1. Introduction

Creating means living - Dejan Stojanovic

This guide will guide you to make smart circuits or systems using discrete components like transistors, resistors, LEDs, NE555 timer IC, without micro-controllers or programming. In the following section, all the kits components' working and uses are explained thoroughly, and after that each chapter is divided according to the experiments and components. You can directly build the circuit you like or go through this guide to get an in-depth knowledge of every component and system and customize them to make your own circuits.

1.1 Kit Introduction

In this section all the electronic components that you have received in the kits are explained with example circuits and use case.

The list of components in the kits -

- Battery
- Battery Connector
- Jumper Wires
- Male Headers
- Breadboard
- Resistor Box
- Ceramic Capacitor
- Potentiometer
- Potentiometer Knob
- LDR
- Push Button
- Diode
- LED
- Transistor

- Power Supply Module
- Buzzer
- NE555 IC
- Toy Motor
- Toy Fan

1.2 Components' Introduction

1.2.1 Battery

2. Fun with LEDs

2.1 Overview

In this section you'll learn about Light Emitting Diodes (LED) and how to turn it on using different methods.

2.2 Component Introduction

Before diving into making circuits, we will first learn about the components that we are going to use and how to select the right component.

2.2.1 Resistors

Resistor is a passive electric component that resists the flow of current through it. They are used in almost all electrical and electronic circuits and systems. The resistance of a resistor in measured in ohms (Ω). An ohm is the resistance that occurs when one ampere (A) of current flows through a resistor with potential (or voltage) drop of one volt (V) across it's terminal.

Figure 2.1: Resistor Symbol

Ohm's Law

Ohm's law state that the current through a resistor is directly proportional to the voltage applied across it.

$$\begin{aligned} & I \propto V \\ \implies & R = \frac{V}{I}(\Omega) \end{aligned}$$

2.2.2 Light Emitting Diode

Light emitting diodes (LEDs) are semiconductor devices that emit lights of different wavelength depending on the substrate semiconductor material used when an electric current is applied. The color of light emitted depends on the amount of energy required by the electrons to cross the band gap of the semiconductor. Since, LEDs are basically a PN junction diode, they allow current flow only in one direction.

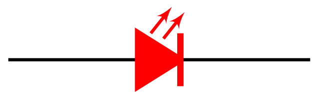


Figure 2.2: LED Symbol

Determining the pins of the LED

There are multiple ways to determine the anode and cathode of an LED:

1. Looking at the LED pins (or legs). The longer leg is anode and the shorter cathode. But sometimes the legs could be trimmed, therefore, you can use this method for new LEDs only.
2. Locate a flat edge on the LED. The pin close to flat edge is cathode.
3. By looking inside the LED, the bigger conductor (flag shaped) is the cathode.
4. By using multi-meter in continuity mode, only is one direction the LED will turn on (or the resistance in one direction will be smaller than in the other).

2.2.3 Breadboard

A breadboard in a rectangular plastic board with a bunch of tiny holes in it. There's strip of metal inside the plastic. Most through hole components have pin spacing of 2.54mm, therefore, the holes have the same spacing between them. You can easily insert electrical components in these holes. There is also a deep grove in the middle, indicating the break in the connection. Some breadboard have two strips of holes (also called rails) along the long edges of the breadboard. They are used for power rails, with strip of metal inside.

A breadboard is used to prototype an electronic circuit. The connection on breadboard are not permanent and can be removed easily. This makes breadboard great for beginners who are new to electronics but the connections are not as reliable as soldered connections.

2.2.4 Breadboard Power Supply

A power supply is a hardware component that provides electricity to power devices like computer, fridge, lights and much more. The breadboard power supply of type linear DC to DC. A linear power supply has two major components, a linear regulator and filtering capacitors.

The breadboard power supply can provide constant 3.3V or 5V and is compatible with the breadboard power rails, i.e., you can directly plug in on top of the breadboard to have voltage across the power rails. The input voltage or power can be provided through the DC barrel jack (for 6-12V) or through the USB connector (5V).

Calculating power dissipation

To calculate the power dissipation across the voltage regulator, we need to determine the output current. For linear regulator the input and output current remains same and the power difference is dissipated through the voltage regulator.

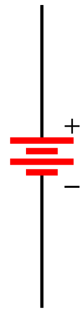


Figure 2.3: Battery Symbol

Example: We need 200mA current at 3,3V output, and the input power supply is of 9V. Then,

$$
\begin{aligned}
P_{out} &= 3.3V \times 0.2A = 0.66W \\
P_{in} &= 9V \times 0.2A = 1.8W \\
P_{reg} &= P_{in} - P_{out} \\
&= 1.8 - 0.66 \\
&= 1.14W \\
\eta &= \frac{P_{out}}{P_{in}} \times 100 \\
&= 36.67\%
\end{aligned}
$$

2.2.5 Push Button

Push button is use to control or provide input to the circuit. It is normally open and only when you press it the current will flow through it. And when released, the current will stop flowing. Push button have mechanical contacts, so when you press or release it, it doesn't instantaneously make or release contact. It bounces back and forth before making a firm connection.

Figure 2.4: Push Button Symbol

2.2.6 Potentiometer

A potentiometer (pot) is a variable resistor and comes in different packages, size and values. They generally have 3 terminals. And the resistance between the outer most terminals is equal to the maximum resistance of the potentiometer and the resistance between middle and any outer pin can vary from 0 to the total resistance of potentiometer.

Figure 2.5: Potentiometer Symbol

2.2.7 Circuit

A circuit is a closed loop that provides path for current to flow. Circuit must have a path that start and end at the same component, or in order words must form a loop. Electronic circuits operates at low voltages.

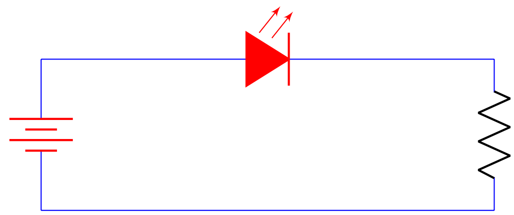


Figure 2.6: Simple Circuit

A circuit has broadly the following components -

- Power sourcesupply
- Load (Light, led, motor etc)
- Pathwire (conductive path providing current flow)

Apart from these, a circuit can have more complex design.

2.3 Lesson 1: Lighting up an LED

2.3.1 Objective

In this activity you'll learn how to turn on an LED

2.3.2 Components Required

1. Breadboard Power Supply × 1
2. 9V Battery × 1
3. 9V Battery Connector × 1
4. Breadboard × 1
5. 5mm Red LED × 1
6. 220Ω resistor × 1
7. Male to Male Jumper Wires × 2

2.3.3 Circuit

(a) Circuit A (b) Circuit B

Figure 2.7: Simple LED Circuits

Throughout this guide we'll be using these symbols for power supply.

(a) Circuit A (b) Circuit B

Figure 2.8: Simplified LED Circuits

2.3.4 Circuit Explanation

If we look at the graphs in the datasheet of RED led[Sem13], the forward current through the led (I_F) is typically in between 10 mA to 20 mA and the voltage drop (V_F) across it is 2 V. If we directly connect the LED across 5 V supply it will burn out due to excessive power. Therefore, we need a resistor in series with the LED to drop the voltage. This resistor is referred as the current-limiting resistor. If you look at the figure 2.7 both the circuits A & B are same because in series circuits the current remains same across all the components.

To calculate the series resistance (R_S) we'll use Ohm's law: We'll take the average value for I_F

$$
\begin{aligned}
V &= I \times R \\
R_S &= \frac{V_{5v} - V_F}{I_F} \\
&= \frac{5V - 2V}{15mA} \\
&= \frac{3 \times 1000}{15} \\
R_S &= 200\,\Omega
\end{aligned}
$$

Since, in the kit a 220 Ω is available, we will use that. If we calculate the current using a 220 Ω resistor, it will $3 \div 220 = 0.0136\,\text{A} = 13.6\,\text{mA}$ which is in the range provided by the datasheet.

2.3.5 Circuit Picture

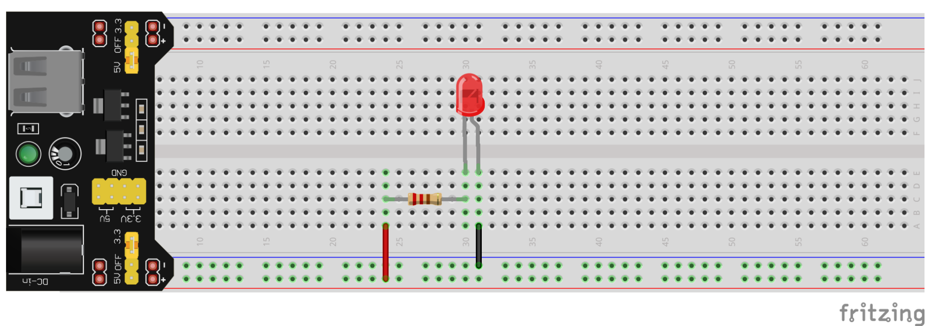


Figure 2.9: Simple Circuit on Breadboard

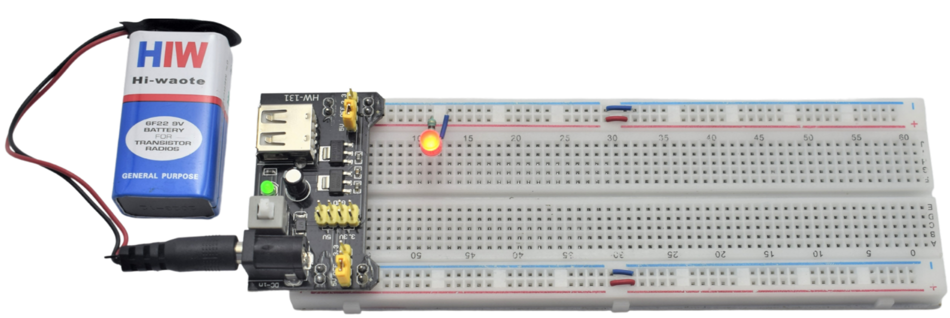


Figure 2.10: Simple Circuit on Breadboard

2.4 Lesson 2: Lighting up an LED by pressing a Switch

2.4.1 Objective

In this activity we'll turn on the led using a push button.

2.4.2 Components Required

1. Breadboard Power Supply × 1
2. 9V Battery × 1
3. 9V Battery Connector × 1
4. Breadboard × 1
5. 5mm Red LED × 1
6. 220Ω resistor × 1
7. Male to Male Jumper Wires × 2
8. Push Button × 1

2.4.3 Circuit

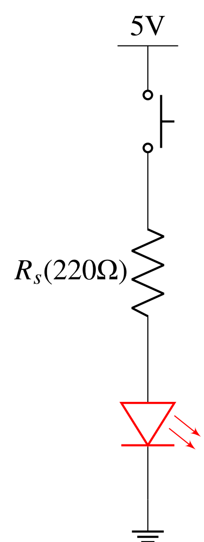


Figure 2.11: Push Button Circuit

2.4.4 Circuit Explanation

This circuit is similar to the one we made previously, except for the fact that we have a push button in series. The button is normally open, meaning no current flows through the circuit (no complete loop or path) and when we press the button the path is complete and LED will turn on.

2.4.5 Circuit Photo

2.5 Controlling LED brightness using a Potentiometer

2.5.1 Objective

In this activity, we'll control the LED brightness/intensity with help on a potentiometer.

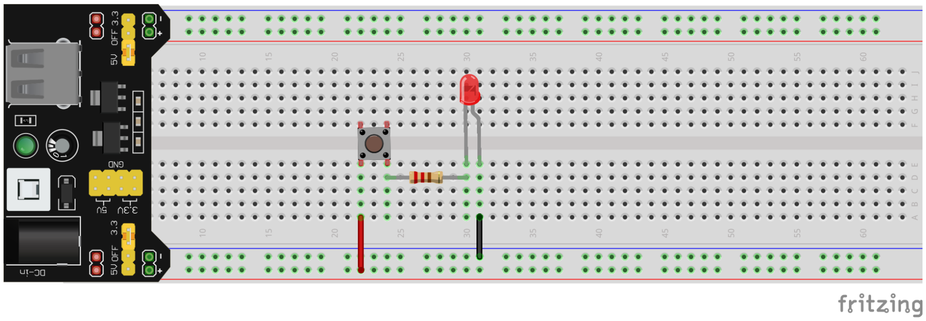


Figure 2.12: Circuit Schematic

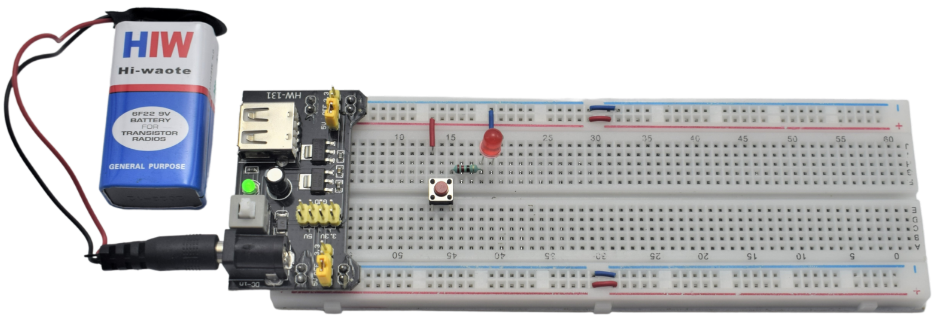


Figure 2.13: LED Off, Switch Open

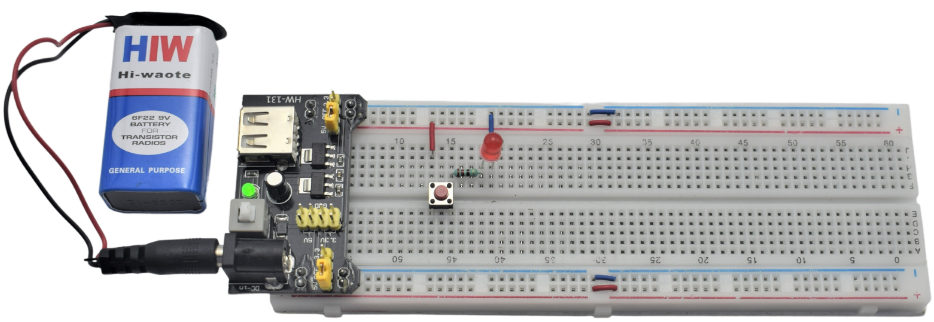


Figure 2.14: LED On, Switch Closed/Pressed

2.5.2 Components Required

1. Breadboard Power Supply × 1
2. 9V Battery × 1
3. 9V Battery Connector × 1
4. Breadboard × 1
5. 5mm Red LED × 1
6. 220Ω resistor × 1
7. Male to Male Jumper Wires × 2
8. Potentiometer × 1

2.5.3 Circuit

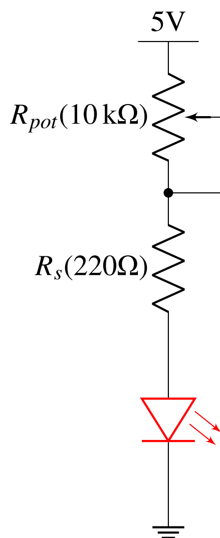


Figure 2.15: Potentiometer LED Circuit

2.5.4 Circuit Explanation

When the potentiometer resistance R_{pot} is 0Ω, the LED will be in series with R_S and glow. As we'll increase the resistance of potentiometer the effective series resistance will increase $R_t = R_S + R_{pot}$. With increase in the series resistance, the current through the circuit will decrease according to the Ohm's law ($I \propto \frac{1}{R}$) changing the intensity of the LED.

2.5.5 Circuit Picture

2.6 DIY: Activities

- Calculate series resistance for RED led using 3.3V power supply

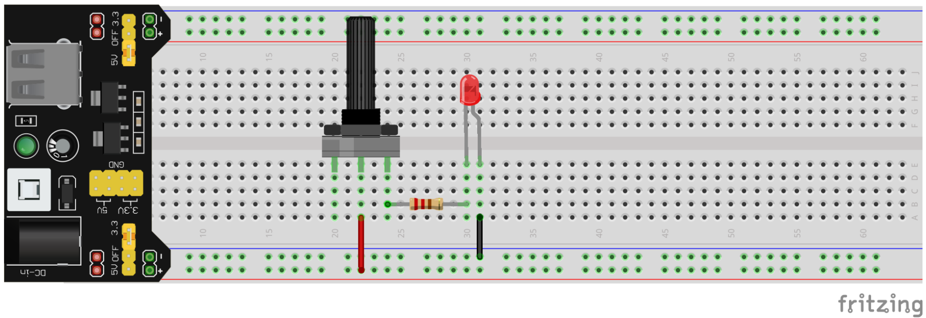


Figure 2.16: Circuit Schematic

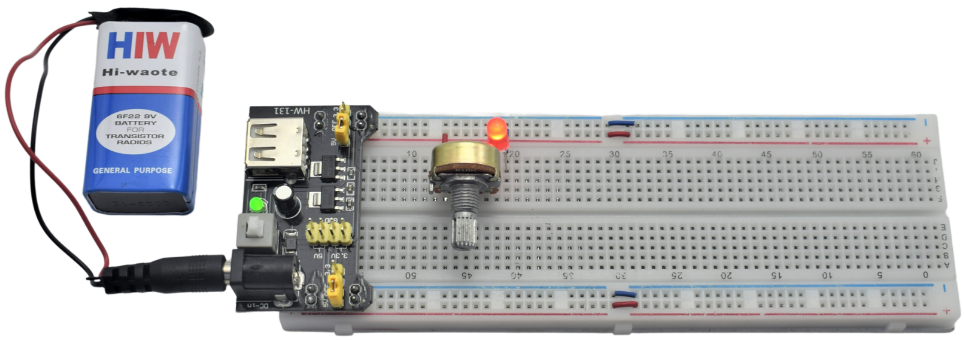


Figure 2.17: Max Intensity, $R_{pot} = 0$

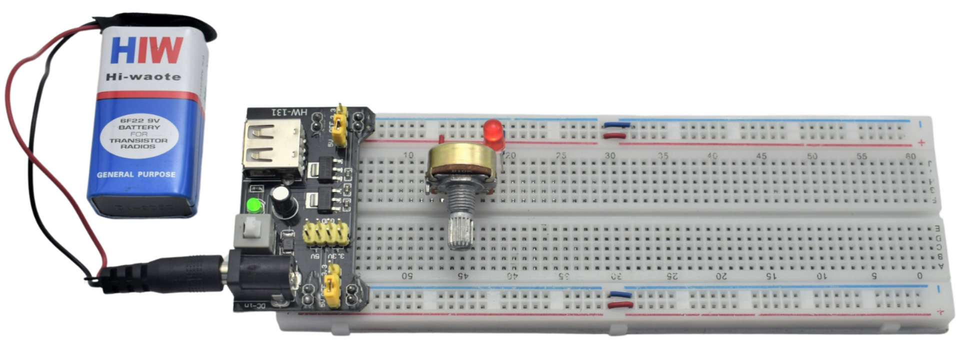


Figure 2.18: Min Intensity, $R_{pot} = 10\text{k}\Omega$

3. Transistors

3.1 Overview

In this section you'll learn about Light Emitting Diodes (LED) and how to turn it on using different methods.

3.2 Component Introduction

In this chapter we will be using transistor to make electronic circuits. There are different types of transistors available but we will be using bipolar junction transistor (BJTs) only. BJTs are the most common transistor type used among the hobbyists and DIYers.

3.2.1 BJT

A transistor is a semiconductor device with 3 terminals or regions. The interface between each of the regions forms a p-n junction, it likes two diodes together. There are two types of BJTs - NPN, when a p-type semiconductor is in-between two n-type. PNP, when a n-type semiconductor is in-between two p-type. Transistors are used to amplify or switch electronic signals and electrical power. Each of the terminals or regions are named -

- Collector: The largest semiconductor region of the transistor.
- Emitter: The second largest semiconductor region of the transistor.
- Base: Middle region of the transistor. This serves as a gatekeeper that determines the amount of current that can flow through emitter-collector regions.

Operation Modes for Transistor

There are 4 modes in which a transistor works -

1. **Cut-off** In cut-off mode no current flows through the transistor. The transistor acts like an open circuit.
2. **Saturation** In saturation mode the transistor allows current to flow freely and acts like an short-circuit.

(a) NPN (b) PNP

Figure 3.1: Transistor Symbol

3. **Active** In active mode the amount of current flowing through the collector-emitter region is proportional to the current flowing through base.
4. **Reverse-Active** It is similar to active mode, but the direction of current is reversed. The transistors are not meant to operate in Reverse-Active mode.

If we make sure that the transistor operates in only cut-off or saturation region, then it can act like a switch turning current flow ON or OFF by controlling the base voltage. In this guide most of the circuits will use transistor in Saturation & cut-off mode.

In NPN transistor, the base voltage should be higher than the emitter voltage by threshold voltage V_{th}, defined in the datasheet of the transistor. Generally it is near about 0.7 V.

For PNP, the base voltage should be lower than the emitter voltage by V_{th}.

(a) NPN (b) PNP

Figure 3.2: Direction of Conventional current in BJTs

For both the transistors, $I_E = I_C + I_B$

3.2.2 Capacitor

Capacitor is a pretty simple electronic device. It consists of two conductive plates separated by an insulated medium called dielectric. Capacitors when powered are able to store energy in the form of electric field between the two plates. With different types of dielectric, there are different types of capacitors and have different qualities and uses. Capacitors can be polarized when dielectric used is polarized and favours electric field in one direction. The value of capacitor is measured in Farads

(a) Non Polarized (b) Polazired

Figure 3.3: Capacitor Symbol

(F), and one farad is a very big value. *The capacitance of earth is* 710 µF.

Capacitors or Caps are used in many ways and can be found in almost every electronic circuits. On Polar capacitors the exact values in written on the body, for ceramic capacitor the values is written with 2 significant digits and 1 multiplier, for example capacitance of a ceramic capacitor with 105 written on it is, 10×10^4pF = $1 \times 10^5 \times 1 \times 10^{-12}$F = 1×10^{-7}F = 0.1 µF

3.2.3 LDR

Light Dependent Resistor(LDR) or photocell or photoresistor is a semiconductor device which exhibits a very special property, it acts like a resistor but the value of resistance depends on the amount of light falling on it.

In bright light, the LDR resistance will be in the range of 0.01-10kΩ and in darkness it's resistance will be in the range of 100-1000kΩ.

Figure 3.4: LDR Symbol

3.2.4 RGB LED

RGB LED is a combination of all three LEDs (RED, GREEN, BLUE) in one single package. You can produce different colors using RGB LEDs by configuring the intensity of each LED.

There are two kinds of RGB LED, one shares the cathode pin and the other shares the anode pin.

(a) Common Anode

(b) Common Cathode

Figure 3.5: RGB LED Symbol

3.3 Lesson 4: Astable Multivibrator

3.3.1 Overview

In this activity, we will make an astable multivibrator using BJTs and flash two LEDs.

3.3.2 Components Required

1. Breadboard Power Supply × 1
2. 9V Battery × 1
3. 9V Battery Connector × 1
4. Breadboard × 1
5. Red LED × 2
6. 220 Ω × 2
7. 100 kΩ × 2
8. 2N2222 NPN Transistor × 2
9. 10 µF × 2
10. Male-Male jumper wire × 6

3.3.3 Circuit

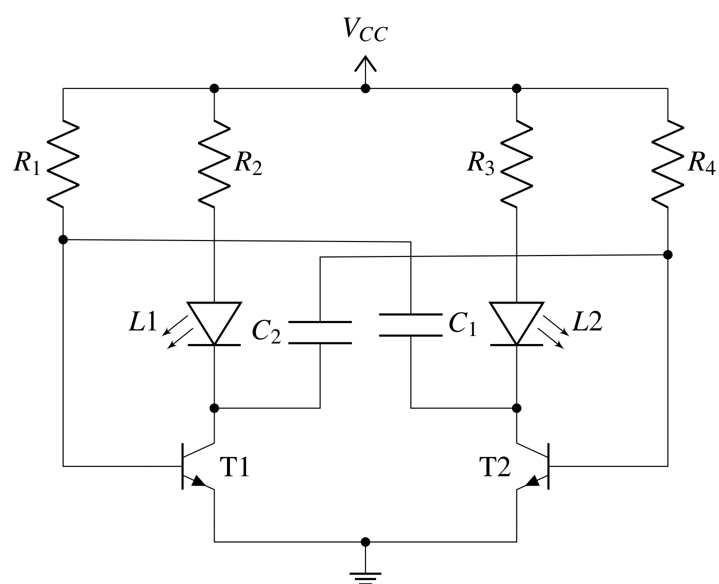


Figure 3.6: Astable Multivibrator

3.3.4 Circuit Explanation

Let's assume that $T1$ has just turned off and $T2$ has just turned on which means C_2 is fully charged and C_1 is discharged. Since, $T1$ is in cut-off mode, the collector $T1.C$ will rise to V_{cc} potential and the potential across the C_2 capacitor will be $V_{cc} - V_{th}$, where V_{th} is the threshold voltage of transistors.

$T2$ is fully on, the capacitor C_1 will start charging through resistor R_1 and the LED_1 will be turned on. When the plate of C_1 connected to base of $T1$ rises to potential V_{th} it will pull $T1$

into conduction and then saturation mode. When the transistor $T1$ is in saturation mode it will immediately pull the capacitor C_1 to ground, this rapid change in voltage at the plate of capacitor C_1 connected to $T1.C$ causes an equal and instantaneous fall in voltage at the plate connected to base of $T2$, turning it hard off. Now $T1$ is On turning LED_1 on and $T2$ is off and the same cycle repeats again, $C2$ starts chargin turning $T2$ on and $C1$ turning $T1$ off.

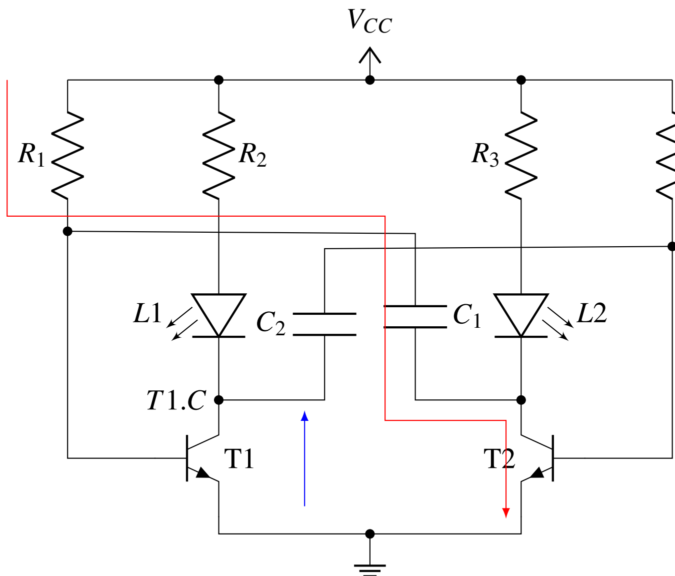


Figure 3.7: T1 off, T2 on

The time period or frequency of oscillation for astable multivibrator can be calculated using the below equations -

$$t_1 = 0.693 \times R_1 \times C_1$$
$$t_2 = 0.693 \times R_4 \times C_2$$

where, t_1 & t_2 are charging and discharging time period for the capacitors.

For symmetrical astable multivibrator $R_1 = R_2$ and $C_1 = C_2$.

The total time period is -

$$T = t_1 + t_2$$
$$T = 0.693RC + 0.693RC$$
$$T = 1.386RC$$

In our circuit we will use $R_2 = R_3 = 220\Omega$, $R_1 = R_4 = 100\text{k}\Omega$ and $C_1 = C_2 = 10\mu\text{F}$.

By changing the values of series RC we have change the time period of oscillation.

3.3.5 Circuit Picture

3.4 Lesson 5: Transistor as Touch Sensor

3.4.1 Overview

In this activity we will build a very basic touch sensor using transistors.

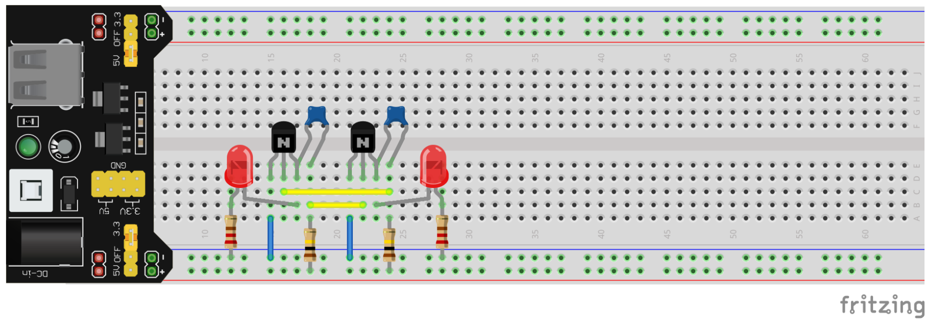


Figure 3.8: Circuit Schematic

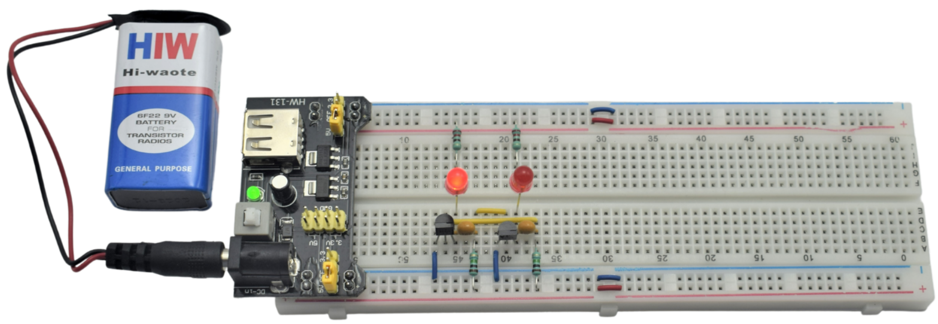


Figure 3.9: Astable Multivibrator on Breadboard

3.4.2 Components Required

1. Breadboard Power Supply × 1
2. 9V Battery × 1
3. 9V Battery Connector × 1
4. Breadboard × 1
5. Red LED × 1
6. 220 Ω × 1
7. 10 kΩ × 1
8. 2N2222 NPN Transistor × 2
9. Male pin header × 2
10. Male-Male jumper wire × 5

3.4.3 Circuit

3.4.4 Circuit Explanation

By default both the transistors are turned off. When you touch the male pin headers connected between VCC and the base of $T1$, you body acts like a resistor between them, allowing a very small current(I_{B1}) to pass through the base of $T1$. This current is not sufficient to push $T1$ into saturation.

Therefore, we have connected the base of $T2$ to the emitter of $T1$ and the base current(I_{B2}) for $T2$ is approximately equal to the collector current(I_{C1}) of $T1$, which is $\beta \times I_{B1}$. This current is sufficient to pull the $T2$ transistor into saturation mode and the LED turn on.

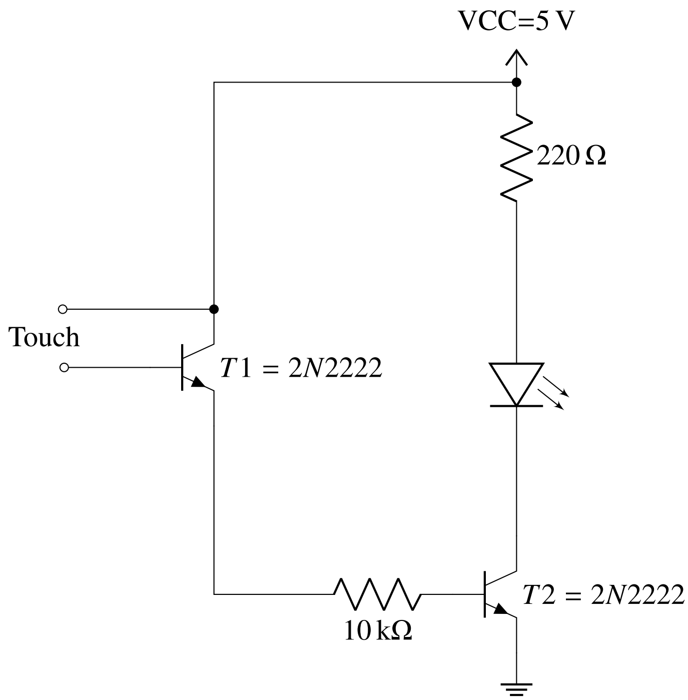


Figure 3.10: Transistors as Touch Sensor

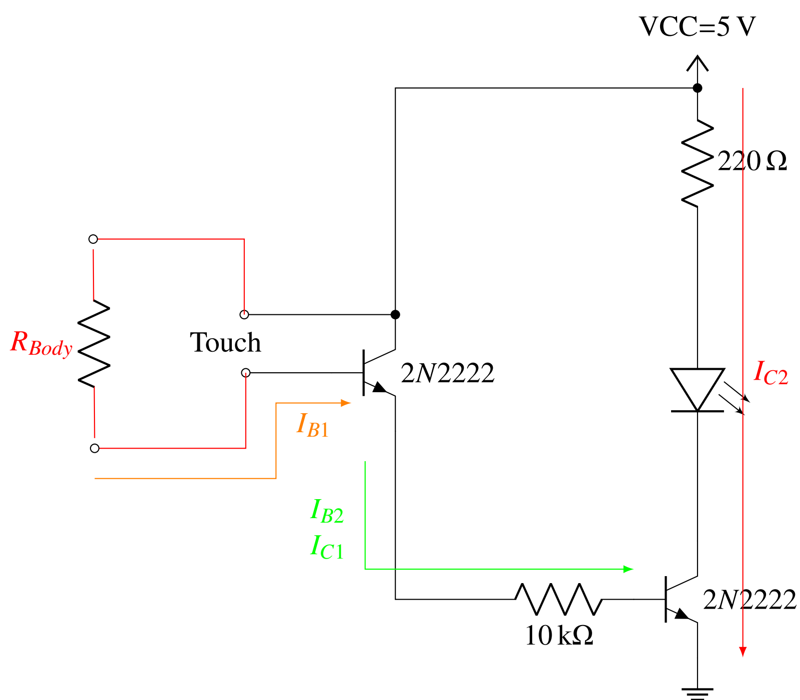


Figure 3.11: Touch Sensor Working

3.4.5 Circuit Picture

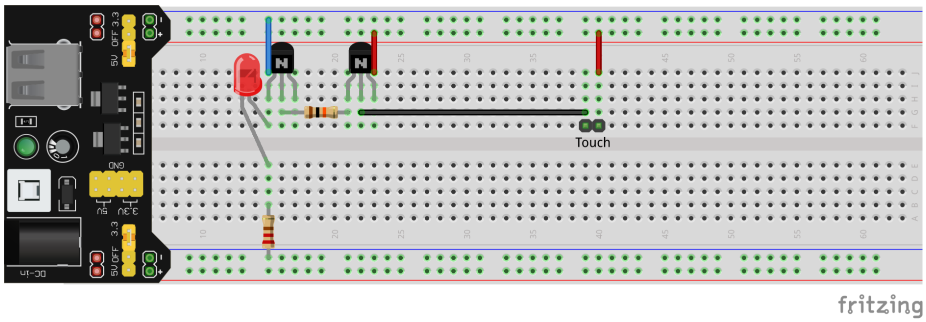


Figure 3.12: Circuit Schematic

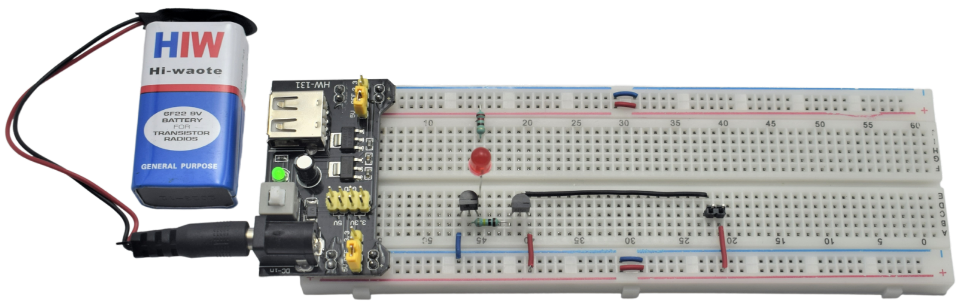


Figure 3.13: Touch Switch on Breadboard

3.5 Lesson 6: Flip Flop

3.5.1 Overview

In this activity we'll use transistors and push buttons to make a flip flop circuit.

3.5.2 Components Required

1. Breadboard Power Supply $\times$ 1
2. 9V Battery $\times$ 1
3. 9V Battery Connector $\times$ 1
4. Breadboard $\times$ 1
5. Red LED $\times$ 2
6. 1 kΩ $\times$ 2
7. 100 kΩ $\times$ 2
8. 2N2222 NPN Transistor $\times$ 2
9. 10-XX Push Buttons $\times$ 2
10. Male-Male jumper wire $\times$ 8

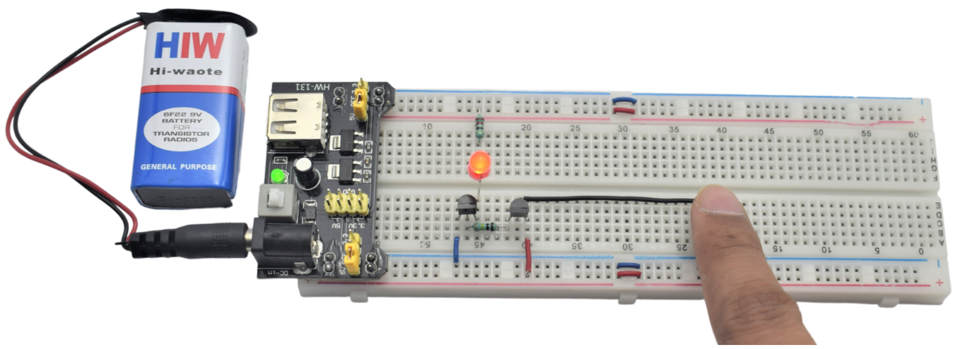


Figure 3.14: Touch Switch on Breadboard - LED glows on touching the pin headers

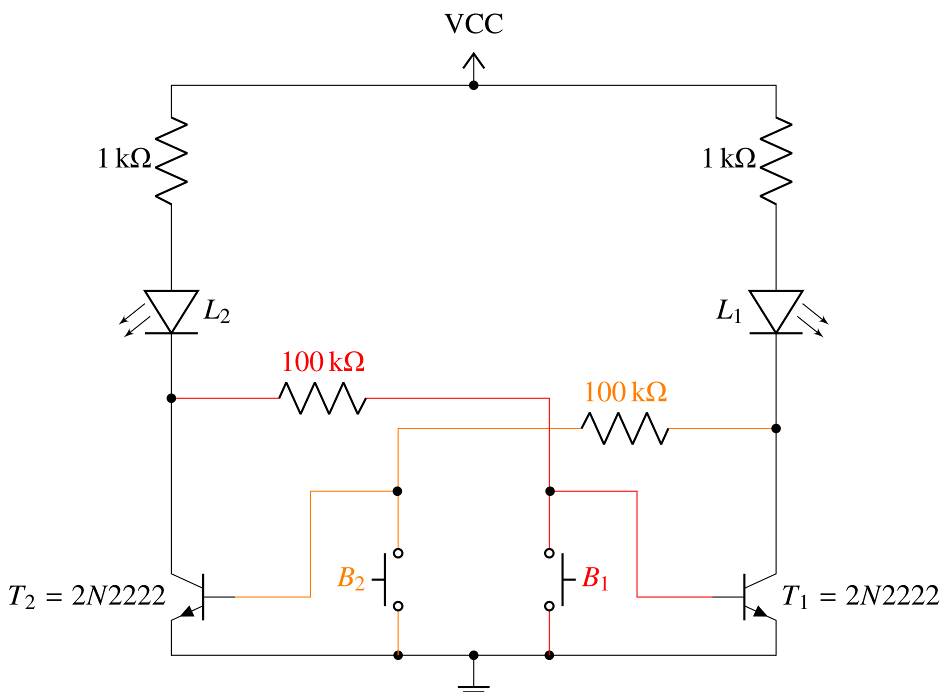


Figure 3.15: Flip Flop

3.5.3 Circuit

3.5.4 Circuit Explanation

Let's assume that L_1 is on, which means there is a very small amount of current flowing through the L_2 to the base of transistor T_1. The current flowing through L_1 will prefer to go through the transistor T_1 because this path offers the least resistance.

Now, when we press the button B_1 the current going to the base of T_1 will now directly go to the ground, switching T_1 off. And there will be a small current going through the led L_1 to the base of transistor T_2, pushing it into saturation. And when we leave the button B_1 the current through L_2 will go through T_2 only, as it will offer a path with least resistance.

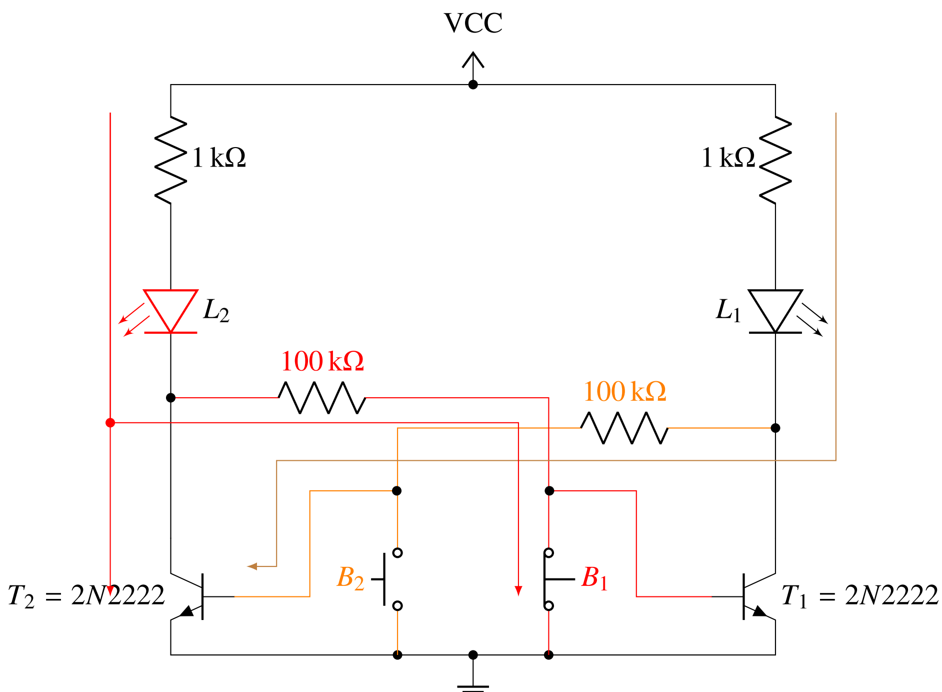


Figure 3.16: Flip Flop Working

3.5.5 Circuit Picture

3.6 Lesson 7: On/Off Touch using Transistors

3.6.1 Overview

In this acitivity we will make an on off touch switch using transistors, which will remember its state.

3.6.2 Components Required

1. Breadboard Power Supply × 1
2. 9V Battery × 1
3. 9V Battery Connector × 1
4. Breadboard × 1
5. Red LED × 1
6. 220 Ω × 1

7. 10 kΩ × 1
8. 100 kΩ × 1
9. 2N2222 NPN Transistor × 3
10. 2N2907 PNP Trsnsistor × 1
11. Male pin headers × 4
12. Male-Male jumper wire × 13

3.6.3 Circuit

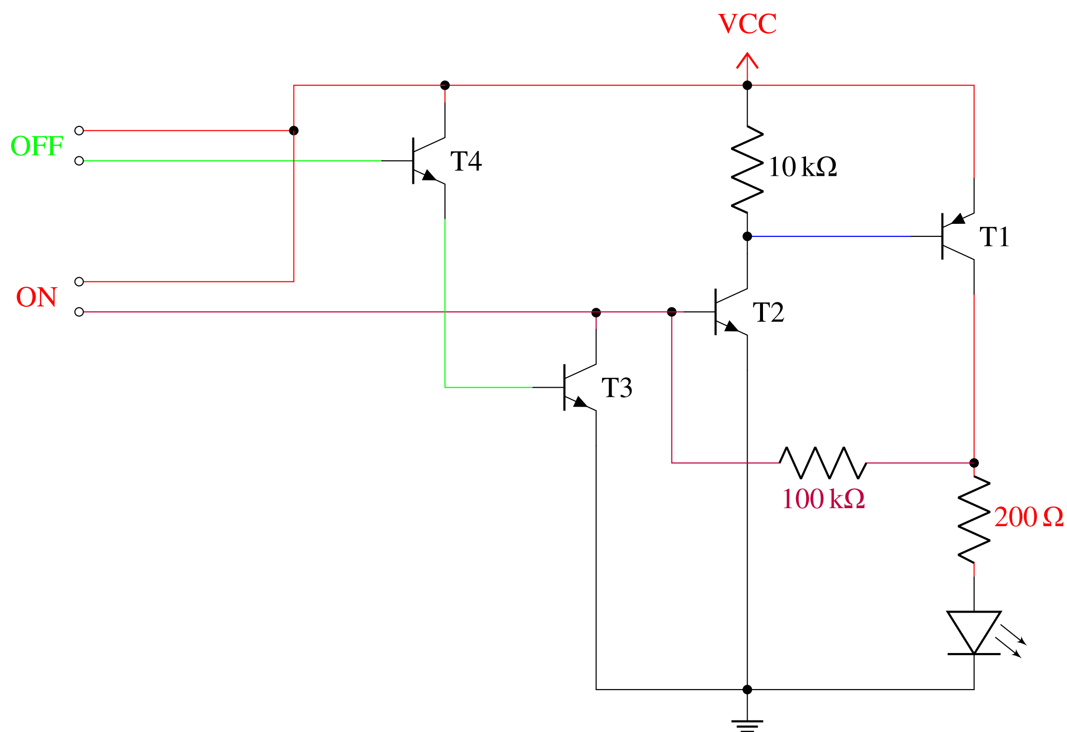


Figure 3.17: On/Off Touch Switch using Transistors

3.6.4 Circuit Explanation

When we touch the pin headers marked *on*, we introduce our body resistance between VCC and base of transistor $T2$, turning it on. When $T2$ is turned on, it pulls the base of transistor $T1$ to ground, pushing it to saturation mode. A small part of the current flowing through the collector of $T1$ goes to the base of $T2$ through feedback resistor. Now, when we remove our body resistance from the circuit the current through feedback keeps $T2$ on, which make sure the $T1$ is on and the led is glowing.

Now, when we touch the pin header marked *off*, we introduce our body resistance in between the VCC and the base of $T4$, turning it on. The $T4$ collector current goes to the base of $T3$, turning it on. There are two things that causes the led to turn off, base of $T2$ is pulled to ground, and the feedback current keeping it on goes to ground via $T3$. It means $T2$ is switched off, and when $T2$ is off the base of $T1$ is pulled high, turning it hard off.

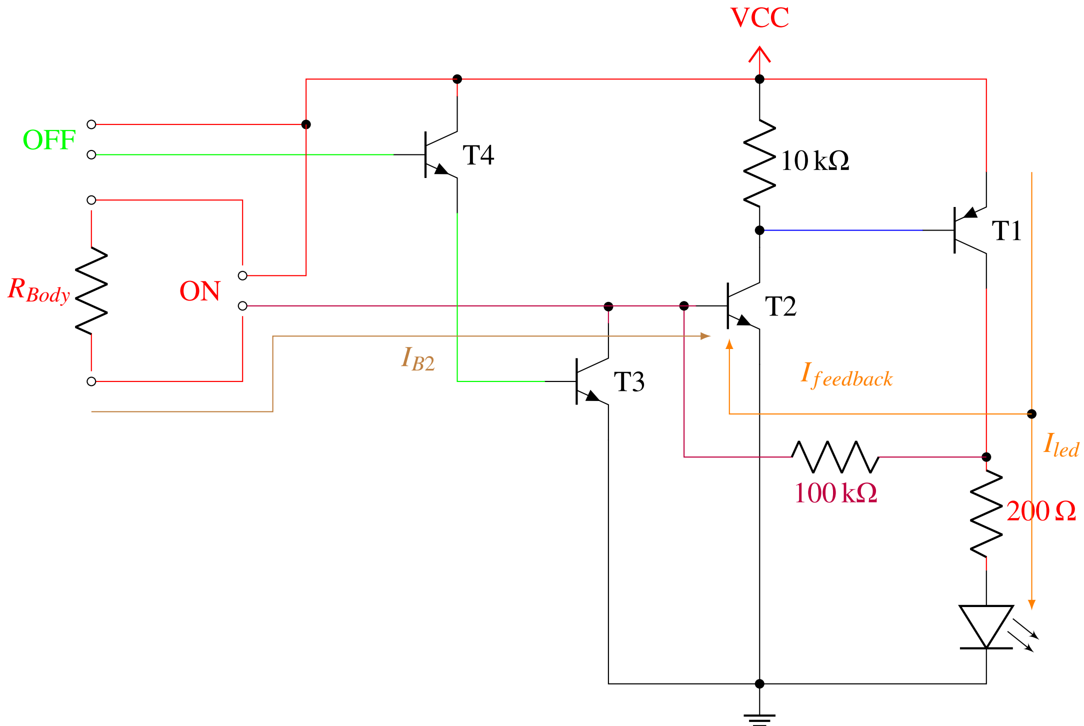


Figure 3.18: Touch Switch using Transistors - On State

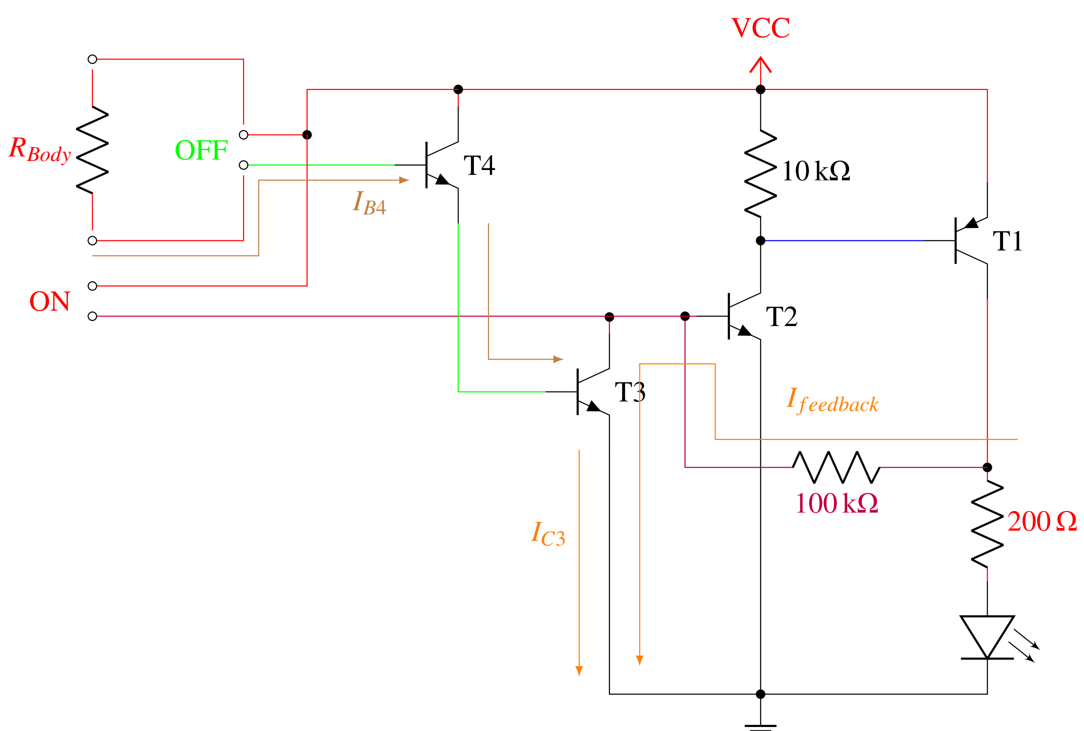


Figure 3.19: Touch Switch using Transistors - Off State

3.6.5 Circuit Picture

3.7 Lesson 8: Toggle Switch using Transistors

3.7.1 Overview

In this activity we will make an toggle switch which toggles the output state using push button and transistors.

3.7.2 Components Required

1. Breadboard Power Supply × 1
2. 9V Battery × 1
3. 9V Battery Connector × 1
4. Breadboard × 1
5. Red LED × 1
6. 100 nF × 1
7. 220 Ω × 1
8. 10 kΩ × 1
9. 100 kΩ × 2
10. 1 MΩ × 2
11. 2N2222 NPN Transistor × 2
12. 2N2907 PNP Trsnsistor × 1
13. 10-XX Push Button × 1
14. Male-Male jumper wire × 10

3.7.3 Circuit

3.7.4 Circuit Explanation

Let us assume that initially all the transistors are off along with the led. In this case, the capacitor gets charged via the two 1MΩ resistors. And no current is flowing through any transistor.

When we press the switch, the capacitor's +ve plate is connected to the base of the transistor $T2$, and therefore a base current starts flowing, turning $T2$ on. With $T2$ on the base of transistor $T1$ is pulled to ground, turning it and the led on. There is also a feedback current flowing back to base of $T2$ and $T3$.

On leaving the switch, the feedback current keeps the $T2$ on which keeps $T1$ on. Also, this feedback current turn on the $T3$ which discharges the capacitor through it. At this stage all the transistors are on, led is on and the capacitor is completely discharged.

Now, when we again press the switch, the feedback current going to base of $T2$, goes to ground via the capacitor, which is discharged and therefore provide little to no resistance. This turns off the $T2$, and the base of $T1$ is pulled back to VCC, causing it to turn off. Now the led is off and all the transistor are not conducting, which is idle state.

3.7.5 Circuit Picture

3.8 Lesson 8: Two Color LED Flasher using Transistors

3.8.1 Overview

In this activity we will use the astable multivibrator to flash a rgb led.

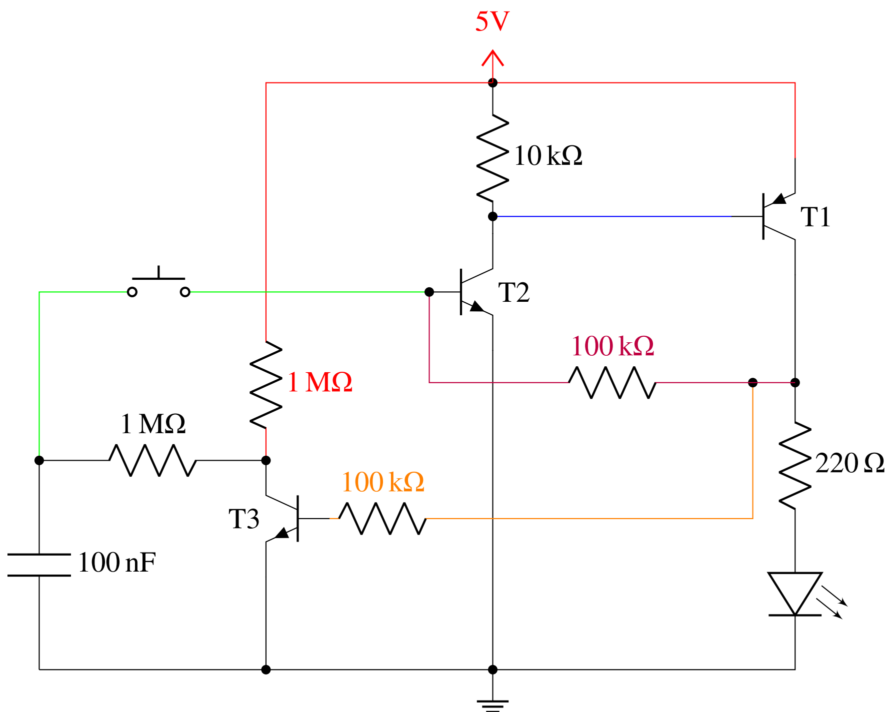


Figure 3.20: Toggle Switch using Transistors

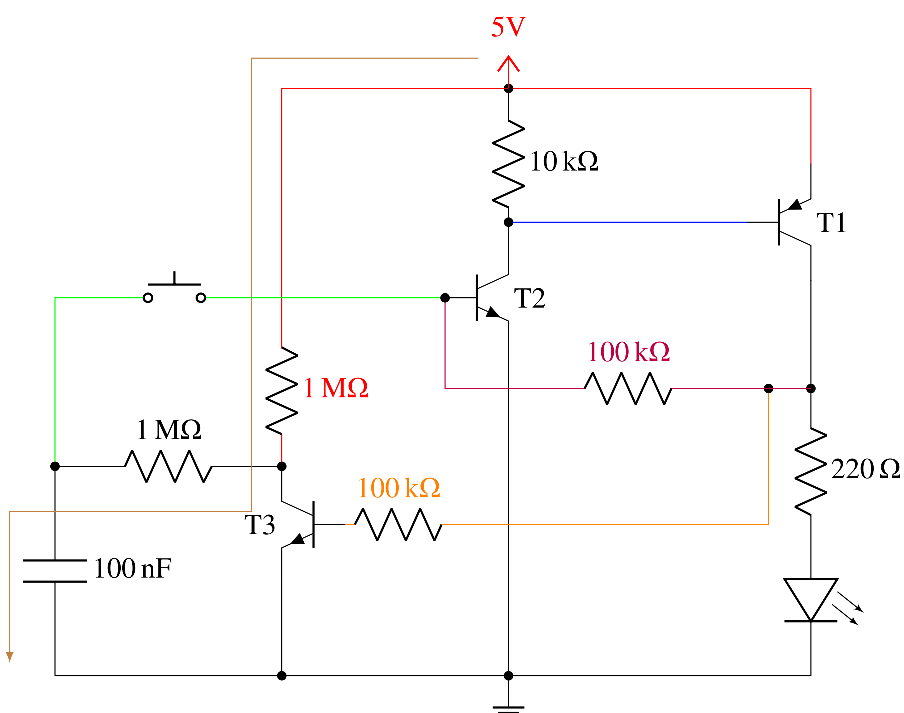


Figure 3.21: Toggle Switch using Transistor - Idle

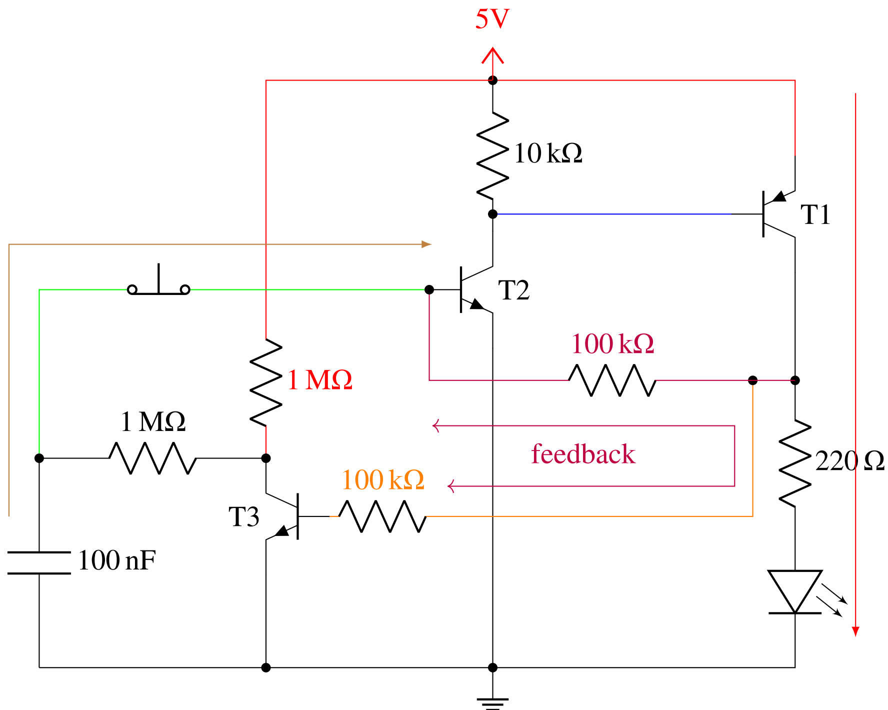


Figure 3.22: Toggle Switch using Transistor - On

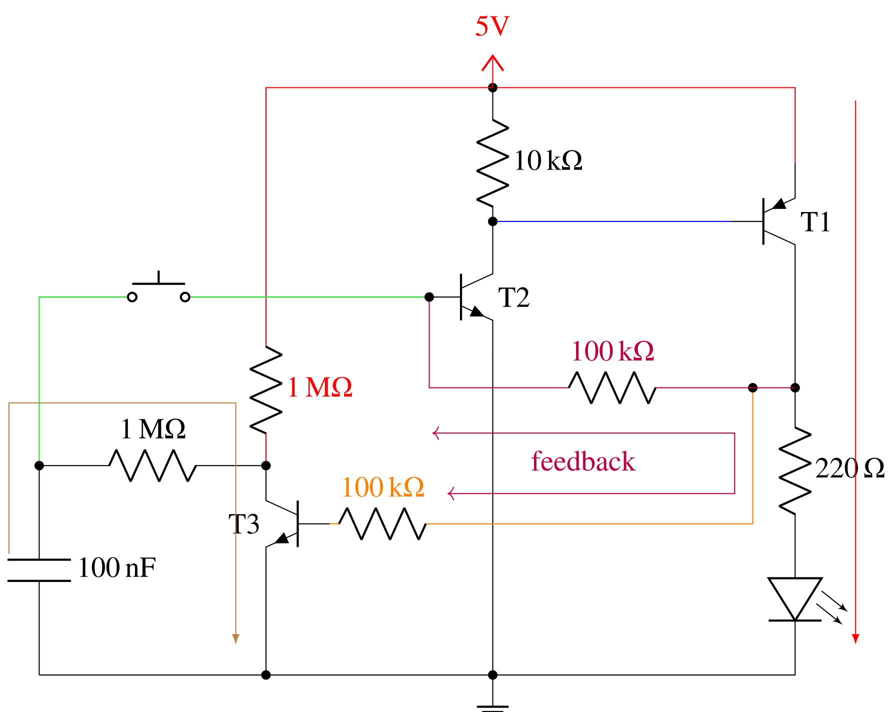


Figure 3.23: Toggle Switch using Transistor - Idle On

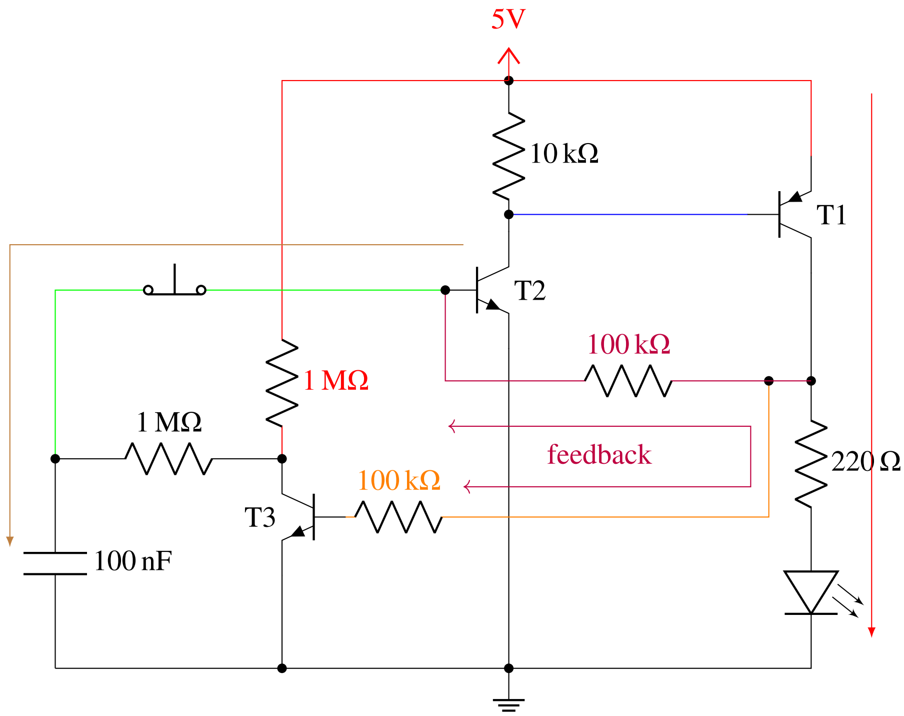


Figure 3.24: Toggle Switch using Transistor - Off

3.8.2 Components Required

1. Breadboard Power Supply × 1
2. 9V Battery × 1
3. 9V Battery Connector × 1
4. Breadboard × 1
5. RGB LED (Common Cathode) × 1
6. 220 Ω × 2
7. 100 kΩ × 2
8. 2N2222 NPN Transistor × 2
9. 10 µF × 2
10. Male-Male jumper wire × 5

3.8.3 Circuit

3.8.4 Circuit Explanation

This circuit operation is similar to that of astable multivibrator. Both the capacitors charge and discharge alternatively and thus turn on and off the transistors, causing the led to light up alternatively or in a flashing manner. By changing the capacitor and resistor values independently we can change the turn on and off time of both the leds.

3.8.5 Circuit Picture

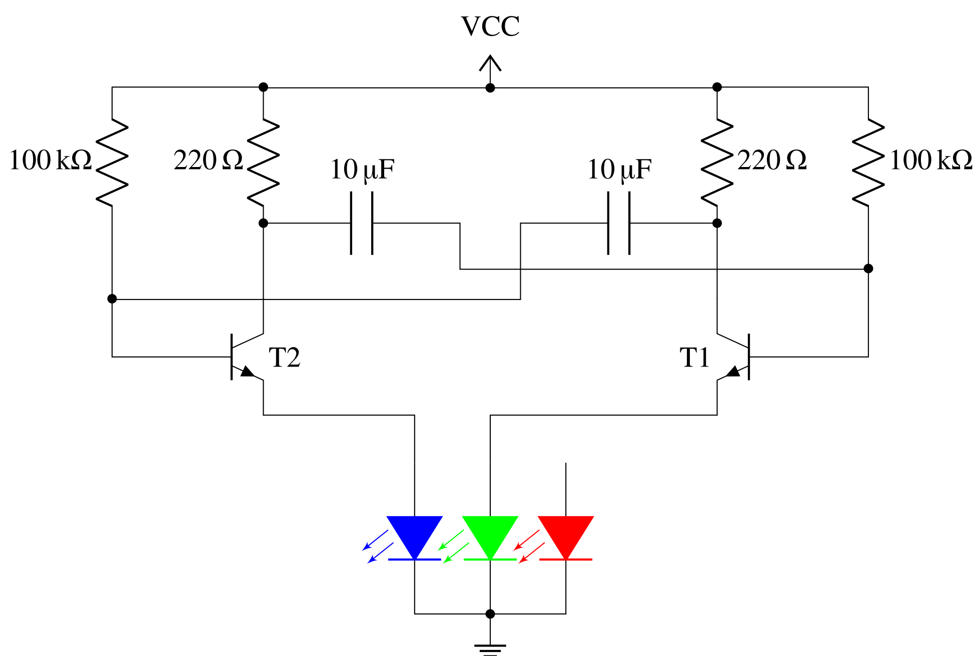
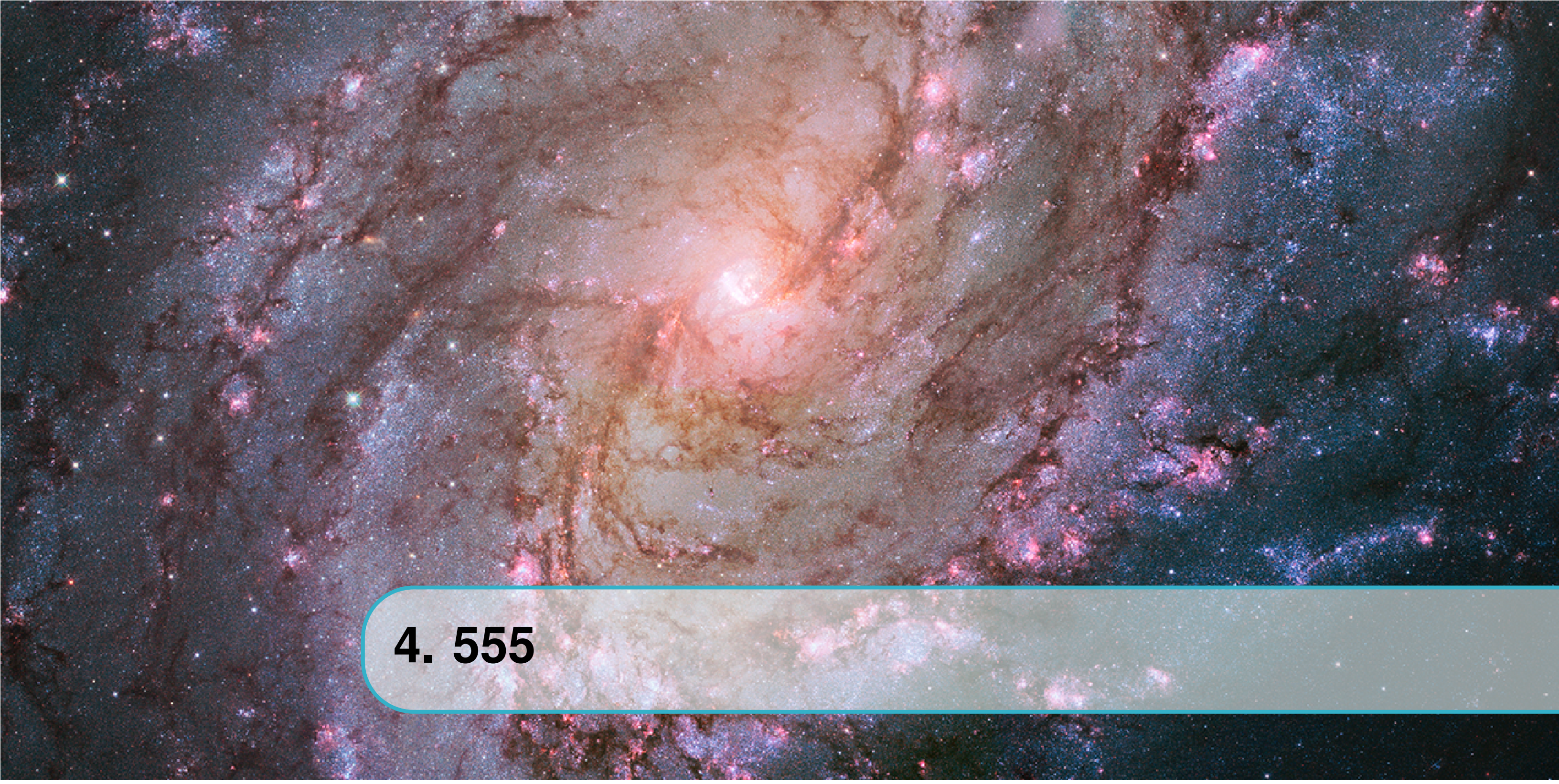


Figure 3.25: Two Color LED Flasher using Transistor



4. 555

4.1 Overview

In this section you'll learn about one of the most famous integrated circuit (IC) in use. Each year millions of 555 Timer ICs are manufactured and sold. It's named 555 because there are three 5 kΩ resistors inside the IC. And as the name suggest, it is a timer circuit. The timing interval is controlled by an external resistor/capacitor network. And by changing the values for the resistor and capacitor the timing duration can be easily varied.

Let's take a look at the pins of 555 Timer IC:

1. **GND - Pin 1** Ground pin of the IC
2. **VCC - Pin 8** Positive supply is connected to this pin, the voltage must be at least 4.5 V and maximum 15 V.
3. **OUT - Pin 3** The output is either low (close to 0 V) or high (close to VCC).
4. **TRG - Pin 2** Trigger is active low, which means when the voltage on this pin drops below one-third of the supply voltage, the output of 555 goes high.
5. **DIS - Pin 7** This pin is used to discharge an external capacitor that works in conjunction with a resistor to control the timing of the 555 IC.
6. **THR - Pin 6** Threshold pin is used to monitor the voltage across the capacitor that's discharged by pin 7. When this voltage reaches two-third of the supply voltage, the output goes low.
7. **CTRL - Pin 5** Control pin can be used to vary the voltage level at the inverting input of the threshold comparator. It is generally connected to ground via 0.01 μF capacitor to eliminate any fluctuation on noise in the operation of the timer.
8. **RST - Pin 4** Reset pin is active low, which means when this pin is momentarily grounded the 555 timer will reset it's state and will stop until it is triggered again.

Figure 4.2 shows the schematic symbol for 555 IC that we will use in this chapter's circuit examples.

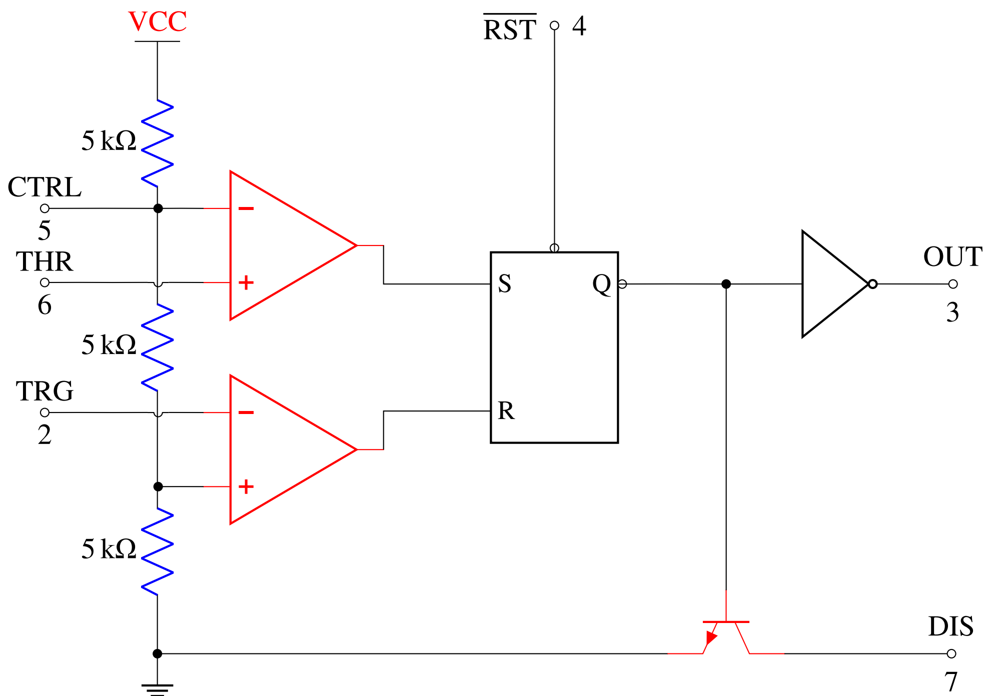


Figure 4.1: 555 Timer Circuit

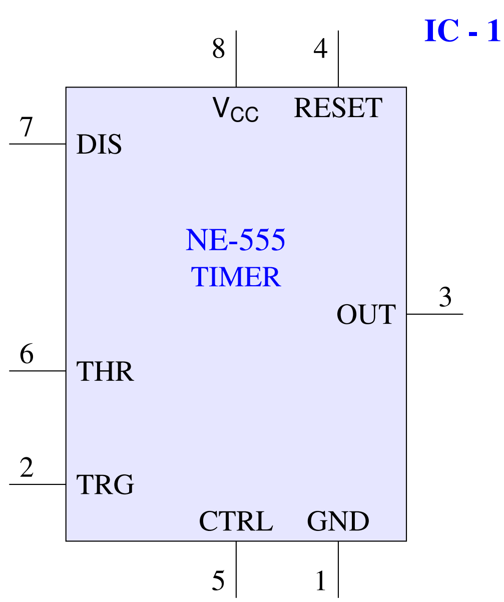
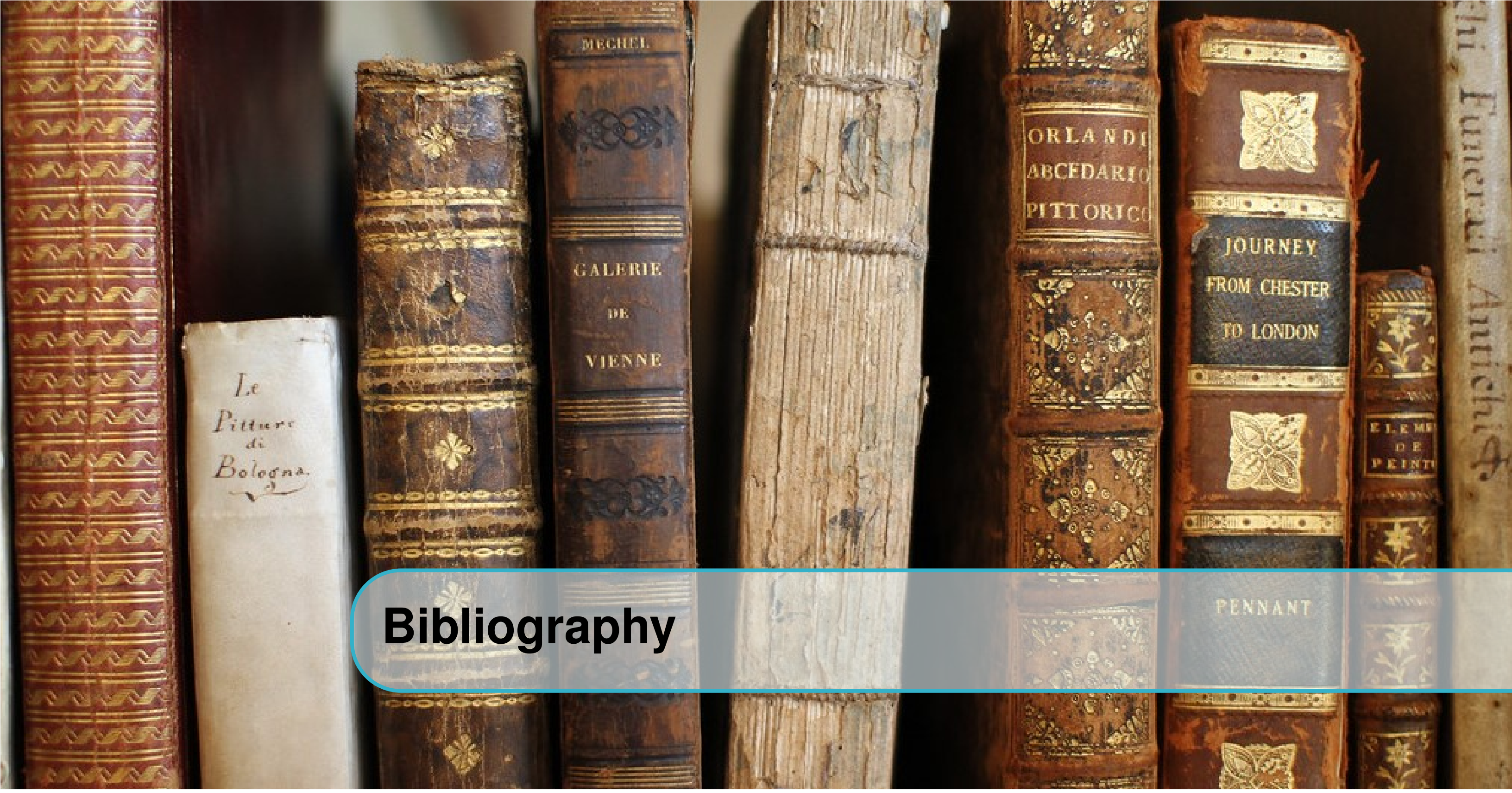


Figure 4.2: 555 Timer Symbol



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