General Purpose Flasher Circuit

By David King

Background

Flashing lights can be found in many locations in our neighbourhoods, from the flashing red light over a stop sign, a yellow warning light located over road divided sign, the warning lights on a tower, warning lights on top of a building, the alternating flashing lights at a railroad grade crossing and more. Everywhere we go there are many warning lights flashing trying to get our attention.

The Purpose

For our miniature worlds that we create, a full layout or a simple module can benefit from some simple details being added. Flashing lights added strategically within a scene can go a long way to making our worlds more believable.

Our Goal

To make this addition to our worlds viable we need to have a simple to build, low in cost, and easy to modify project. The simple 555 flasher can meet these needs. Before we start building the circuits let us look at the components that will be used, some components that can be traded for others to vary the project and the tools needed to complete the project.

Tools

A list of the tools that are needed were e-mailed to the you if you were on the mailing list but I will include the list here as well. Most railroad modelers will have these or vary similar tools.

<u>Equipment and Tools required for you to complete the project.</u>

1. Standard 9 volt battery.
2. Small sheet of plywood or cutting mat to work on. (9" x 12" or larger)
3. Low wattage fine tip soldering iron, round or chisel tip. (pencil type NOT a soldering gun)
4. Soldering stand to hold the tip of the iron off of the table.
5. Small sponge in a dish to clean the tip of the soldering iron.
6. Small needle nose pliers.
7. Small flush cutting pliers or rail nips.
8. Small flat or round files.
9. Fine tip marker, permanent ink.
10. Small slotted screwdriver or jewellers set.

Optional items that may make this easier.

11. Small table top work lamp
12. Magnifying lens. Some work lamps have these built in.
13. Circuit board holder or clamp.
14. Power bar to plug in the soldering iron and work lamp.
15. Items 3, 4 and 5 could be replaced with a soldering station if you have one.

Here are some important items to remember when working with these items.

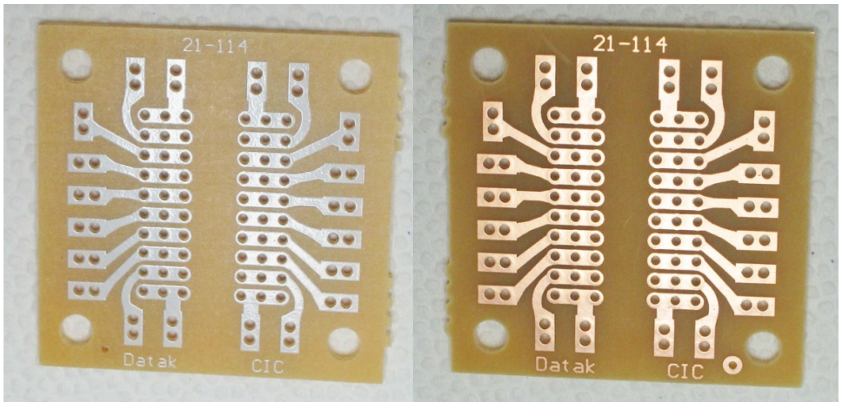
- Don't let anything short across the top of battery.
- Keep the tip of the soldering iron clean by using the wet sponge when the iron is hot.
- Place the soldering in the holder when not using it so the hot end doesn't touch anything.
- When soldering do not breathe in the fumes.
- After working with solder wash your hands before eating any food.
- Wear safety glasses when cutting wires or make sure small trimmings won't go flying.

Components

Quantity	Location	Part Number	Description	Newark Code
1 (half)		MCM 21-4595	Circuit Board	38C9101
1	D1	1N4001	Diode	05R5977
1	IC1	LM555	555 Integrated Chip	97K9426
1			8 Pin DIP Socket	52K3276
1	C1	1µf	50v Electrolytic Capacitor	55T0354
2	R3, R4	470 ohm	1/8 watt Resistor	24R6887
1	R1	10K ohm	1/8 watt Resistor	24R6903
1	R2	100K ohm	1/8 watt Resistor	24R6915
1	R2a	1M ohm	Potentiometer	05N1591
3			2 Pin Terminal	04R6893
2	L1, L2	5mm	Red LED	14N9419
1 (1/10)			9v Battery Lead	31M0724
8		J1 – J8	Jumper	
coil			Solder	

To be able to identify the components that are in the list above let us look at each of these items.

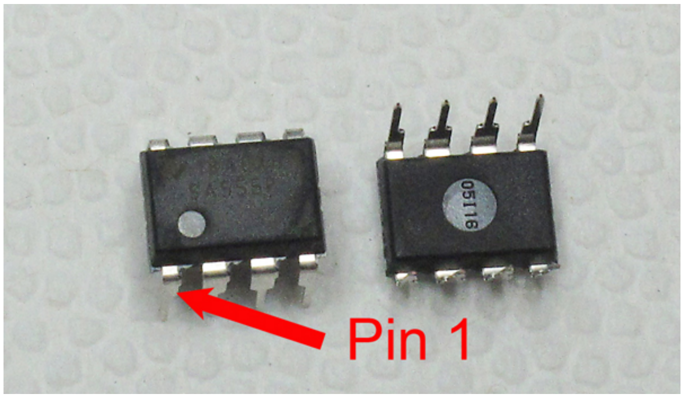
Circuit boards are used to mount the components and connect them together electrically. This is done once you have tested a new circuit using a breadboard first. The breadboard has the advantage of being able to remove, replace or relocate components when testing. If you plan on creating variations of this circuit or try other completely different circuits you may wish to purchase a breadboard. I find these a great asset when experimenting and in the end these will save you many hours of testing. The circuit board we are using for this project is one half of a board. These boards come with two identical halves allow you to break the board in two and being able to use both halves separately. With the pre-defined copper pattern and the pre-drilled holes make building these circuits easy and quick.



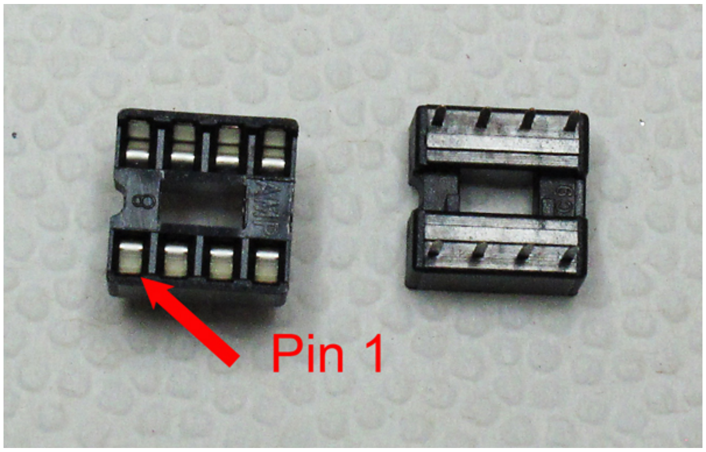
Diodes are used to limit the current flow from the power supply to a single direction. In out circuit we have added a 1N4001 diode in series with the positive lead of the battery. Some components such as the 555 chip and the electrolytic capacitor are polarity sensitive devices and could be damaged if power is applied with reverse polarity. As stated the current will pass in only one direction through the diode and a small voltage drop is measurable across the diode. The voltage drop is 0.7 volts so if you have a power supply of 9.0 volts and you use a diode the voltage getting to the rest of the circuit is (9.0 – 0.7) = 8.3 volts. If the diode is connected in reverse the voltage is blocked and the no damaged has occurred. This diode will block a maximum of 50 volts in the reverse direction so if a higher voltage is needed to be block a diode with a higher reverse voltage could be used. The 1N4001 diode is one in a family of diodes where changing the last number will represent a diode with a different maximum reverse voltage.

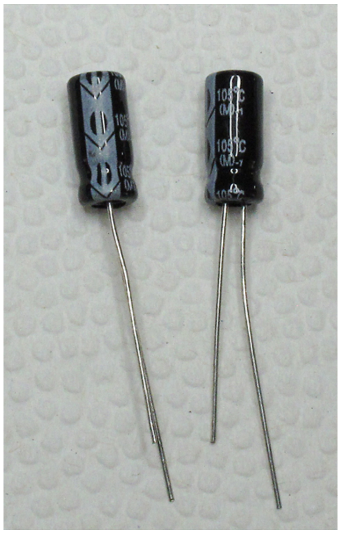
1N4001	1 Amp	50 Volts in Reverse
1N4002	1 Amp	100 Volts in Reverse
1N4003	1 Amp	200 Volts in Reverse
1N4004	1 Amp	400 Volts in Reverse
1N4005	1 Amp	600 Volts in Reverse
1N4006	1 Amp	800 Volts in Reverse
1N4007	1 Amp	1000 Volts in Reverse

The ***LM555 Integrated Circuit*** is the heart of the project. This chip is nothing more than a fancy timer with a number of components connected together inside a single package. This single package allows you to only add the components needed to achieve the results you are looking for. In this project we want a pair of alternating flashing lights that have equal on and off times. With this circuit we can also change the flash rate or frequency of the flashes. This same IC chip can be used to create a strobe circuit with a single light or even a simple PWM (pulse width modulation) throttle. Everything depends on which components you add and what the values of those components are.



DIP Sockets are used to separate the ICs physically from the circuit boards. An IC can be damaged when being soldered to the circuit board as heat is transferred from the iron to the pins on the IC to the internal components of the IC. Soldering the IC directly causes more damage to ICs than anything else I have come across. Using the DIP socket all of the heat is applied from the soldering iron to the socket and no heat makes its way into the IC. The IC is simply pressed into the socket to make the connection. If for some reason the IC does ever fail it can be removed from the socket and a new IC inserted.





Capacitors are energy storage devices that do exactly that, storage energy when a voltage is applied and then discharge the stored energy when the voltage is removed. The capacitor we are using is fairly small in size and will only store a limited amount of energy. This voltage direction of energy is seen by the IC because of the way it is electrically connected. While the capacitor is storing energy the IC turns the output to a low signal causing LED 1 to be on. Once the capacitor is full of energy no more energy is being stored. The IC sees this and triggers the output to a high state and allows the stored energy from the capacitor to enter the IC and turn on LED 2. So the capacitor stores energy and then discharges the energy and keeps doing this until we disconnect the power supply. How long it takes to store the energy is determined by the values of resistors R1, R2 and R2a as well the voltage of the power supply. How much energy is stored is determined by the size of the capacitor being used. We can vary the flash rate by big intervals by using larger or smaller capacitors.

Resistors are very important to this and most electronic circuits. We need to learn how to identify the ohm, resistive, values for each of them. The types of resistors we are using have a colour code that can be used to determine their resistive value.

The resistors we are using for this project are 470 ohms, 10,000 ohms and 100,000 ohms so using the chart we can determine the colour codes. From the edge the bands are;

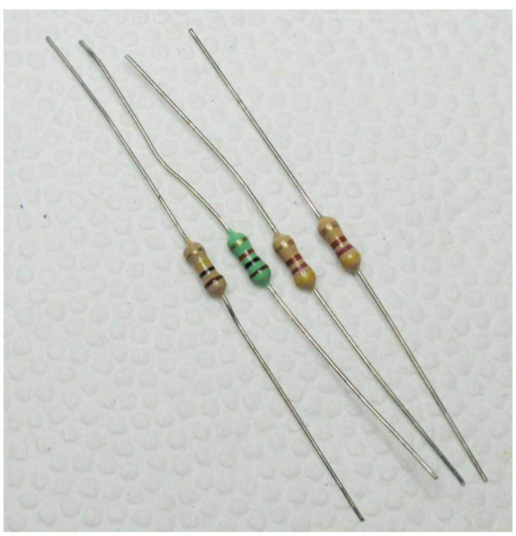
Number, Number, Multiplier, Tolerance

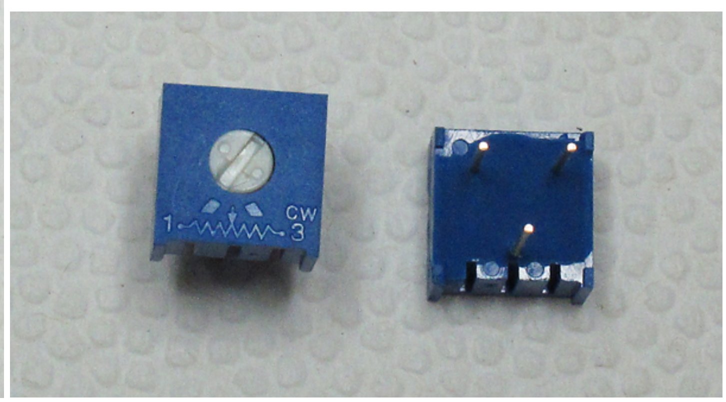
470 ohms = Yellow, Violet, Brown

10,000 ohms = Brown, Black, Orange

100,000 ohms = Brown, Black, Yellow

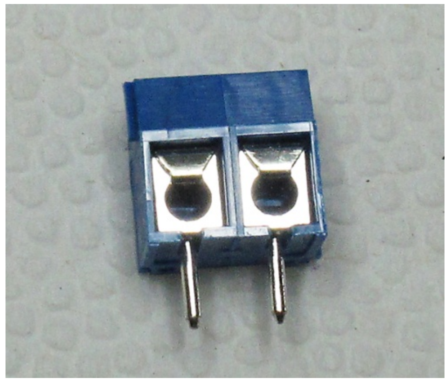
Band Color	Digit	Multiplier	Tolerance
Black	0	1	---
Brown	1	10	±1%
Red	2	100	±2%
Orange	3	1,000	±3%
Yellow	4	10,000	±4%
Green	5	100,000	---
Blue	6	1,000,000	---
Violet	7	10,000,000	---
Gray	8	100,000,000	---
White	9	---	---
Gold	---	0.1	±5%
Silver	---	0.01	±10%
None	---	---	±20%



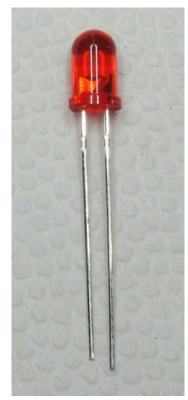


The ***Potentiometer*** used in this project is nothing more than a variable resistor. By using the center pin and one of the outside pins the dial can be rotated (about 300 degrees) which will vary the resistance value between 0 ohms and 1,000,000 ohms. Using this as R2a allows us to vary the flash rate for our LEDs.

Terminal Connectors are used for this project to make it easier to connect the LEDs and the battery. These can be one of the more expensive items that are used on this project. All of these terminal connections make it easier to use and test this circuit. If you decide to build more of these circuits or modified versions of this circuit you could save some money by soldering wires directly to the board and making the connections permanent.



The ***LED***'s used for this project are simple red T1-3/4 or 5mm light emitting diodes. These diodes have a forward current flow of 15 to 20 milliamps. This current flow is common for most LED's but there are ones out there that may have a different current rating. I mentioned a forward current flow as this is when the LED with light up with about 3 volts applied. The reverse current flow should always be zero and at this time the LED would be dark. LED's are also available in different colours such as red, orange, yellow, green, blue, white and many shades of these colours.



The ***Battery Lead*** we are using is of a design to allow us to connect a regular 9 volt battery with snap terminals. This enables us to test or operate the circuits with a voltage that is both convenient and safe to use. The circuit we are building today will operate with a DC voltage range of 6 to 15 volts. Changing the voltage with increase or decrease the brightness of the LED's and varies the flash rate.

The Circuit

The circuit that is being used for this project is referred to as running in Astable Mode. What this means for us is that the output from pin 3 of the LM555 IC will be at voltage (high) about 50% of the time and at 0 volts (low) 50% of the time giving us that alternating flashing light look. We can adjust the frequency or speed of the flashes by altering just 3 components, C1, R1 and R2 (including R2a). Acceptable values for C1 can be from 0.001µf to 10µf. The larger the capacitor value the slower the flash rate will be. The R2 and R2a combination value can vary from 0 ohms to 10 million ohms but most of the time we use a starting value of about 10 x R1. The R1 value can vary from a minimum of 1,000 ohms and as high as 100,000 ohms. The following formula would be used to calculate the flash rate for the circuit.

$$frequency = \frac{1}{0.693\ x\ (\ R2 + R2a + (\ 2\ x\ R1))\ x\ C1}$$

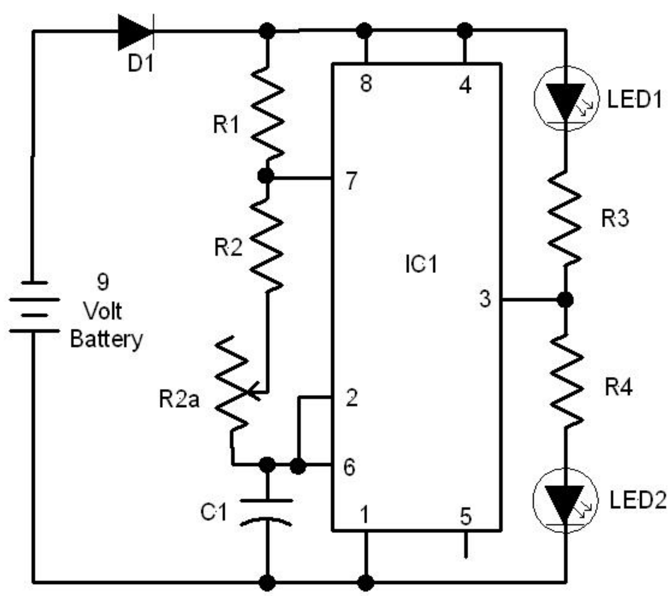
Using the values for our circuit we can calculate the minimum and maximum flash rate for the components in our kits.

$$minimum\ frequency = \frac{1}{0.693\ x\ (\ 100{,}000 + 1{,}000{,}000 + (\ 2\ x\ 10{,}000))\ x\ 0.000001}$$

$$minimum\ frequency = \ 1.29\ Hertz$$

$$maximum\ frequency = \frac{1}{0.693\ x\ (\ 100{,}000 + 0 + (\ 2\ x\ 10{,}000))\ x\ 0.000001}$$

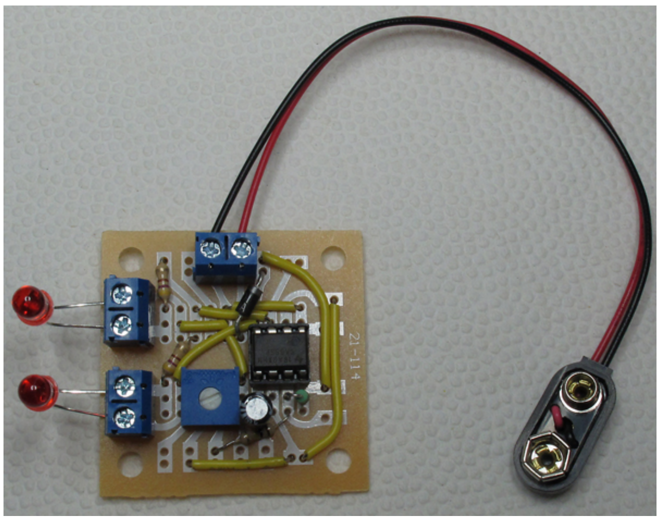
$$maximum\ frequency = \ 12.03\ Hertz$$

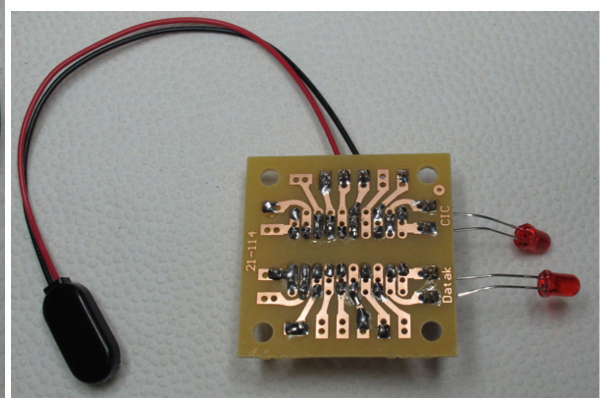


The basic operation of the circuit is fairly straight forward and I will it explain it here. When the power supply is first connected a current flow will pass through the resistors R2a, R2 and R1 allowing the capacitor C1 to charge up (store energy). Once the voltage in the capacitor is about $2/3^{rd}$ of the supply voltage the LM555 IC is triggered and at this moment the capacitor starts to release the voltage stored into the LM555 IC which sets to the output of the LM555 IC to high. Once the voltage in the capacitor has dropped to about $1/3^{rd}$ of the supply voltage the LM555 IC is reset and the output is set to low. The capacitor starts to store energy again and the cycle just keeps repeating.

The Assembly

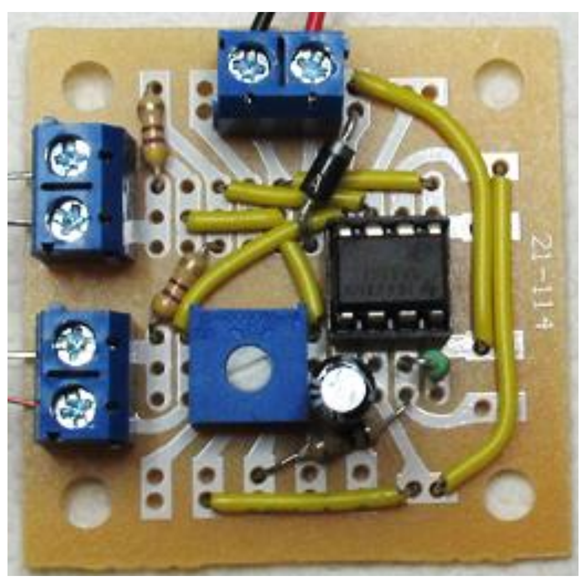
Let us start by getting ourselves organized by looking at the top and the bottom of both the bare circuit board and the finished circuit boards with all of the components mounted.





Now the assembling of the boards can be done. It is usually best to start with the items that need other parts fit around them first then move onto the balance of the components starting with the smallest and working your way to the largest. This is not a strict rule but I will give a list of steps that I would use for assembling this project.

1. 8 Pin DIP Socket
2. Potentiometer
3. Resistors R1, R2, R3 and R4
4. Capacitor C1, watch polarity
5. Diode D1, watch polarity
6. 2 Pin Terminals (3)
7. Jumpers
8. LM555
9. LED L1, L2
10. Trim excess leads on the bottom of the board
11. Battery Lead
12. Check everything
13. Attach 9 volt Battery

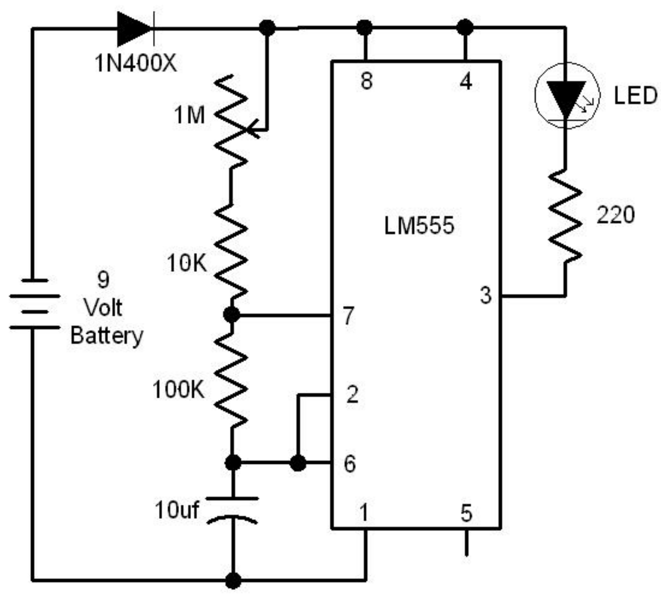


The LED's should start flashing at this point and you can adjust the potentiometer and you should see the flash rate change. If this is all working to your satisfaction you should now take a moment to label the terminals and add any other notes to the board using your fine tip marker.

Now you can sit back in the glowing of your red flashing LED's and admire your work.

Create a Strobe Circuit

The 555 timer chip can be used to simulate other functions such as strobe light. A strobe would be located on a tall structure such as a radio tower, tall building, navigation buoy and other locations. The circuit is similar but not identical. Here is the schematic drawing for an adjustable strobe light.



The resistance values are all in ohms. This circuit only uses 1 LED and the resistor is a smaller value for the LED, also the capacitor is a higher value so that more energy can be stored to flash the LED brightly and with a short duration then used in the alternating flasher circuit.

Resources

Information on the Internet;

wild-bohemiam.com/electronics/flasher.html

www.simplecircuitdiagram.com/2009/05/20/led-flasher-circuit-using-555-ic/

Component Suppliers;

Newark Canada, canada.newark.com

Sayal, www.sayal.com