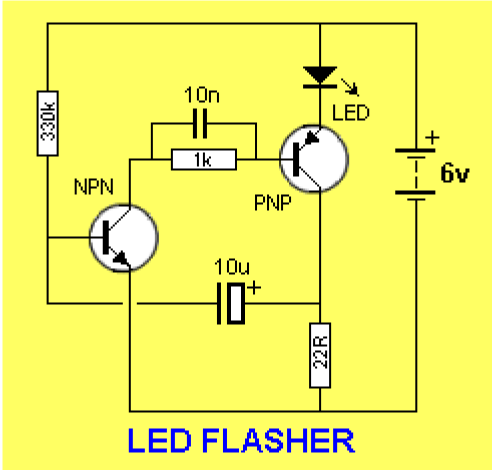
THE LED FLASHER K-LF1 $3.10

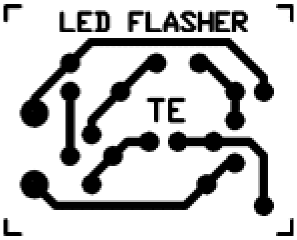
This is a very simple project using a printed circuit board and 8 components. It will flash an ordinary 3mm or 5mm (1/8" or 1/4") LED at a rate of about one flash per second.

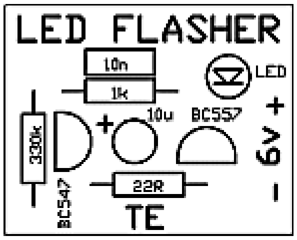


PARTS LIST

1 - 22R
1 - 1k
1 - 330k
1 - 10n
1 - 10u 16v electrolytic
1 - BC 547 - NPN
1 - BC 557 - PNP
1 - 1/4" (5mm) red LED
1 - LED FLASHER PC

A complete kit for this project is available from Talking Electronics. (or: Talking Electronics) The circuit has a couple of advantages over a flashing LED you can buy as an individual item. It pulses it with a higher peak current to give a brighter illumination and consumes less average current. This means it will work for a long time on an almost flat battery and cost nothing to run. It can be used for battery equipment to indicate the power is ON or as an ALARM ON indicator. You can use a super-bright LED and get a really bright flash, or an ordinary green, orange or yellow LED to get something better than a flashing red LED.





The LED Flasher PC board

THE CIRCUIT

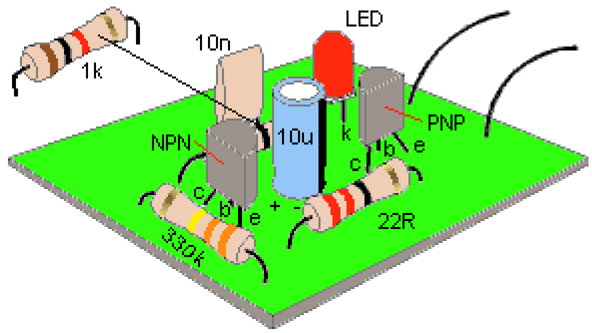
This circuit works on the basis of a high-gain amplifier being driven into saturation (fully turned-on), firstly by the very small amount of current delivered by a high-value resistor and then from energy stored in an electrolytic.

When the energy from the electrolytic has been fully delivered, it cannot keep the amplifier fully turned on and it turns off slightly. This action removes the "turn-on" effect from the electrolytic and the amplifier begins to turn off. This action continues until the amplifier is fully turned off and is kept in the off state while the electrolytic begins to charge. The off-state is very long and the on-state is very short. This is how the LED produces a brief flash.

Here is the technical description of the operation of the circuit:

When the supply is connected, both transistors are off and the electrolytic charges via the 330k resistor and 22R. When the voltage on the base of Q1 rises to about .6v, the transistor begins to turn on and the resistance between its collector-emitter terminals is reduced. This allows current to flow in the collector-emitter circuit and Q2 is turned on via the 1k resistor. The 10n reduces the effect (the resistance) of the 1k resistor. Q2 conducts and the LED is illuminated. The current through the LED is limited by the 22R resistor and at this point in the cycle a voltage is developed across the 22R. The negative end of the electrolytic is `jacked up' by this voltage and the positive end pushes the charge on the electrolytic into the base of Q1 to turn it on even harder. In a very short time all the energy in the electrolytic has been delivered to Q1 and it cannot hold Q1 ON any longer. The transistor turns off slightly and this has the effect of turning off Q2 a small amount. The LED begins to turn off and the voltage across the 22R reduces. The negative lead of the electro drops a small amount and so does the positive lead. This action continues around the circuit until Q1 is fully turned off. This turns off Q2 and the LED is extinguished. The cycle starts again by the 10u charging. The charge-time is considerably longer than the discharge time and this gives the LED a very brief flash.

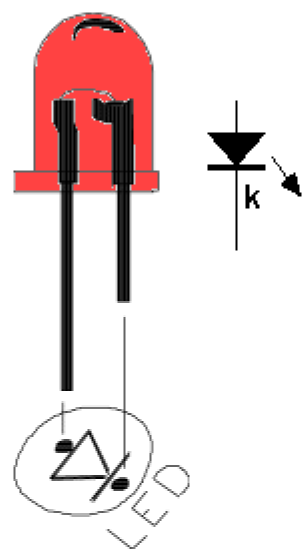
CONSTRUCTION
All the parts mount on a small PC board and it has an overlay (all our boards have overlays) as shown in the diagram below:



Mounting the components

This makes construction very easy and all you have to do is bend the leads of the components so they pass down the holes in the board. The resistor leads are bent to 90° and are pushed all the way down so they rest on the board. The leads are then bent slightly to hold them in place while the leads are soldered. Fit the three resistors in this way and you are ready for the two capacitors. The 10n can be fitted either way around but the 10u electrolytic must be fitted so the positive lead goes down the hole marked with a "+." The positive lead is the shorter of the two leads and the negative lead is marked on the side of the body of the component with a " —"
The two transistors are next and it is important not to mistake the PNP for the NPN. They both look identical. Check with the parts list for the types you have been given in the kit. Fit the leads down the holes so that the transistor is 2mm (1/8") from the board and bend the leads slightly so it does not fall out when the board is turned over and soldered. Finally the LED is fitted to the board.

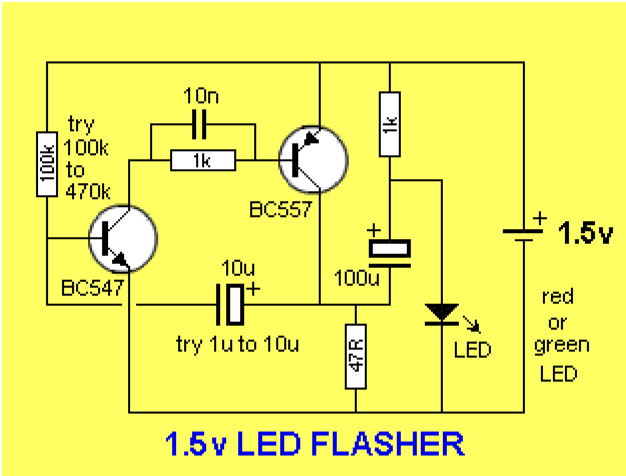
Fitting the LED



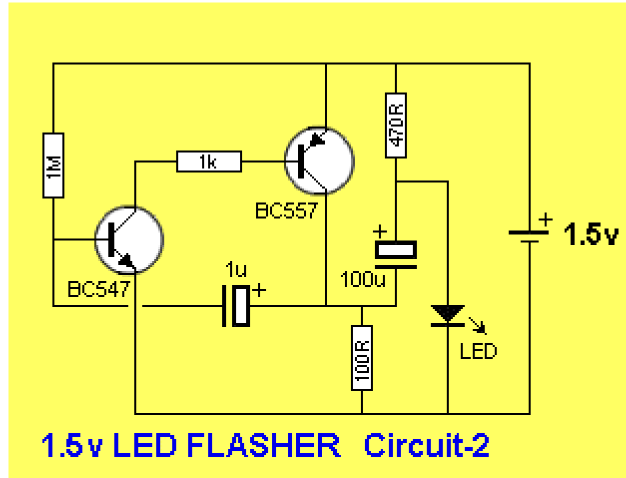
Refer to the diagram above for the identification of the cathode lead. Keep the LED above the board so it can be clearly seen. Solder a short length of red and black wire to the board and to 4 cells to complete the project. You can use almost any old cells for the 6v supply and let the LED FLASHER use them up completely.

1.5v LED FLASHER
The next circuit flashes a LED and uses a 1.5v supply. The LED does not turn on via the 1k resistor because the characteristic voltage of a LED is between 1.7v and 2.3v, (depending on the colour). It turns on when the 100u is "jacked up" by the collector of the BC557.
The circuit is a charge-pump design. This is where a capacitor (electrolytic) is allowed to charge and is then raised higher and allowed to discharge into a load. The load sees a voltage that can be higher than the supply.
This is the case with this circuit.
The two transistors operate as a high-gain amplifier with the output being the 47R. The cycle starts with the first transistor being turned on via the 100k. This action also charges the 10u until 0.75v

appears on the base of the transistor.
This turns on the second transistor and the negative end of the 10u is raised when the BC557 turns on. This raises the positive end of the 10u and the first transistor turns on even more. This action continues until the first transistor is fully turned on and the BC557 is fully turned on. The voltage across the collector-emitter terminals of the BC557 will be small and about 1v will appear across the 47R. This voltage "jacks up" the 100u and since it is fully charged via the 1k resistor, it will present a voltage of about 2.5v to the LED. Any voltage over 1.7v will turn on a red LED and a green LED will turn on at 2.3v. The energy in the 100u is now passed to the LED to illuminate it.
The flash is very brief due to the operation of the two-transistor amplifier. Although the energy in the 100u will produce a brief flash, the timing of the two transistor circuit is even faster and it provides the duration.
The actual duration of the flash depends on the time the two transistor amplifier can be in a fully turned-on state. This is governed by the charging of the 10u electrolytic.
When the base of the first transistor sees 0.7v, the two transistors start to turn on by a process called REGENERATION. This is explained further in our article: REGENERATION, in Circuit Tricks.
Regeneration is a condition where a circuit turns on more and more without any external assistance. And this is what happens in this circuit.
The 10u is "jacked up" by the BC557 turning on and it delivers a current to the base of the BC547. Initially it delivers its energy to the base but very soon is is higher than 0.7v and it is fully discharged. The electrolytic now starts to charge in the reverse direction and this process continues to keep the BC 547 turned on. It charges very quickly in the reverse direction as the charging path is the emitter-collector junction of the BC557 and base-emitter junction of the BC547. When it is nearly charged, the current-flow reduces and this turns off the BC547 very slightly. This turns off the BC557 slightly and the 10u is "lowered." This puts less "turn-on" on the BC547 and the two transistors start to turn off very quickly.
The 10u is now charged in the reverse direction and a negative voltage is presented to the base of the first transistor. This voltage is is gradually reduced by the electrolytic charging via the 100k and that's why the circuit has a very long off cycle.
Two circuits are shown. They use slightly different components to produce the same results.
The only critical value is the 100R. The circuit will not work with a value higher than about 150R. It needs a low value so the BC557 transistor is turned on to a high level before a voltage is developed across the 100R. If the value is too high, a voltage will be developed across this resistor when the BC557 is turned on a small amount and this voltage will be sent to the BC547 to turn it on too. The two transistor will sit in a conditions that they are both turned on and the circuit will freeze.
The circuit has to function such that the BC547 is turned on to its maximum when the electrolytic is pulled HIGH. This transistor will now be turned on by the current delivered by the 100k (or 1M) plus the charging current of the electrolytic. As the electrolytic charges, the current into the base of the BC547 will fall and the transistor will turn off slightly. This slight turn-off must be passed to the BC557 to turn it off slightly too and lower the "turn-on" effect of the electrolytic. It is the 47R (or 100R) that is pulling the electrolytic down to the 0v rail and if this resistor does not have sufficient "pull-down" effect, the cycle will not continue. When this resistor has a low value, the BC557 must deliver a high current and it must be turned on via a proportionally high current into the base. This current comes from the BC547 and it needs a proportionally high current into its base to provide this condition. We are only talking about fractions of milliamps and microamps, but these conditions must be met for the circuit to work.



1.5v LED FLASHER

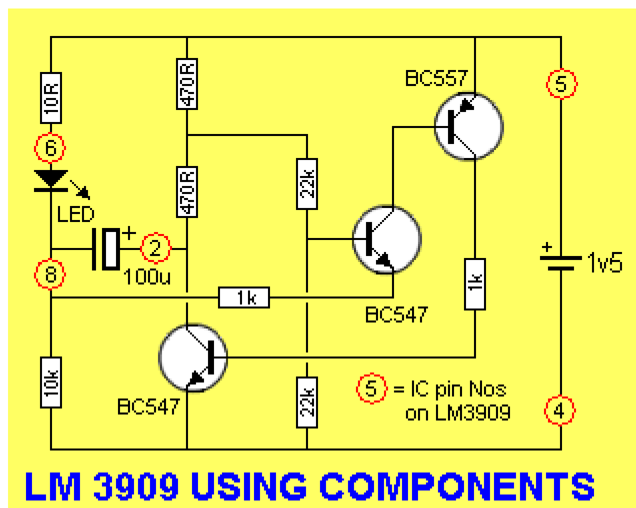


1.5v LED FLASHER Circuit-2

The next circuit replaces a flasher chip. These are no longer available but many circuits use them. Here's the alternative:

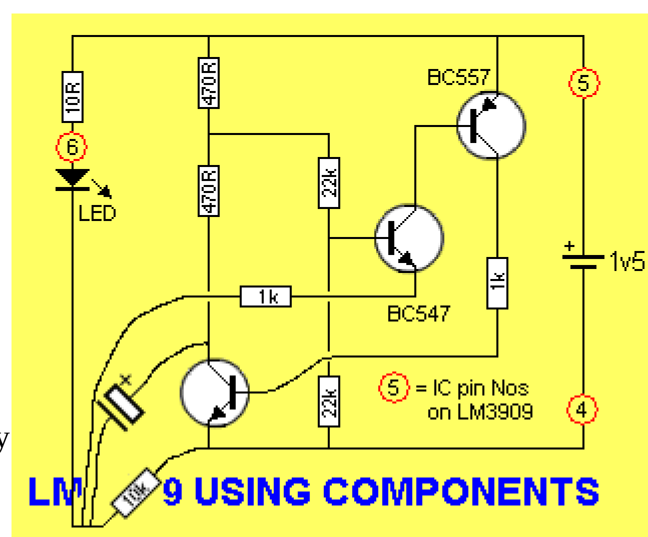
THE LM 3090 FLASHER CHIP

The LM3909 flasher chip has been discontinued for a number of years and the following circuit can take its place:



LM 3909 USING COMPONENTS

When power is applied, the 100u is uncharged and zero voltage is across its terminals.
It is charged via the two 470R resistors and 10k resistor and these three resistors create a voltage divider across the 1.5v supply such that the voltage on the top of the 10k resistor is about 1.4v
This makes the emitter of the middle transistor about 1.4v and thus it is not turned on.
The BC 557 is also not turned on and the first transistor is also not turned on.
As the 100u charges, the voltage across the 10k resistor decreases and the middle transistor begins to turn on.
This turns on the BC 557 and the first transistor begins to turn on very quickly and very soon it is fully turned on.
This effect brings the positive of the 100u towards the 0v rail and the best way to see how the voltage across the electrolytic adds to the 1.5v supply to produce a voltage above 2v, is to refer to the following diagram:

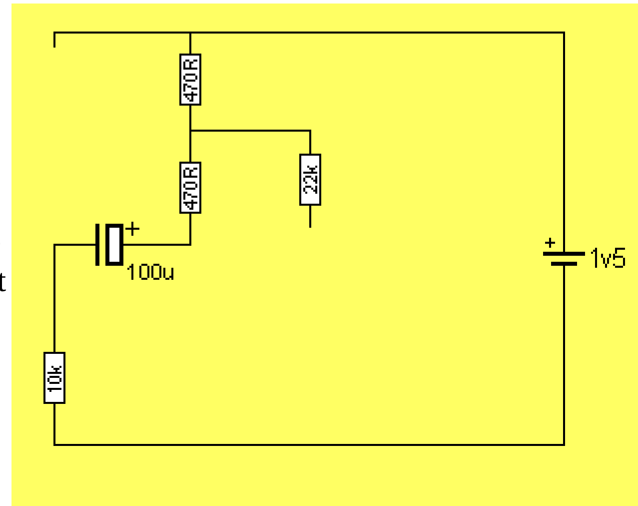


The voltage on the top of the 10k resistor actually goes about 1v below the 0v rail and makes the 10k dip down as shown in the diagram above.

There is one very important requirement when designing an oscillator.
The timing capacitor must be discharged.
In other words the circuit must create a state that discharges the capacitor and remains in that state until the capacitor is fully or almost fully discharged. If it is not discharged, it cannot be charged again!

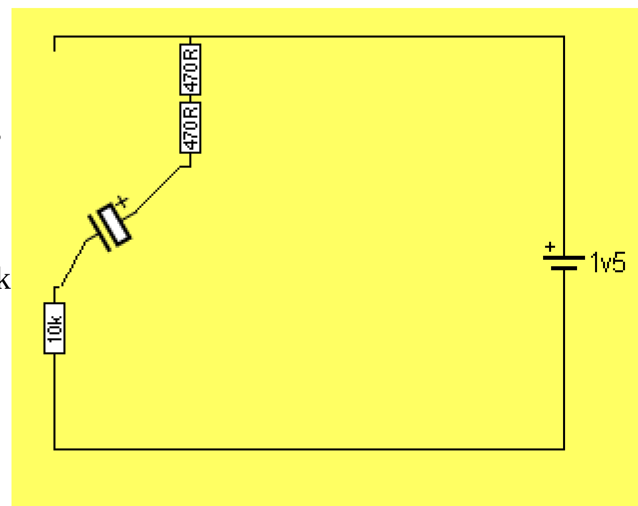
HOW THE CIRCUIT WORKS

So, let's start at the beginning:
The analysis of the circuit starts at the base of the middle transistor. The voltage at this point is approx half the supply voltage when the circuit is turned on as no transistor is conducting and the electrolytic is discharged.
Since the voltage on the circuit is only 1.5v, the LED is a very high impedance at this voltage as it does not activate until the voltage is above its characteristic voltage of approx 1.7v.
The only components that are effectively "in circuit" are shown in the following diagram, and the electrolytic begins to charge:



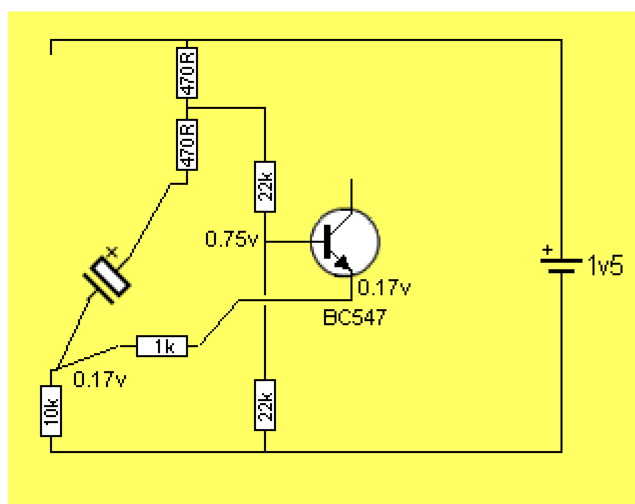
Charging the electrolytic

When the circuit is first tuned on, the electrolytic has zero voltage across it and the 10k and 470R resistors are in series. About 0.13v is across the two 470R resistors and 1.37v is across the 10k resistor.
As the electrolytic charges, the voltage across the 10k reduces.
The following animation shows how the voltage across the 10k changes:



The electrolytic charging

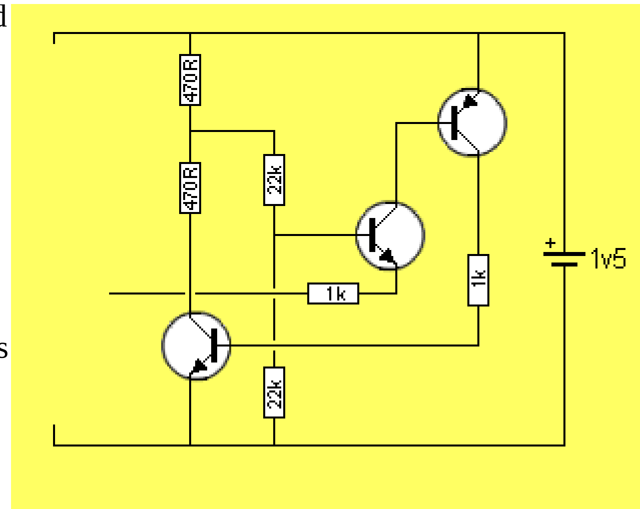
As the electrolytic charges to about 1.2v, the middle transistor begins to turn ON as the voltage on the top of the 10k resistor drops from 1.37v to about .17v.



The voltage on the transistor turns it ON

The voltage between the base and emitter of the transistor is 0.58v and the transistor begins to turn on. The transistor used in the prototype turned on at 0.38v and this is the secret behind the circuit operating down to a supply voltage of about 0.8v

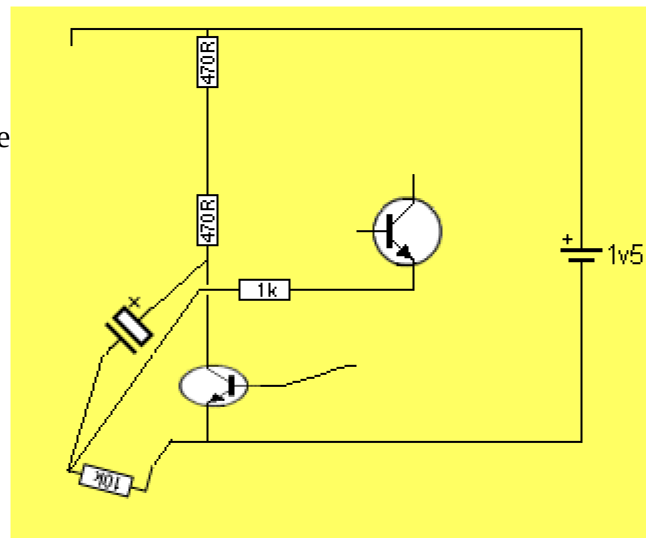
In the diagram below, the middle transistor is turned on slightly and this turns on the third transistor. The third transistor turns on the first transistor.



All the transistors are turned ON

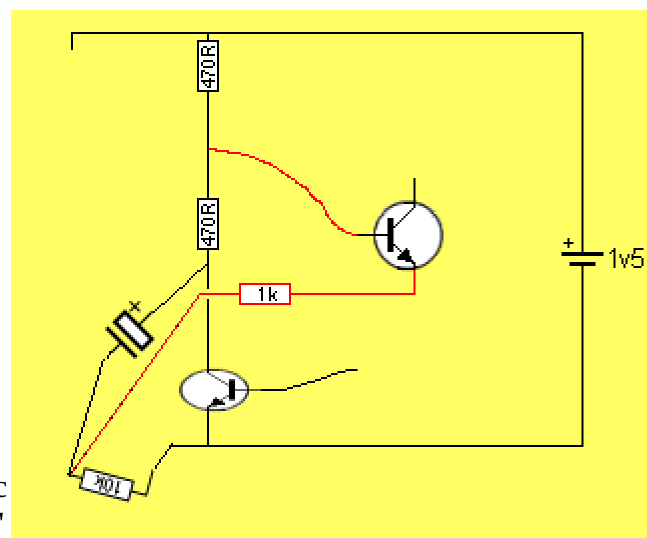
The first transistor pulls the lower 470R resistor towards the 0v rail and the positive end of the electrolytic. The negative end is also pulled down as shown in the following animation:

The electrolytic getting pulled to the 0v rail



Here is the clever part:
As the electrolytic charges, the emitter of the middle transistor is being pulled down and the base is being pulled down at half the rate. This means the voltage between the base and emitter is widening and the transistor is being turned on MORE.
This is called REGENERATIVE ACTION. The action continues until the first transistor is fully turned ON.

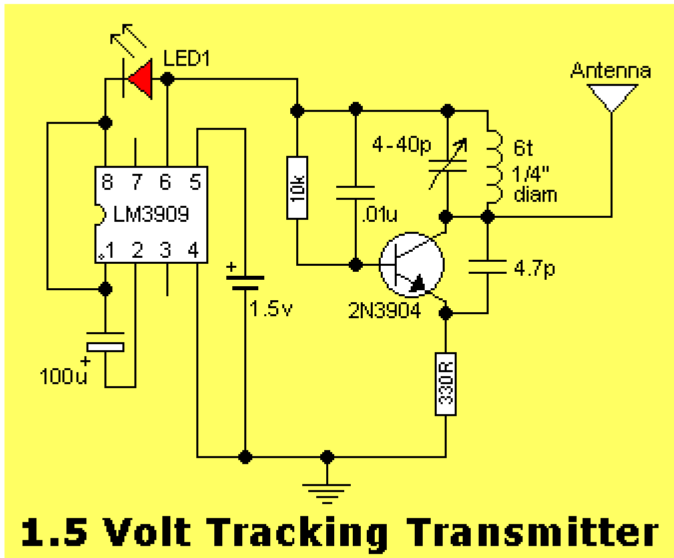
The voltage between base and emitter increases



Here is a circuit using the LM 3909:

The FM transmitter section above operates continually from the 1.5v and the "flasher chip" provides a slight interruption to create a "beep" on the airwaves which is really the transmitter shifting off frequency and the carrier being lost. It does not use the "jacked-up voltage" feature of the chip.
If a load other than a LED is connected to the circuit, the electrolytic will not charge.
The circuit relies on the fact that the LED is an "open-circuit" when the supply voltage is below the characteristic voltage of the LED (approx 1.7v).
The circuit, however, can be used as an oscillator to drive other loads providing the LED and electrolytic are retained as they provide the "timing component" and "load."
This makes the circuit very wasteful with current if required for other applications.
There are other circuits more suitable, as you will see.

Next, we have the astable multivibrator, or FLIP FLOP [pronounced (h)ay stable] - meaning it has unstable states. In this case, two unstable states.



1.5 Volt Tracking Transmitter