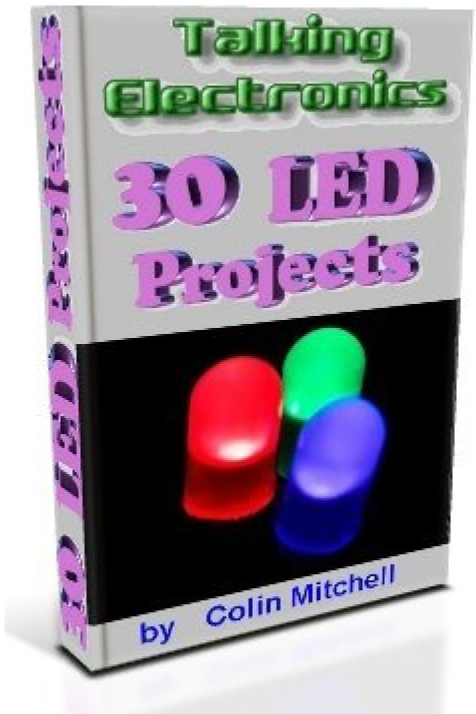

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50 - 555 Circuits
1 - 100 Transistor Circuits **and:** **101 - 200 Transistor Circuits**
100 IC Circuits

For a list of every electronic symbol, see: Circuit Symbols.

For more articles and projects for the hobbyist: **see TALKING ELECTRONICS WEBSITE**

email Colin Mitchell: talking@tpg.com.au

CONTENTS

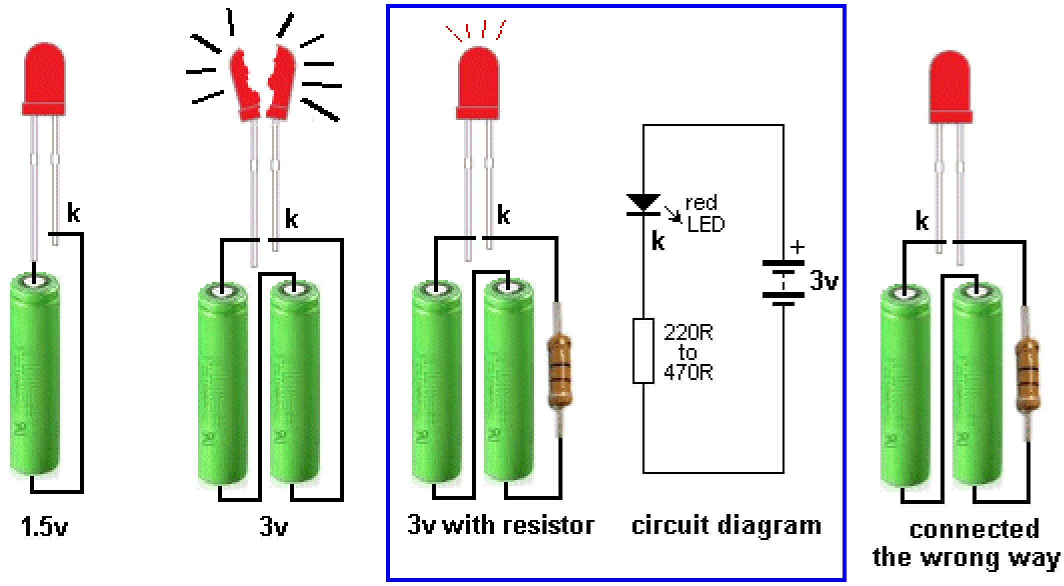
INTRODUCTION

This e-book covers the Light Emitting Diode.

The LED (Light Emitting Diode) is the modern-day equivalent to the light-globe.
It has changed from a dimly-glowing indicator to one that is too-bright to look at.
However it is entirely different to a "globe."
A globe is an electrical device consisting of a glowing wire while a LED is an electronic device.
A LED is more efficient, produces less heat and must be "driven" correctly to prevent it being damaged.
This eBook shows you how to connect a LED to a circuit plus a number of projects using LEDs.
It's simple to use a LED - once you know how.

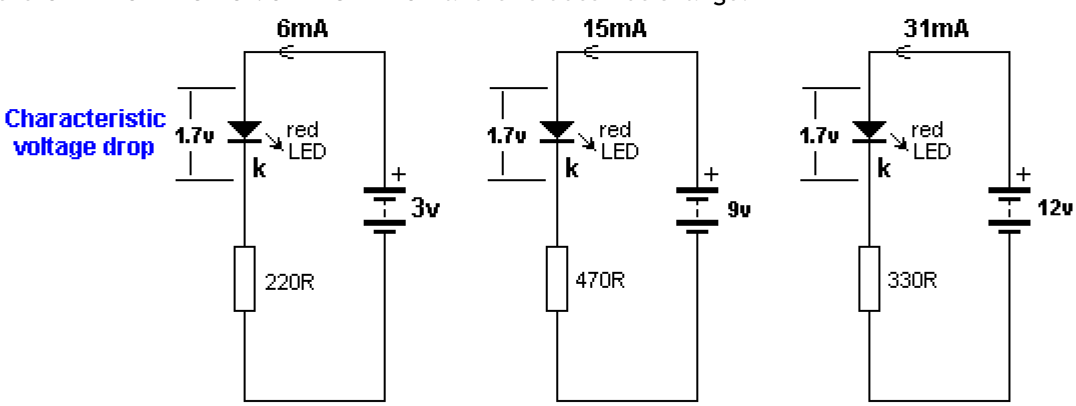
CONNECTING A LED

A LED must be connected around the correct way in a circuit and it must have a resistor to limit the current.
The LED in the first diagram does not illuminate because a red LED requires 1.7v and the cell only supplies 1.5v. The LED in the second diagram is damaged because it requires 1.7v and the two cells supply 3v. A resistor is needed to limit the current to about 25mA and also the voltage to 1.7v, as shown in the third diagram. The fourth diagram is the circuit for layout #3 showing the symbol for the LED, resistor and battery and how the three are connected. The LED in the fifth diagram does not work because it is around the wrong way.

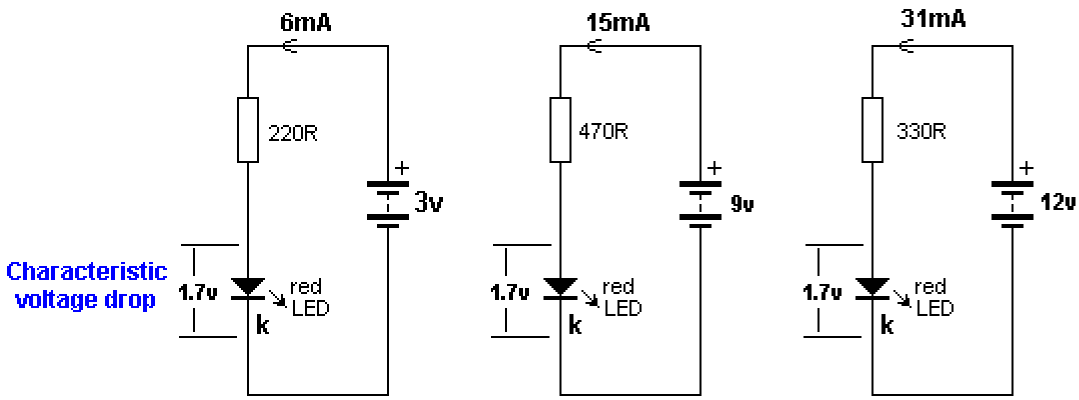


CHARACTERISTIC VOLTAGE DROP

When a LED is connected around the correct way in a circuit it develops a voltage across it called the CHARACTERISTIC VOLTAGE DROP.
A LED must be supplied with a voltage that is higher than its "CHARACTERISTIC VOLTAGE" via a resistor - called a VOLTAGE DROPPING RESISTOR or CURRENT LIMITING RESISTOR - so the LED will operate correctly and provide at least 10,000 to 50,000 hours of illumination.
A LED works like this: A LED and resistor are placed in series and connected to a voltage.
As the voltage rises from 0v, nothing happens until the voltage reaches about 1.7v. At this voltage a red LED just starts to glow. As the voltage increases, the voltage across the LED remains at 1.7v but the current through the LED increases and it gets brighter.
We now turn our attention to the current though the LED. As the current increases to 5mA, 10mA, 15mA, 20mA the brightness will increase and at 25mA, it will be a maximum. Increasing the supply voltage will simply change the colour of the LED slightly but the crystal inside the LED will start to overheat and this will reduce the life considerably.
This is just a simple example as each LED has a different CHARACTERISTIC VOLTAGE DROP and a different maximum current.
In the diagram below we see a LED on a 3v supply, 9v supply and 12v supply. The current-limiting resistors are different and the first circuit takes 6mA, the second takes 15mA and the third takes 31mA. But the voltage across the red LED is the same in all cases. This is because the LED creates the CHARACTERISTIC VOLTAGE DROP and this does not change.

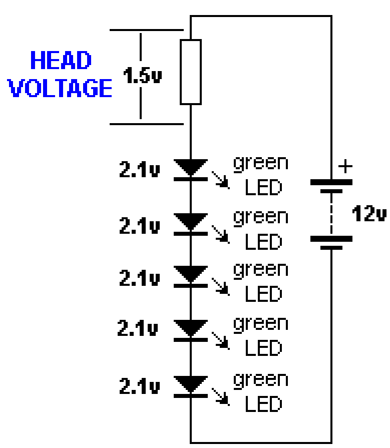


It does not matter if the resistor is connected above or below the LED. The circuits are the SAME in operation:



HEAD VOLTAGE

Now we turn our attention to the resistor.
As the supply-voltage increases, the voltage across the LED will be constant at 1.7v (for a red LED) and the excess voltage will be dropped across the resistor. The supply can be any voltage from 2v to 12v or more.
In this case, the resistor will drop 0.3v to 10.3v.
This is called **HEAD VOLTAGE - or HEAD-ROOM.**
The following diagram shows **HEAD VOLTAGE:**
The voltage dropped across this resistor, combined with the current, constitutes wasted energy and should be kept to a minimum, but a small HEAD VOLTAGE is not advisable (such as 0.5v). The head voltage should be a minimum of 1.5v - and this only applies if the supply is fixed.
The head voltage depends on the supply voltage. If the supply is fixed and guaranteed not to increase or fall, the head voltage can be small (1.5v minimum).

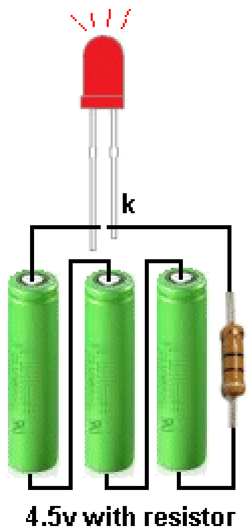


But most supplies are derived from batteries and the voltage will drop as the cells are used.
Here is an example of a problem:
Supply voltage: 12v
7 red LEDs in series = 11.9v
Dropper resistor = 0.1v
As soon as the supply drops to 11.8v, no LEDs will be illuminated.
Example 2:
Supply voltage 12v
5 green LEDs in series @ 2.1v = 10.5v
Dropper resistor = 1.5v
The battery voltage can drop to 10.5v
But let's look at the situation more closely.
Suppose the current @ 12v = 25mA.
As the voltage drops, the current will drop.
At 11.5v, the current will be 17mA
At 11v, the current will be 9mA
At 10.5v, the current will be zero

You can see the workable supply drop is only about 1v.
Many batteries drop 1v and still have over 80% of their energy remaining. That's why you need to design your circuit to have a large **HEAD VOLTAGE.**

TESTING A LED

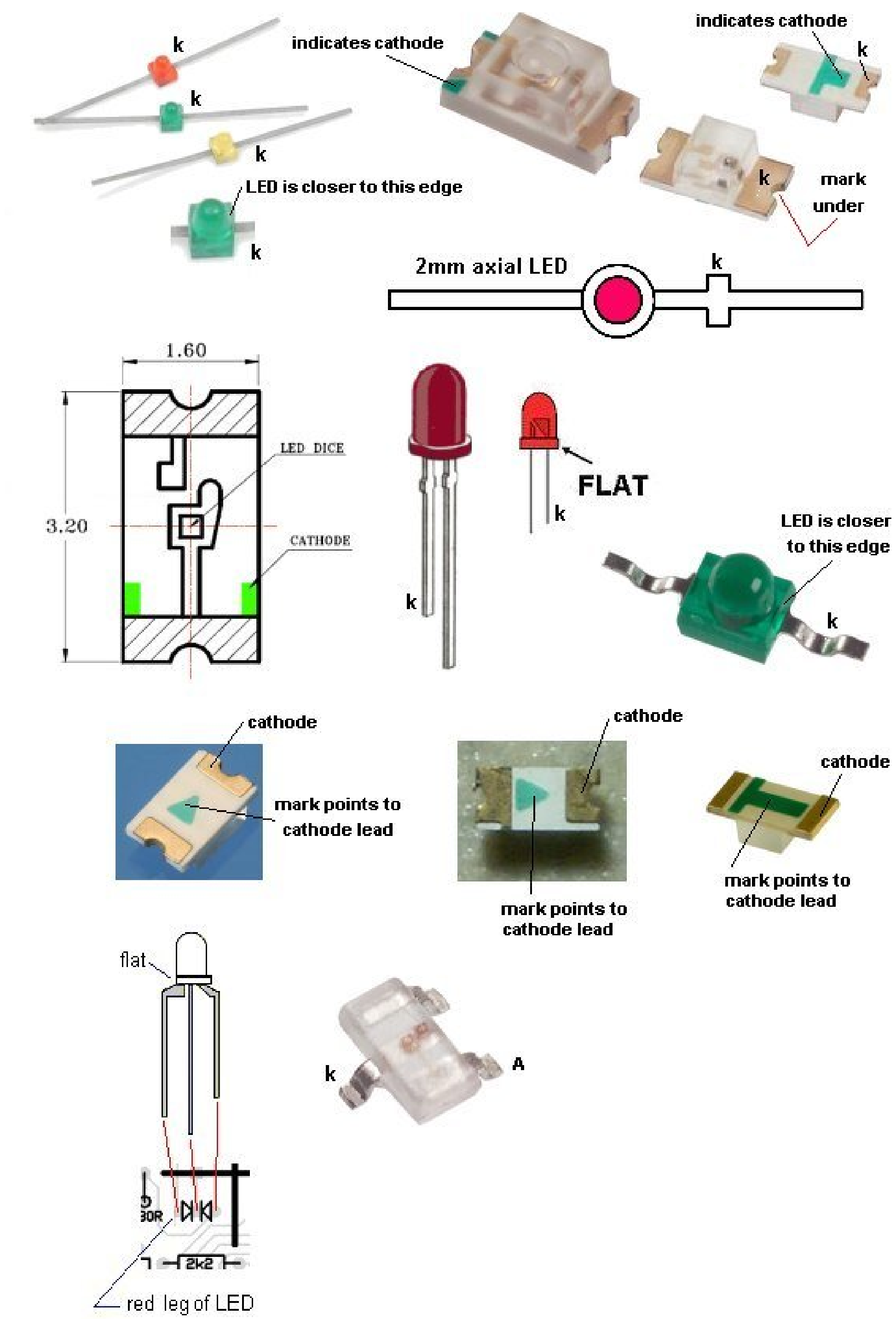
If the cathode lead of a LED cannot be identified, place 3 cells in series with a 220R resistor and illuminate the LED. 4.5v allows all types of LEDs to be tested as white LEDs require up to 3.6v. Do not use a multimeter as some only have one or two cells and this will not illuminate all types of LEDs. In addition, the negative lead of a multimeter is connected to the positive of the cells (inside the meter) for resistance measurements - so you will get an incorrect determination of the cathode lead.



CIRCUIT TO TEST ALL TYPES OF LEDs

IDENTIFYING A LED

A LED does not have a "Positive" or "Negative" lead. It has a lead identified as the "Cathode" or Kathode" or "k". This is identified by a flat on the side of the LED and/or by the shortest lead. This lead goes to the 0v rail of the circuit or near the 0v rail (if the LED is connected to other components).
Many LEDs have a "flat" on one side and this identifies the cathode. Some surface-mount LEDs have a dot or shape to identify the cathode lead and some have a cut-out on one end.
Here are some of the identification marks:



LEDs ARE CURRENT DRIVEN DEVICES

A LED is described as a CURRENT DRIVEN DEVICE. This means the illumination is determined by the amount of current flowing through it.
The brightness of a LED can be altered by increasing or decreasing the current. The effect will not be linear and it is best to experiment to determine the best current-flow for the amount of illumination you want. High-bright LEDs and super-bright LEDs will illuminate at 1mA or less, so the quality of a LED has a lot to do with the brightness. The life of many LEDs is determined at 17mA. This seems to be the best value for many types of LEDs.

1mA to 5mA LEDs

Some LEDs will produce illumination at 1mA. These are "high Quality" or "High Brightness" LEDs and the only way to check this feature is to test them @1mA as shown below.

THE 5v LED

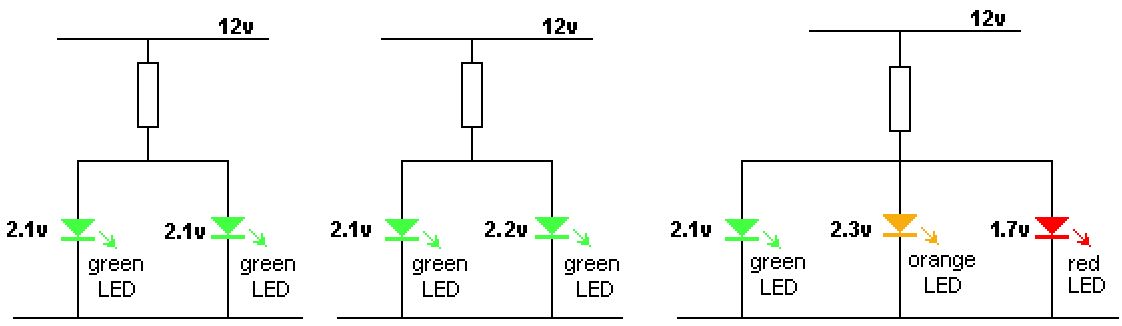
Some suppliers and some websites talk about a 5v white or blue LED. Some LEDs have a small internal resistor and can be placed on a 5v supply. This is very rate.
Some websites suggest placing a white LED on a 5v supply. These LEDs have a characteristic voltage-drop of 3.6v and should not be placed directly on a voltage above this value.
The only LED with an internal resistor is a FLASHING LED. These LEDs can be placed on a supply from 5v to 12v and flash at approx 2Hz.
NEVER assume a LED has an internal resistor. Always add a series resistor. Some high intensity LEDs are designed for 12v operation. These LEDs have a complete internal circuit to deliver the correct current to the LED. This type of device is not covered in this eBook.

LEDs IN SERIES

LEDs can be placed in series providing some features are taken into account. The main item to include is a current-limiting resistor.
A LED and resistor is called a string. A string can have 1, 2, 3 or more LEDs.
Three things must be observed:
1. MAXIMUM CURRENT through each string = 25mA.
2. The CHARACTERISTIC VOLTAGE-DROP must be known so the correct number of LEDs are used in any string.
3. A DROPPER RESISTOR must be included for each string.
The following diagrams show examples of 1-string, 2-strings and 3-strings:

LEDs IN PARALLEL

LEDs **CANNOT** be placed in parallel - until you read this:
LEDs "generate" or "possess" or "create" a voltage across them called the CHARACTERISTIC VOLTAGE-DROP (when they are correctly placed in a circuit).
This voltage is generated by the type of crystal and is different for each colour as well as the "quality" of the LED (such as high-bright, ultra high-bright etc). This characteristic cannot be altered BUT it does change a very small amount from one LED to another in the same batch. And it does increase slightly as the current increases.
For instance, it will be different by as much as 0.2v for red LEDs and 0.4v for white LEDs from the same batch and will increase by as much as 0.5v when the current is increased from a minimum to maximum.
You can test 100 white LEDs @15mA and measure the CHARACTERISTIC VOLTAGE-DROP to see this range.
If you get 2 LEDs with identical CHARACTERISTIC VOLTAGE-DROP, and place them in parallel, they will each take the same current. This means 30mA through the current-limiting resistor will be divided into 15mA for each LED.
However if one LED has a higher CHARACTERISTIC VOLTAGE-DROP, it will take less current and the other LED will take considerably more. Thus you have no way to determine the "current-sharing" in a string of parallel LEDs. If you put 3 or more LEDs in parallel, one LED will start to take more current and will over-heat and you will get very-rapid LED failure. As one LED fails, the others will take more current and the rest of the LEDs will start to self-destruct.
Thus **LEDs in PARALLEL** should be avoided.
Diagram **A** below shows two green LEDs in parallel. This will work provided the Characteristic Voltage Drop across each LED is the same.
In diagram **B** the Characteristic Voltage Drop is slightly different for the second LED and the first green LED will glow brighter.
In diagram **C** the three LEDs have different Characteristic Voltage Drops and the red LED will glow very bright while the other two LEDs will not illuminate. All the current will pass through the red LED and it will be damaged.
The reason why the red LED will glow very bright is this: It has the lowest Characteristic Voltage Drop and it will create a 1.7v for the three LEDs. The green and orange LEDs will not illuminate at this voltage and thus all the current from the dropper resistor will flow in the red LED and it will be destroyed.



A This circuit will work

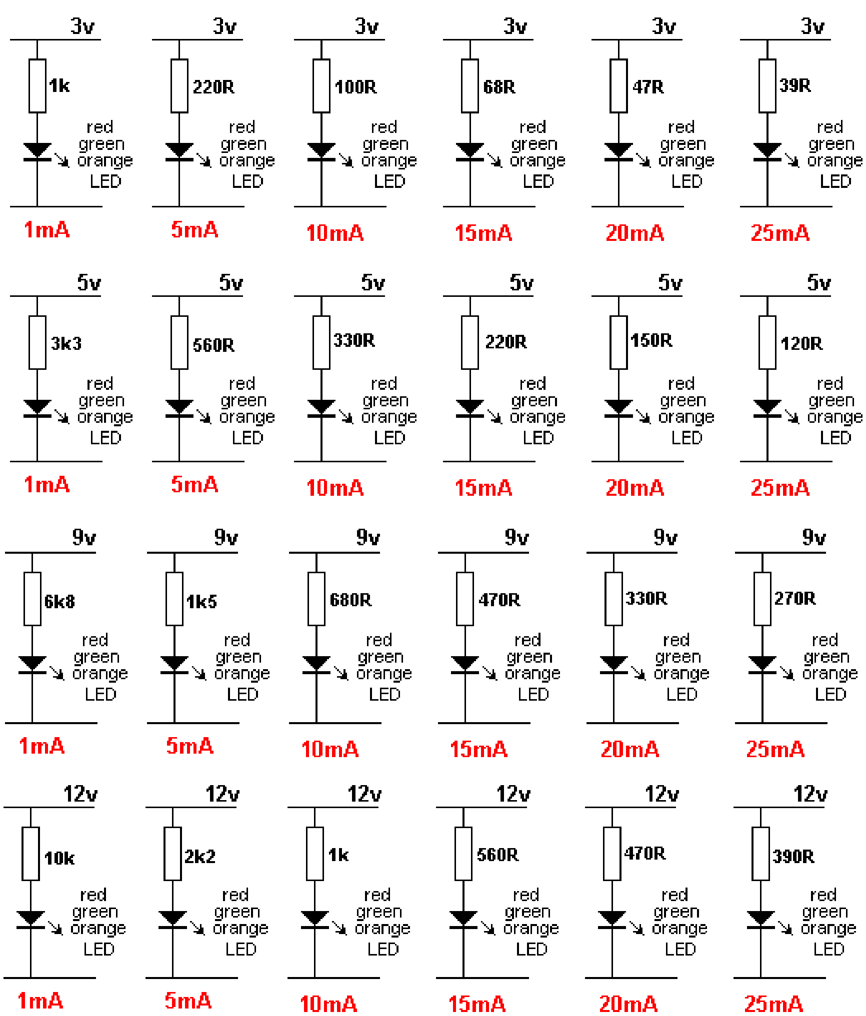
B 2.1v LED will be brighter

C red LED will glow and get damaged

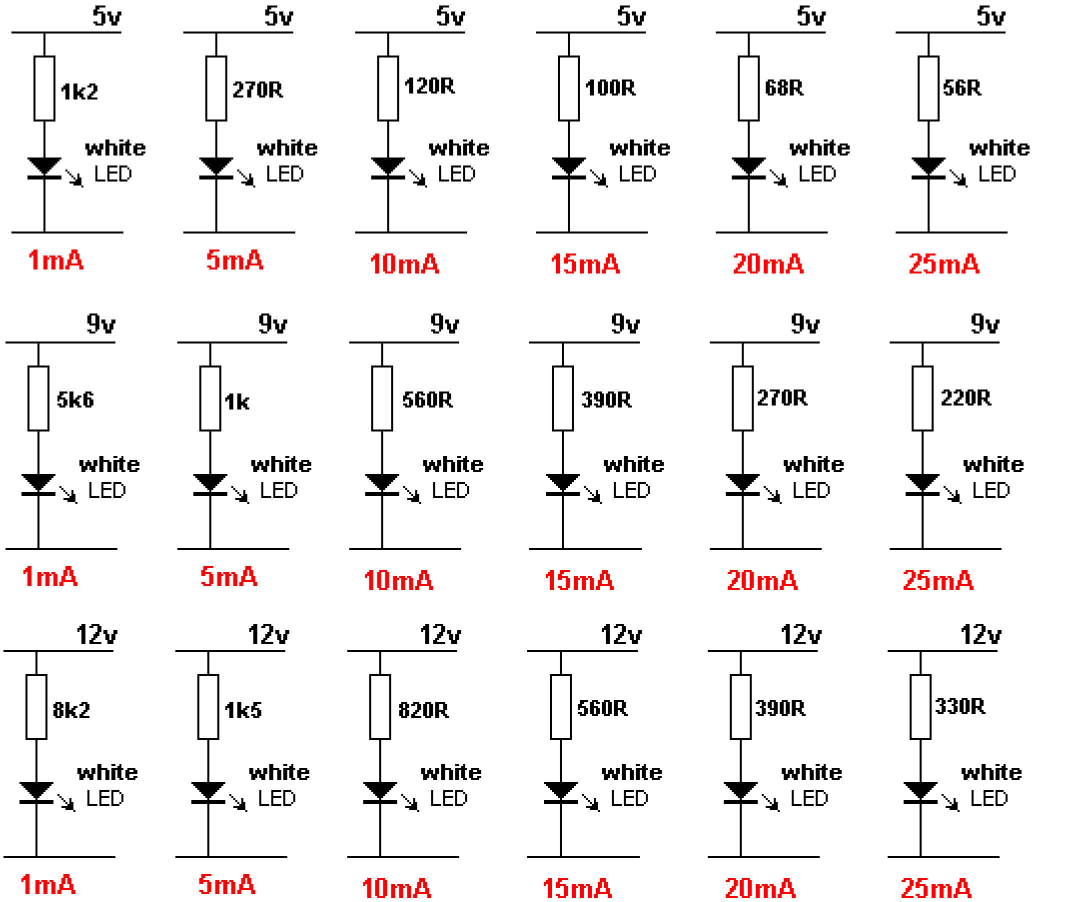
THE RESISTOR

The value of the current limiting resistor can be worked out by Ohms Law.
Here are the 3 steps:
1. Add up the voltages of all the LEDs in a string.   e.g: 2.1v + 2.3v + 2.3v + 1.7v = 8.4v
2. Subtract the LED voltages from the supply voltage. e.g: 12v - 8.4v = 3.6v
3. Divide the 3.6v (or your voltage) by the current through the string.
for 25mA: 3.6/.025 =144 ohms
for 20mA: 3.6/.02 = 180 ohms
for 15mA: 3.6/.015 = 250 ohms
for 10mA: 3.6/.01   = 360 ohms
This is the value of the current-limiting resistor.

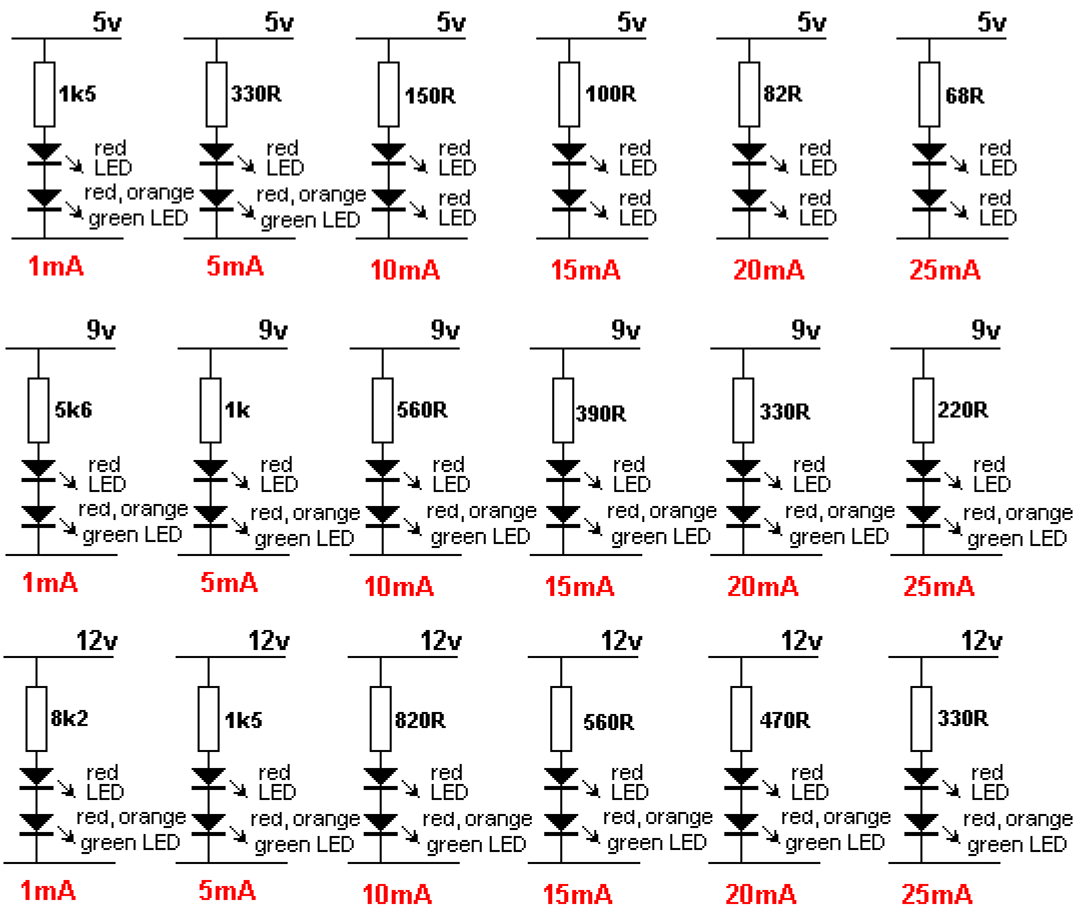
Here is a set of strings for a supply voltage of 3v to 12v and a single LED:



Here is a set of strings for a supply voltage of 5v to 12v and a white LED:



Here is a set of strings for a supply voltage of 5v to 12v and two LEDs:



LED series/parallel array wizard

The **LED series/parallel array wizard** below, is a calculator that will help you design large arrays of single-colour LEDs.
This calculator has been designed by **Rob Arnold** and you will be taken to his site: http://led.linear1.org/led.wiz when you click: **Design my array**
The wizard determines the current limiting resistor value for each string of the array and the power consumed. All you need to know are the specs of your LED and how many you'd like to use. The calculator only allows one LED colour to be used. For mixed colours, you will have to use the 3 steps explained above.

[ ] Source voltage
[ ] diode forward voltage
[ ] diode forward current (mA)
[ ] number of LEDs in your array

View output as: (•) ASCII ( ) schematic ( ) wiring diagram

[ ] help with resistor colour codes

Design my array

Resistor Calculator

Use this JavaScript resistor calculator to work out the value of the current-limiting resistor:

Source voltage	=	12.6
LED forward voltage drop	=	3.6
LED current in milliamps	=	25
Current-limiting resistance in Ohms	=	
Closest 5% Resistor	=	
Resistor wattage	=	
Actual current	=	
Power dissipated by LED (watts)	=	
Power dissipated by resistor (watts)	=	

LED VOLTAGE AND CURRENT

LED characteristics are very broad and you have absolutely no idea of any value until you test the LED.
However here are some of the generally accepted characteristics:

Lens Color	Forward Voltage		Forward Current	
	Typical	Maximum	Typical	Maximum
RED	1.6 Volts	2.0 Volts	.010 Amp	.020 Amp
GREEN	2.2 Volts	3.0 Volts	.010 Amp	.020 Amp
YELLOW	2.2 Volts	3.0 Volts	.010 Amp	.020 Amp
* Blue * (Note)	3.8 Volts	4.5 Volts	.020 Amp	.020 Amp
WHITE	3.2 – 3.6 Volts	3.8 Volts	.010 Amp	.020 Amp

NOTE 1: The above Voltage and Current ratings are based on several everyday generic LEDS in the 3 mm and 5 mm size ranges.

NOTE 2: Blue color LEDS may typically have forward working voltages exceeding those used in the above example. Forward working voltages for some Blue color LEDS may also fall in the 4.9 to 5.5 Volt range.

SOLDERING LEDs

LEDs are the most heat-sensitive device of all the components.
When soldering surface-mount LEDs, you should hold the LED with tweezers and "tack" one end. Then wait for the LED to cool down and solder the other end very quickly. Then wait a few seconds and completely solder the first end. Check the glow of each LED with 3 cells in series and a 220R resistor. If you have overheated the LED, its output will be dim, or a slightly different colour, or it may not work at all. They are extremely sensitive to heat - mainly because the crystal is so close to the soldering iron.

HIGH-BRIGHT LEDs

LEDs have become more efficient over the past 25 years.
Originally a red LED emitted 17mcd @20mA. These LEDs now emit 1,000mcd to 20,000mcd @20mA. This means you can lower the current and still produce illumination. Some LEDs operate on a current as low as 1mA

LEDs as LIGHT DETECTORS

LEDs can also be used to detect light.
Green LEDs are the best, however all LEDs will detect light and produce a voltage equal to the CHARACTERISTIC VOLTAGE-DROP, providing they receive sufficient light. The current they produce is miniscule however high-bright and super-bright LEDs produce a higher output due to the fact that their crystal is more efficient at converting light into electricity.
The Solar Tracker project uses this characteristic to track the sun's movement across the sky.

LEDs LEDs LEDs

There are hundreds of circuits that use a LED or drive a LED or flash a LED and nearly all the circuits in this eBook are different.
Some flash a LED on a 1.5v supply, some use very little current, some flash the LED very brightly and others use a flashing LED to create the flash-rate.
You will learn something from every circuit. Some are interesting and some are amazing. Some consist of components called a "building Block" and they can be added to other circuits to create a larger, more complex, circuit.
This is what this eBook is all about.
It teaches you how to build and design circuits that are fun to see working, yet practical.

You will learn a lot . . . . even from these simple circuits.

Colin Mitchell
TALKING ELECTRONICS.
talking@tpg.com.au

SI NOTATION

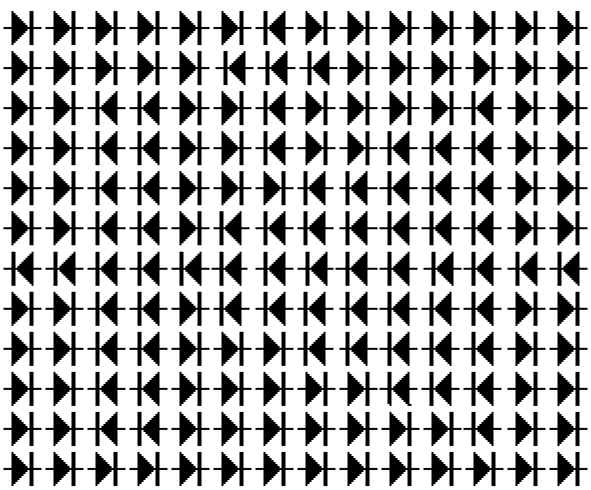
All the schematics in this eBook have components that are labelled using the System International

(SI) notation system. The SI system is an easy way to show values without the need for a decimal point. Sometimes the decimal point is difficult to see and the SI system overcomes this problem and offers a clear advantage.
Resistor values are in ohms (R), and the multipliers are: k for kilo, M for Mega. Capacitance is measured in farads (F) and the sub-multiples are u for micro, n for nano, and p for pico. Inductors are measured in Henrys (H) and the sub-multiples are mH for milliHenry and uH for microHenry.
A 10 ohm resistor would be written as 10R and a 0.001u capacitor as 1n.
The markings on components are written slightly differently to the way they are shown on a circuit diagram (such as 100p on a circuit and 101 on the capacitor or 10 on a capacitor and 10p on a diagram) and you will have to look on the internet under **Basic Electronics** to learn about these differences.

We have not provided lengthy explanations of how any of the circuits work. This has already been covered in TALKING ELECTRONICS Basic Electronics Course, and can be obtained on a CD for $10.00 (posted to anywhere in the world)

For photos of nearly every electronic component, see this website:
https://www.egr.msu.edu/eceshop/Parts_Inventory/totalinventory.php

How good is your power of observation?
Can you find the LED:



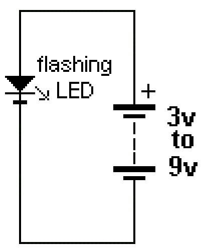
POWERING A PROJECT

The safest way to power a project is with a battery. Each circuit requires a voltage from 3v to 12v. This can be supplied from a set of AA cells in a holder or you can also use a 9v battery for some projects.
If you want to power a circuit for a long period of time, you will need a "power supply." The safest power supply is a Plug Pack (wall-wort, wall wart, wall cube, power brick, plug-in adapter, adapter block, domestic mains adapter, power adapter, or AC adapter). Some plug packs have a switchable output voltage: 3v, 6v, 7.5v, 9v, 12v) DC with a current rating of 500mA. The black lead is negative and the other lead with a white stripe (or a grey lead with a black stripe) is the positive lead.
This is the safest way to power a project as the insulation (isolation) from the mains is provided inside the adapter and there is no possibility of getting a shock.
The rating "500mA" is the maximum the Plug Pack will deliver and if your circuit takes just 50mA, this is the current that will be supplied. Some pluck packs are rated at 300mA or 1A and some have a fixed output voltage. All these plug packs will be suitable.
Some Plug Packs are marked "12vAC." This type of plug pack is not suitable for these circuits as it does not have a set of diodes and electrolytic to convert the AC to DC. All the circuits in this eBook require DC.

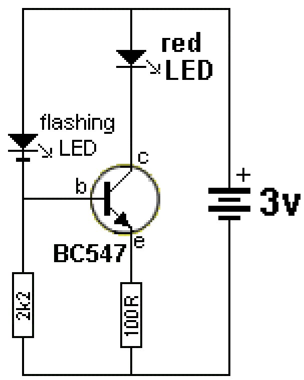
PROJECTS

FLASHING A LED

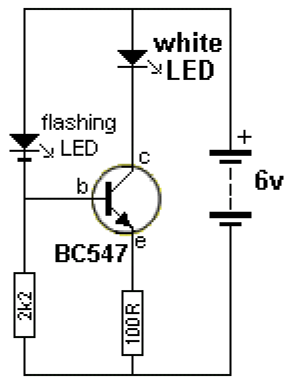
These 7 circuits flash a LED using a supply from 1.5v to 12v.
They all have a different value of efficiency and current consumption. You will find at least one to suit your requirements.
The simplest way to flash a LED is to buy a FLASHING LED as shown in figure **A**. It will work on 3v to 9v but it is not very bright - mainly because the LED is not high-efficiency.
A Flashing LED can be used to flash a super-bright red LED, as shown in figure **B**.
Figure **C** shows a flashing LED driving a buffer transistor to flash a white LED. The circuit needs 4.5v - 6v.
Figure **D** produces a very bright flash for a very short period of time - for a red, green, orange or white LED.
Figure **E** uses 2 transistors to produce a brief flash - for a red, green, orange or white LED.
Figure **F** uses a single cell and a voltage multiplying arrangement to flash a red or green LED.
Figure **G** flashes a white LED on a 3v supply.



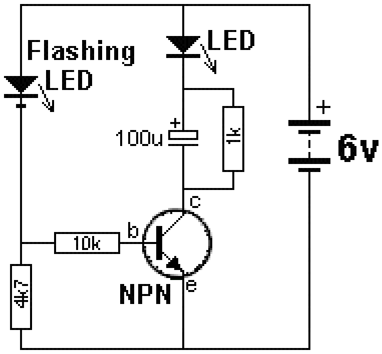
A



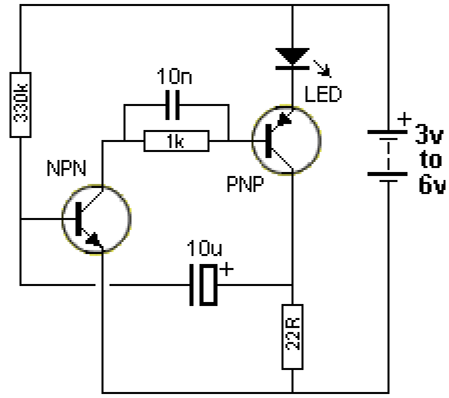
B



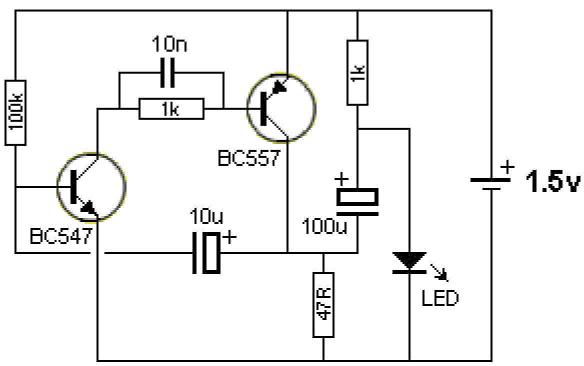
C



D

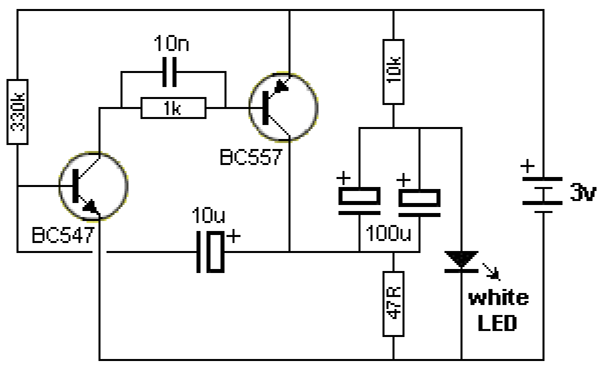


E



1.5v LED FLASHER

F

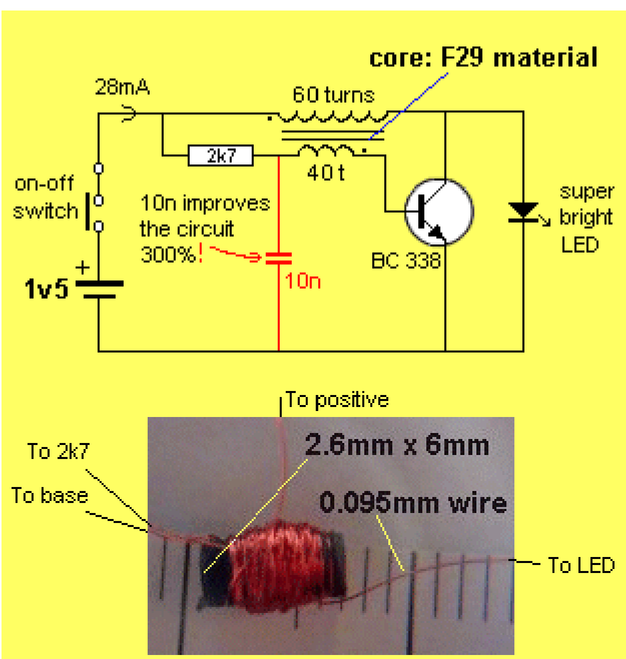


WHITE LED FLASHER

G

WHITE LED on 1.5v SUPPLY

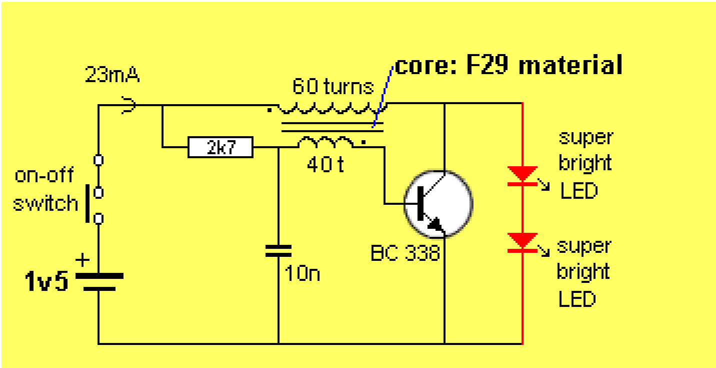
This circuit will illuminate a white LED using a single cell.
See LED Torch Circuits article for more details.



Transformer Details

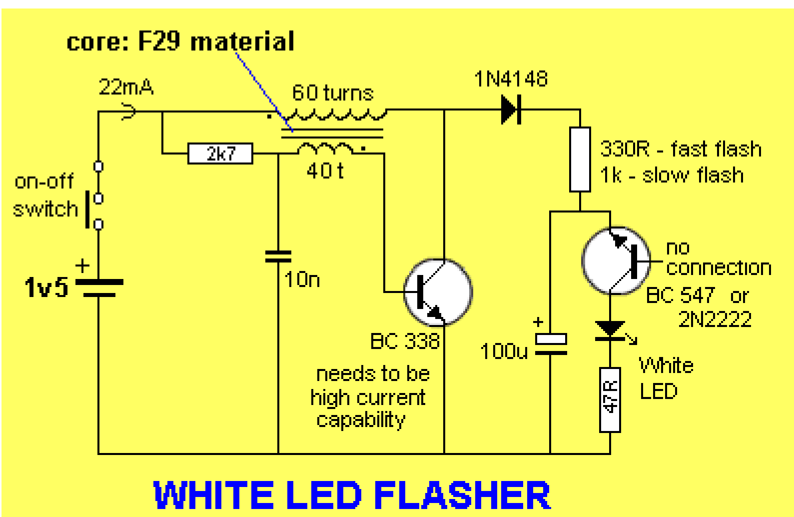
2 WHITE LEDs on 1.5v SUPPLY

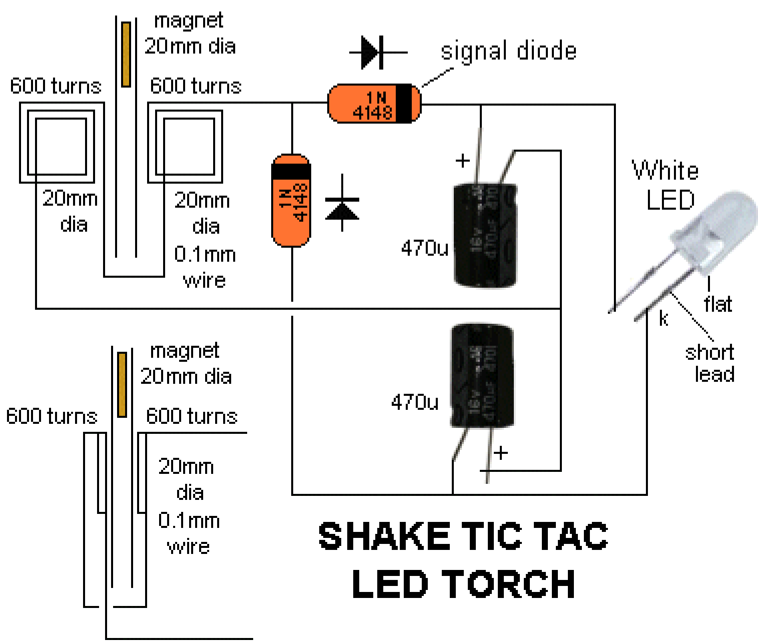
This circuit will illuminate two white LEDs using a single cell.
See LED Torch Circuits article for more details.



WHITE LED FLASHER

This circuit will flash a white LEDs using a single cell.
See LED Torch Circuits article for more details.

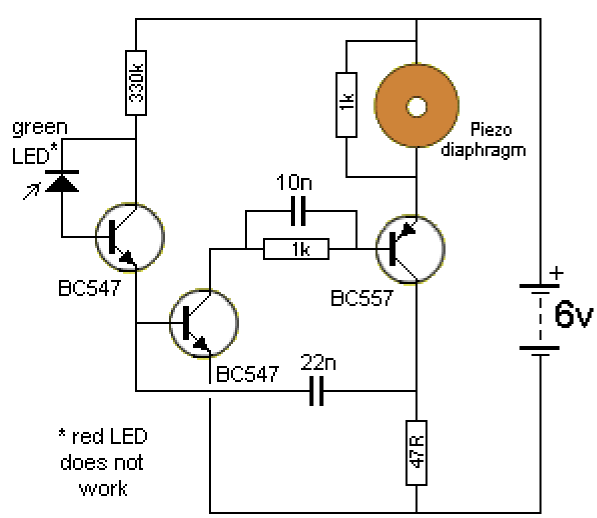




SHAKE TIC TAC LED TORCH

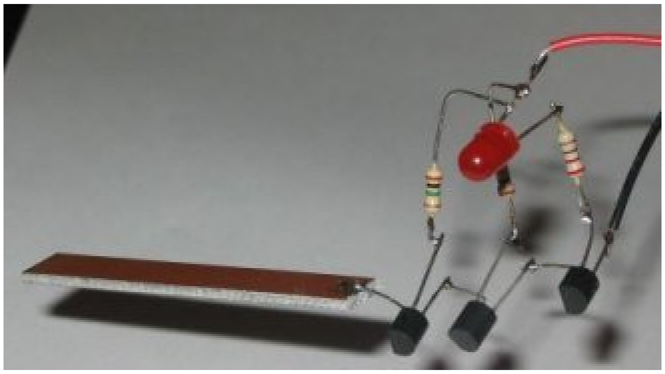
In the diagram, it looks like the coils sit on the "table" while the magnet has its edge on the table. This is just a diagram to show how the parts are connected. The coils actually sit flat against the slide (against the side of the magnet) as shown in the diagram: The output voltage depends on how quickly the magnet passes from one end of the slide to the other. That's why a rapid shaking produces a higher voltage. You must get the end of the magnet to fully pass though the coil so the voltage will be a maximum. That's why the slide extends past the coils at the top and bottom of the diagram.

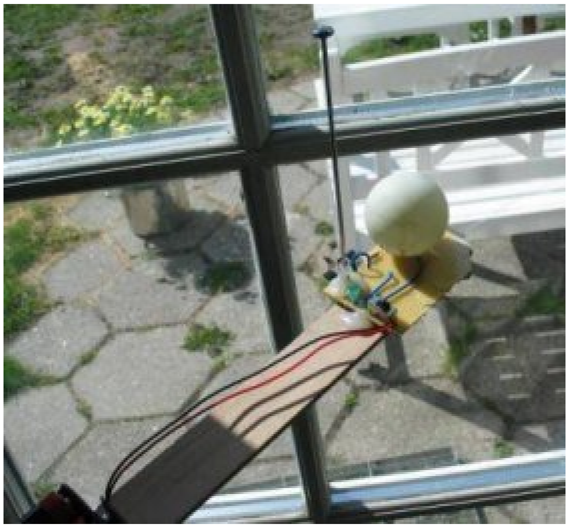
The circuit consists of two 600-turn coils in series, driving a voltage doubler. Each coil produces a positive and negative pulse, each time the magnet passes from one end of the slide to the other.
The positive pulse charges the top electrolytic via the top diode and the negative pulse charges the lower electrolytic, via the lower diode.
The voltage across each electrolytic is combined to produce a voltage for the white LED. When the combined voltage is greater than 3.2v, the LED illuminates. The electrolytics help to keep the LED illuminated while the magnet starts to make another pass.



LED DETECTS LIGHT

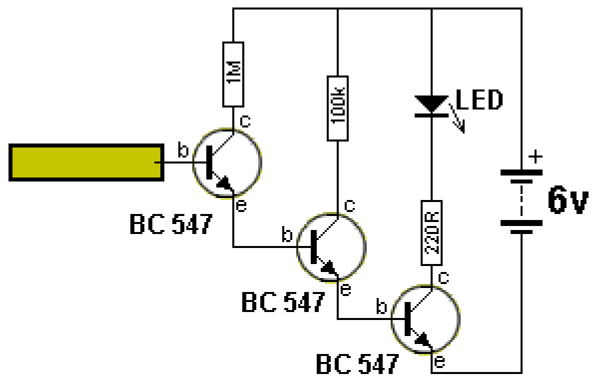
The LED in this circuit will detect light to turn on the oscillator. Ordinary red LEDs do not work. But green LEDs, yellow LEDs and high-bright white LEDs and high-bright red LEDs work very well.
The output voltage of the LED is up to 600mV when detecting very bright illumination.
When light is detected by the LED, its resistance decreases and a very small current flows into the base of the first transistor. The transistor amplifies this current about 200 times and the resistance between collector and emitter decreases. The 330k resistor on the collector is a current limiting resistor as the middle transistor only needs a very small current for the circuit to oscillate. If the current is too high, the circuit will "freeze."
The piezo diaphragm does not contain any active components and relies on the circuit to drive it to produce the tone.



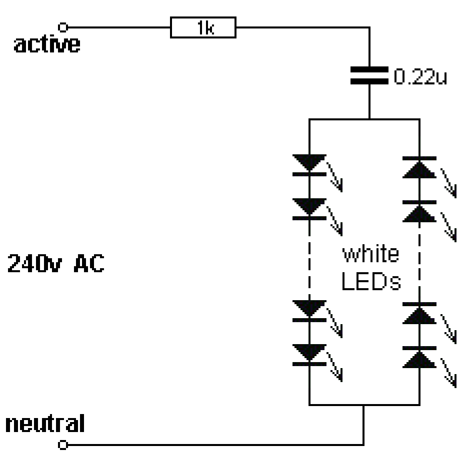


8 MILLION GAIN!

This circuit is so sensitive it will detect "mains hum." Simply move it across any wall and it will detect where the mains cable is located. It has a gain of about 200 x 200 x 200 = 8,000,000 and will also detect static electricity and the presence of your hand without any direct contact. You will be amazed what it detects! There is static electricity EVERYWHERE! The input of this circuit is classified as very high impedance.



Here is a photo of the circuit, produced by a constructor.



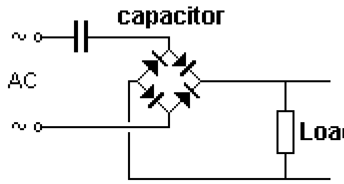
LEDs on 240v

I do not like any circuit connected directly to 240v mains. However Christmas tress lights have been connected directly to the mains for 30 years without any major problems.

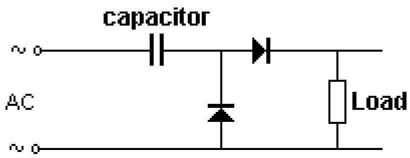
Insulation must be provided and the lights (LEDs) must be away from prying fingers.

You need at least 50 LEDs in each string to prevent them being damaged via a surge through the 1k resistor - if the circuit is turned on at the peak of the waveform. As you add more LEDs to each string, the current will drop a very small amount until eventually, when you have 90 LEDs in each string, the current will be zero.

For 50 LEDs in each string, the total characteristic voltage will be 180v so that the peak voltage will be 330v - 180v = 150v. Each LED will see less than 7mA peak during the half-cycle they are illuminated. The 1k resistor will drop 7v - since the RMS current is 7mA (7mA x 1,000 ohms = 7v). No rectifier diodes are needed. The LEDs are the "rectifiers." Very clever. You must have LEDs in both directions to charge and discharge the capacitor. The resistor is provided to take a heavy surge current through one of the strings of LEDs if the circuit is switched on when the mains is at a peak.



Full-wave capacitor Supply



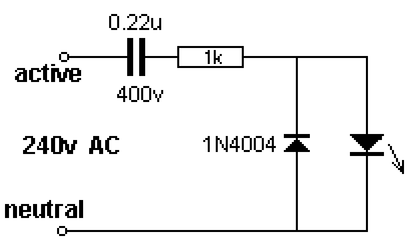
Half-wave capacitor Supply

This can be as high as 330mA if only 1 LED is used, so the value of this resistor must be adjusted if a small number of LEDs are used. The LEDs above detect peak current.
A 100n cap will deliver 7mA RMS or 10mA peak in full wave or 3.5mA RMS (10mA peak for half a cycle) in half-wave. (when only 1 LED is in each string).

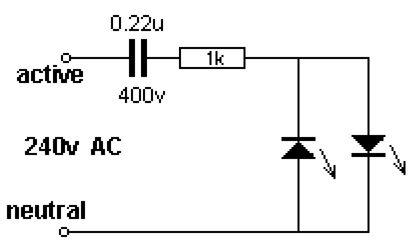
The current-capability of a capacitor needs more explanation. In the diagram on the left we see a capacitor feeding a full-wave power supply. This is exactly the same as the **LEDs on 240v** circuit above. Imagine the LOAD resistor is removed. Two of the diodes will face down and two will face up. This is exactly the same as the LEDs facing up and facing down in the circuit above. The only difference is the mid-point is joined. Since the voltage on the mid-point of one string is the same as the voltage at the mid-point of the other string, the link can be removed and the circuit will operate the same.
This means each 100n of capacitance will deliver 7mA RMS (10mA peak on each half-cycle).
In the half-wave supply, the capacitor delivers 3.5mA RMS (10mA peak on each half-cycle, but one half-cycle is lost in the diode) for each 100n to the load, and during the other half-cycle the 10mA peak is lost in the diode that discharges the capacitor.
You can use any LEDs and try to keep the total voltage-drop in each string equal. Each string is actually working on DC. It's not constant DC but varying DC. In fact is it zero current for 1/2 cycle then nothing until the voltage rises above the total characteristic voltage of all the LEDs, then a gradual increase in current over the remainder of the cycle, then a gradual decrease to zero over the falling portion of the cycle, then nothing for 1/2 cycle. Because the LEDs turn on and off, you may observe some flickering and that's why the two strings should be placed together.

SINGLE LED on 240v

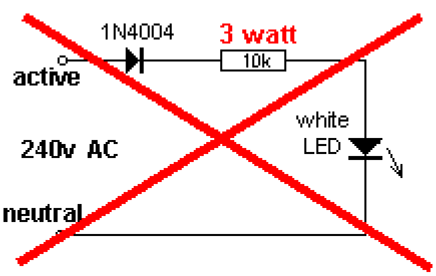
A single LED can be illuminated by using a 100n or 220n capacitor with a rating of 400v. These capacitors are called "X2" and are designed to be connected to the mains.



The LED will be 240v above earth if the active and neutral are swapped and this represents a shock of over 340v if anything is exposed. The power diode in the first diagram is designed to discharge the 0.22u during one half of the cycle so that the capacitor will charge during the other half-cycle and deliver energy to the LED. The 1k resistor limits the peak in-rush current when the circuit is first turned on and the mains happens to be at a peak.



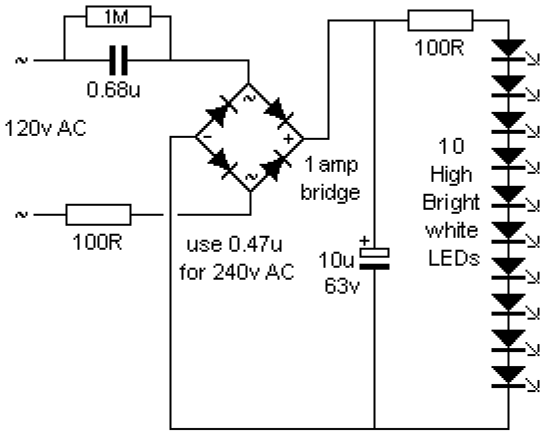
Two LEDs can be driven from the same circuit as one LED will be illuminated during the first half cycle and the other LED will be driven during the second half of the cycle.



LEDs can also be connected to the mains via a power diode and current-limiting resistor. But the wattage lost (dropped) in the resistor is about 2.5 watts and a 3 watt resistor will be needed to illuminate a 70mW white LED. This is an enormous waste of energy and a capacitor-fed supply shown above is the best solution.

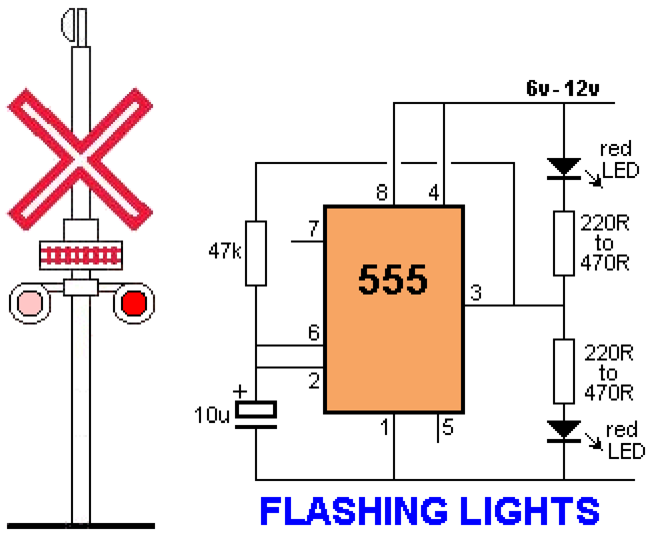
MAINS NIGHT LIGHT

The circuit illuminates a column of 10 white LEDs. The 10u prevents flicker and the 100R also reduces flicker.



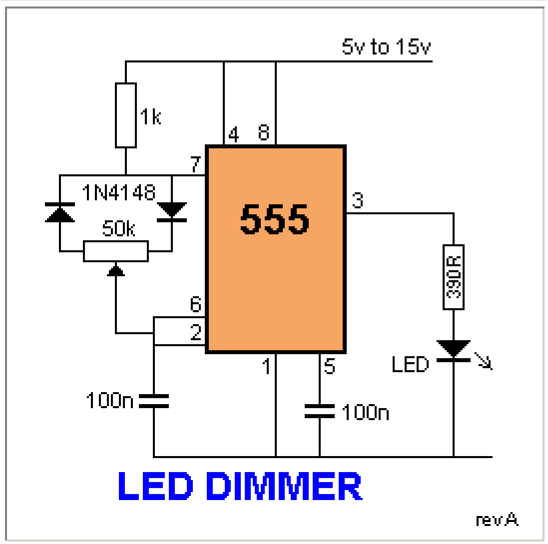
FLASHING RAILROAD LIGHTS

This circuit flashes two red LEDs for a model railway crossing.



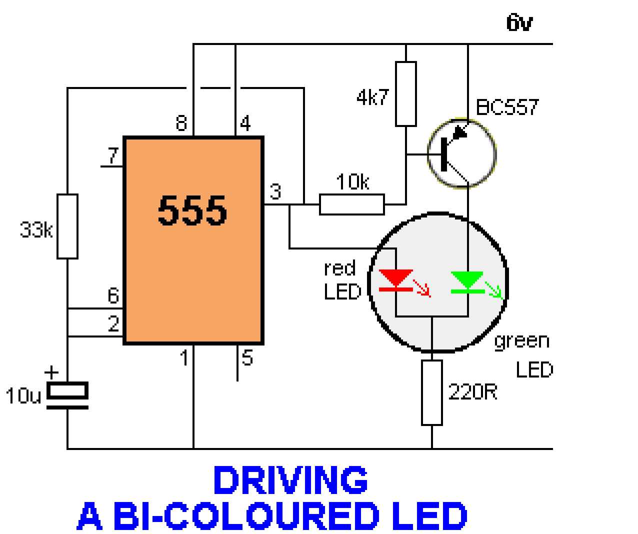
LED DIMMER

This circuit will adjust the brightness of one or more LEDs from 5% to 95%.



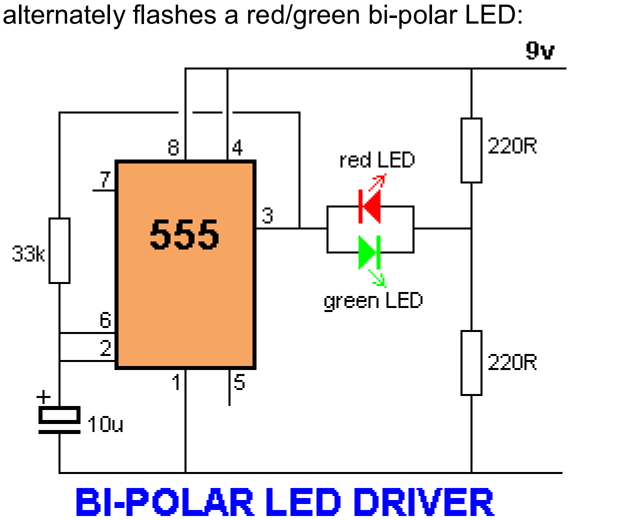
DRIVING A BI-COLOUR LED

Some 3-leaded LEDs produce red and green. This circuit alternately flashes a red/green bi-coloured LED:

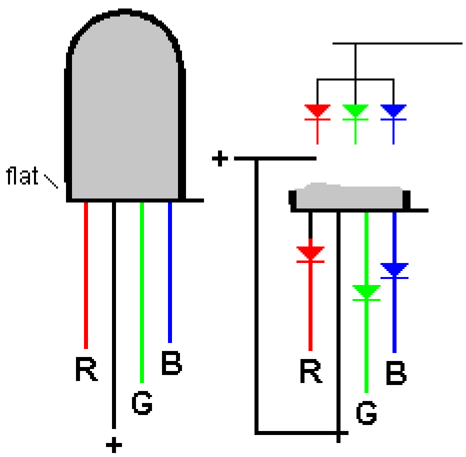


BI-POLAR LED DRIVER

Some 2-leaded LEDs produce red and green. These are called Bi-polar LEDs. This circuit alternately flashes a red/green bi-polar LED:

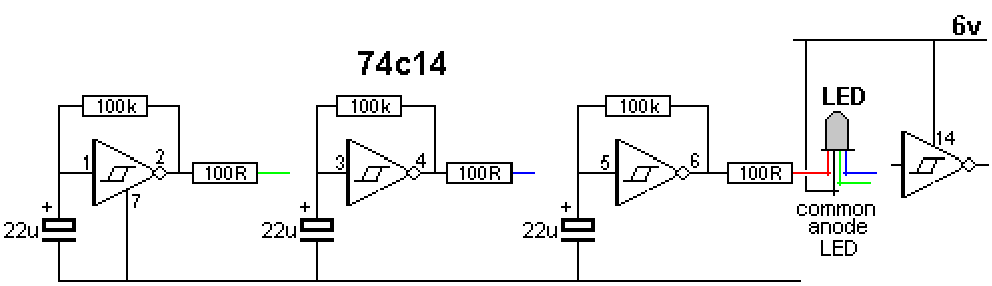


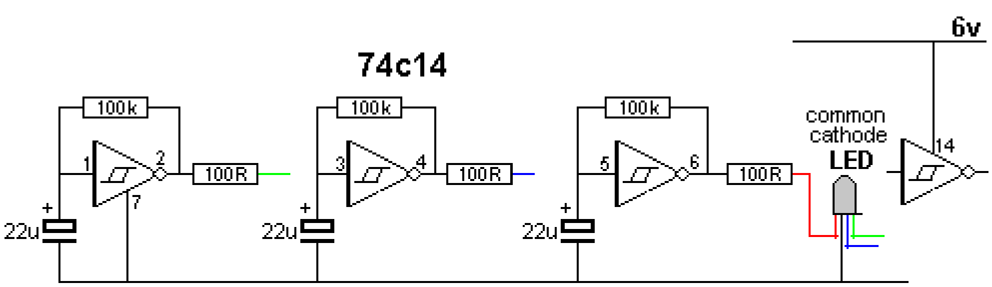
RGB LED DRIVER



COMMON ANODE RGB LED

This is a simple driver circuit that drives the 3 LEDs in an RGB LED to produce a number of interesting colours. Even though the component values are identical in the three oscillators, the slight difference in tolerances will create a random display of colours and it will take a while for the pattern to repeat.
The colours change abruptly from one colour to another as the circuit does not use Pulse Width Modulation to produce a gradual fading from one colour to another.
This LED is called COMMON ANODE. This has been done so it can be connected to transistors or other devices that "SINK."
The second circuit a common cathode LED. Note the different pinout.



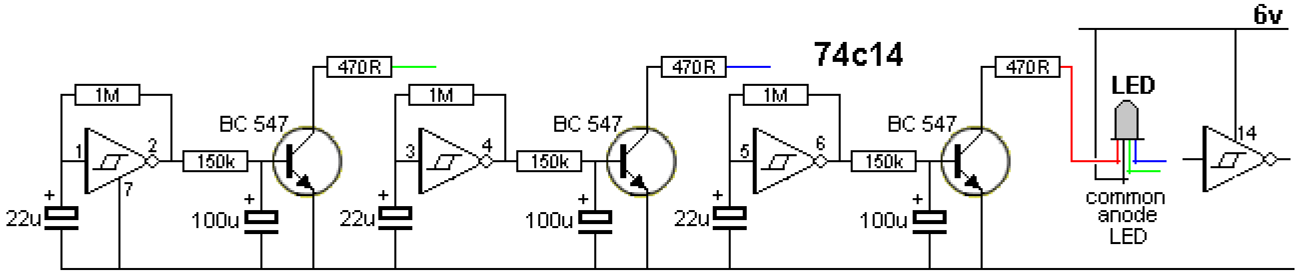


RGB LED FLASHER

This LED flashes at a fast rate then a slow rate. It only requires a current-limiting resistor of 100R for 4.5v to 6v supply or 470R for 7v to 12v supply.
This LED is available from: http://alan-parekh.vstore.ca/flashing-5000mcd-p-88.html for 80 cents plus postage.

There are two different types of RGB LEDs. The **RGB LED Driver** circuit above uses an RGB LED with 4 leads and has 3 coloured chips inside and NOTHING ELSE.
The LED described in the video has 2 leads and requires a dropper resistor so that about 20mA flows. The

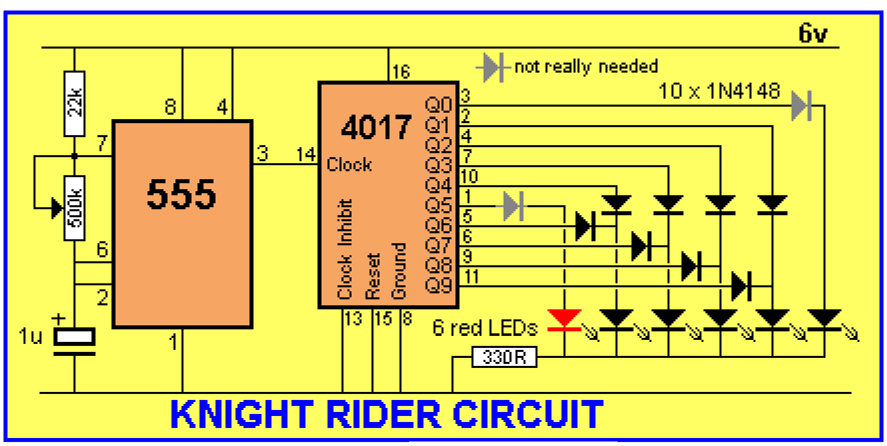
LED also contains a microcontroller producing PWM signals. If you cannot get the 2-leaded LED, you can use a 4-leaded LED plus the circuit below. It is an analogue version of the circuit inside the self-flashing LED, for the slow-rate:



As with everything Chinese, the self-flashing LED is too gimmicky.
It is better to produce your own colour-change via the circuit above. You can alter the rate by changing the value of the components and/or remove one or more of the 100u's. The circuit for a common cathode RGB LED is shown in the RGB LED Driver above.

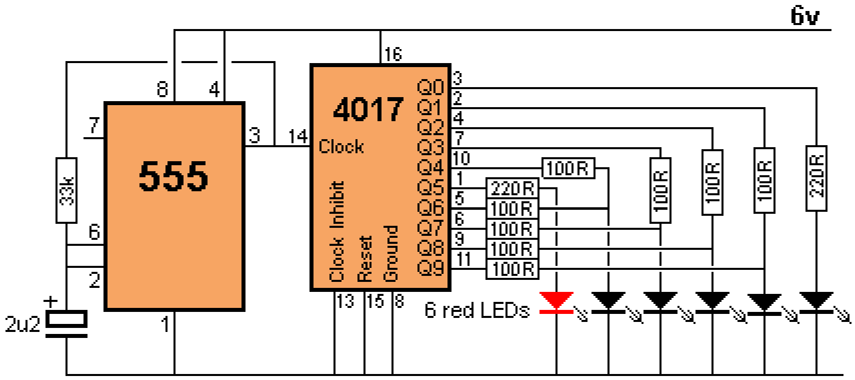
KNIGHT RIDER

In the **Knight Rider** circuit, the 555 is wired as an oscillator. It can be adjusted to give the desired speed for the display. The output of the 555 is directly connected to the input of a Johnson Counter (CD 4017). The input of the counter is called the CLOCK line.
The 10 outputs Q_0 to Q_9 become active, one at a time, on the rising edge of the waveform from the 555. Each output can deliver about 20mA but a LED should not be connected to the output without a current-limiting resistor (330R in the circuit above).
The first 6 outputs of the chip are connected directly to the 6 LEDs and these "move" across the display. The next 4 outputs move the effect in the opposite direction and the cycle repeats. The animation above shows how the effect appears on the display.
Using six 3mm LEDs, the display can be placed in the front of a model car to give a very realistic effect. The same outputs can be taken to driver transistors to produce a larger version of the display.



The **Knight Ride** ...le as a kit for less than $15.00 plus ...**Scanner**.

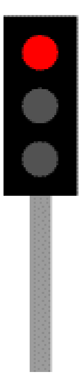
Here is a simple Knight Rider circuit using resistors to drive the LEDs. This circuit consumes 22mA while only delivering 7mA to each LED. The outputs are "fighting" each other via the 100R resistors (except outputs Q0 and Q5).

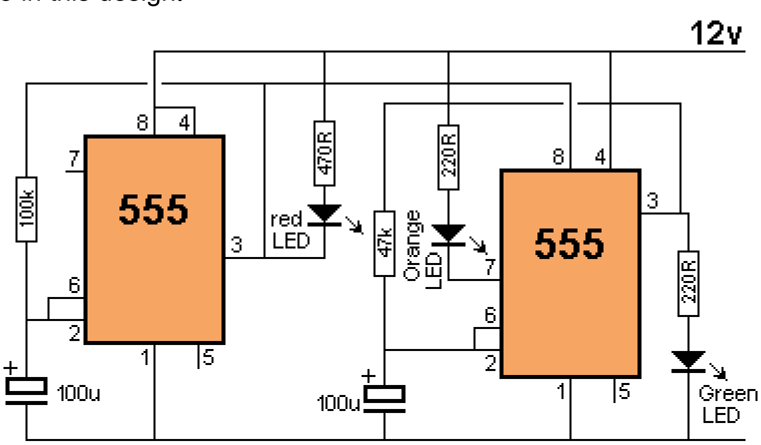


KNIGHT RIDER CIRCUIT-2

TRAFFIC LIGHTS

Here's a clever circuit using two 555's to produce a set of traffic lights for a model layout.
The animation shows the lighting sequence and this follows the Australian-standard.
The red LED has an equal on-off period and when it is off, the first 555 delivers power to the second 555. This illuminates the Green LED and then the second 555 changes state to turn off the Green LED and turn on the Orange LED for a short period of time before the first 555 changes state to turn off the second 555 and turn on the red LED.
A supply voltage of 9v to 12v is needed because the second 555 receives a supply of about 2v less than rail. This circuit also shows how to connect LEDs high and low to a 555 and also turn off the 555 by controlling the supply to pin 8. Connecting the LEDs high and low to pin 3 will not work and since pin 7 is in phase with pin 3, it can be used to advantage in this design.

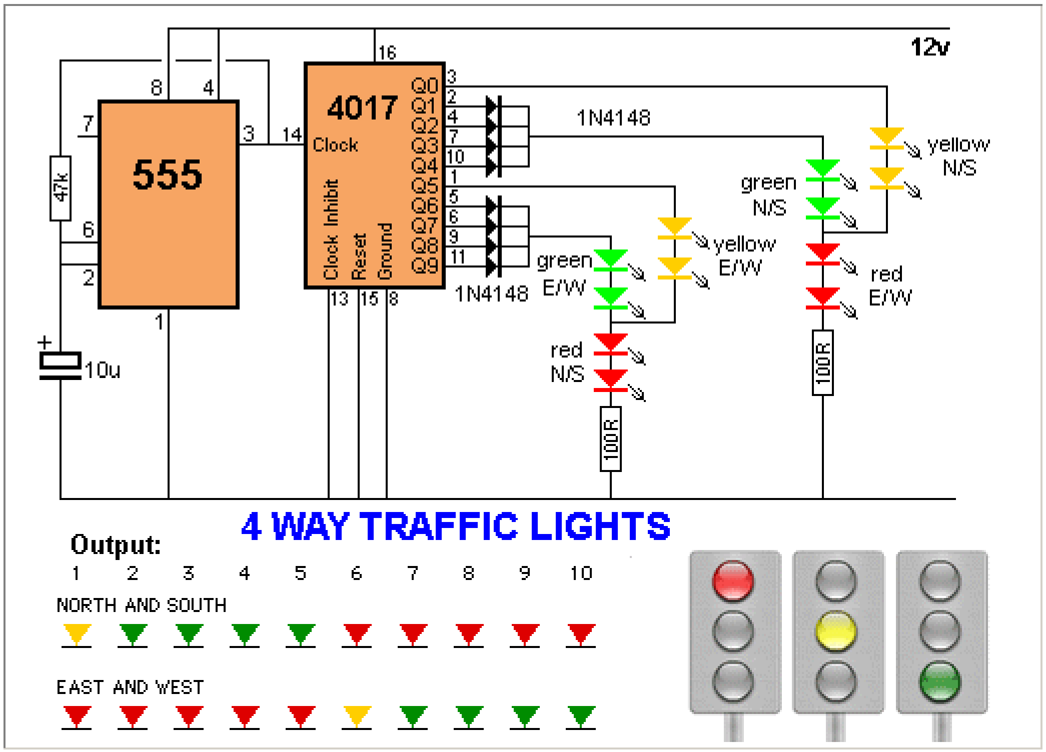




TRAFFIC LIGHTS

4 WAY TRAFFIC LIGHTS

This circuit produces traffic lights for a "4-way" intersection. The seemingly complex wiring to illuminate the lights is shown to be very simple.



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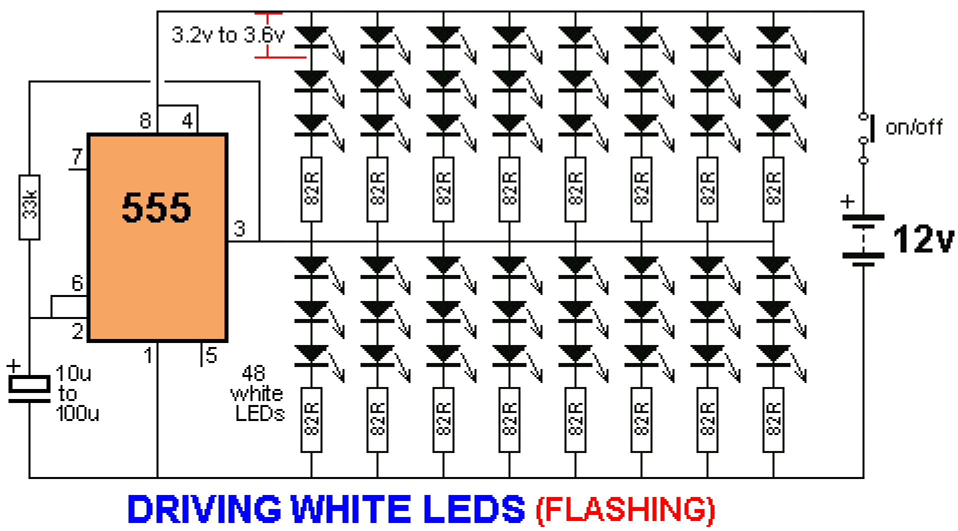
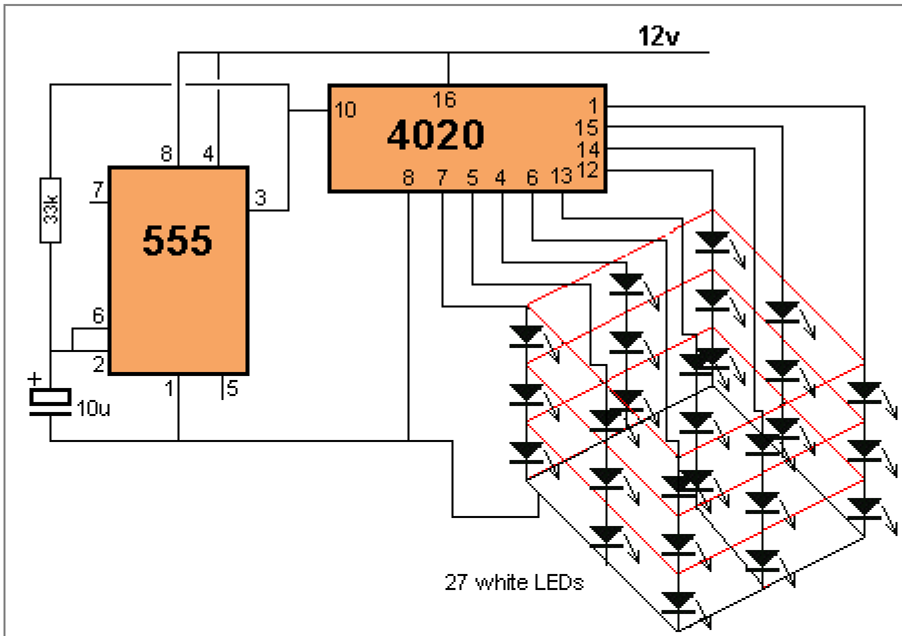
DRIVING MANY LEDS

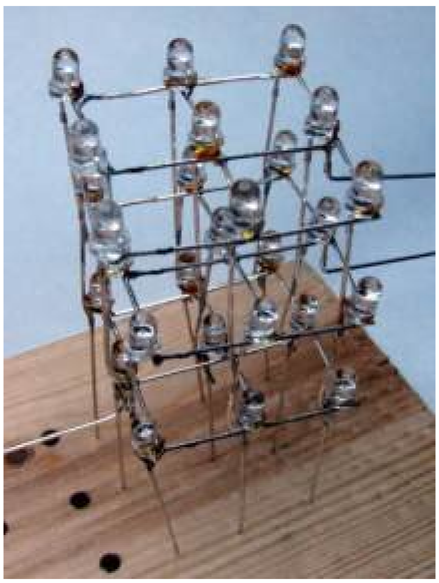
The 555 is capable of sinking and sourcing up to 200mA, but it gets very hot when doing this on a 12v supply.
The following circuit shows the maximum number of white LEDs that can be realistically driven from a 555 and we have limited the total current to about 130mA as each LED is designed to pass about 17mA to 22mA maximum. A white LED drops a characteristic 3.2v to 3.6v and this means only 3 LEDs can be placed in series.



3x3x3 CUBE

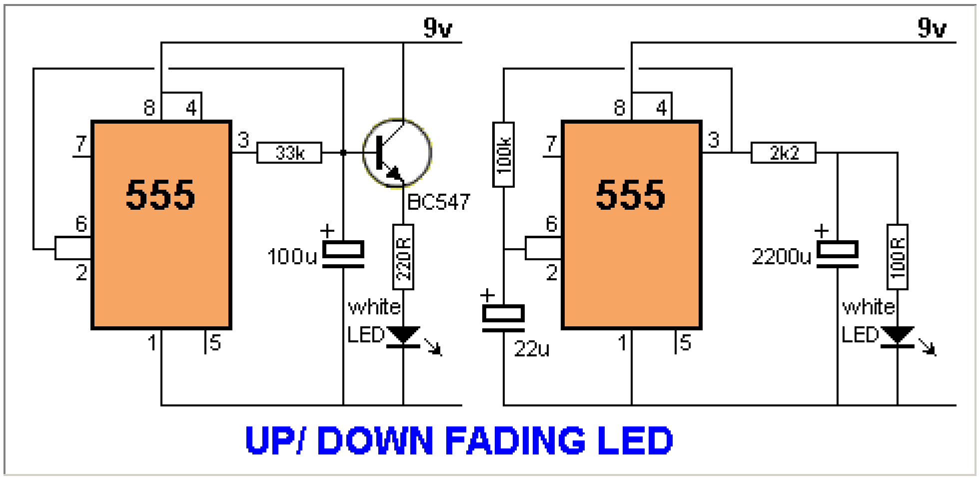
This circuit drives a 3x3x3 cube consisting of 27 white LEDs. The 4020 IC is a 14 stage binary counter and we have used 9 outputs. Each output drives 3 white LEDs in series and we have omitted a dropper resistor as the chip can only deliver a maximum of 15mA per output. The 4020 produces 512 different patterns before the sequence repeats and you have to build the project to see the effects it produces on the 3D cube.





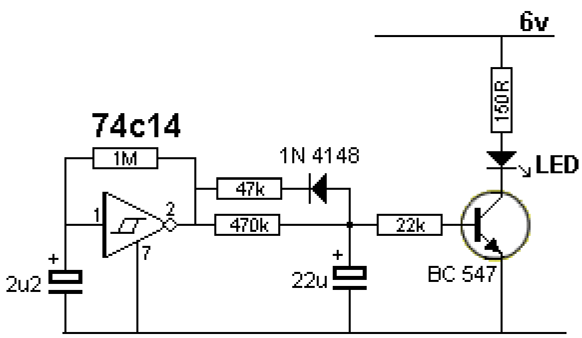
UP/DOWN FADING LED

These two circuits make a LED fade on and off. The first circuit charges a 100u and the transistor amplifies the current entering the 100u and delivers 100 times this value to the LED via the collector-emitter pins. The circuit needs 9v for operation since pin 2 of the 555 detects 2/3Vcc before changing the state of the output so we only have a maximum of 5.5v via a 220R resistor to illuminate the LED. The second circuit requires a very high value electrolytic to produce the same effect.



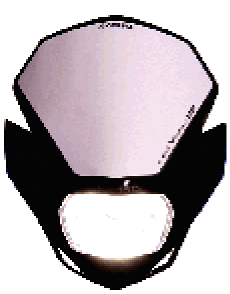
UP/DOWN FADING LED-2

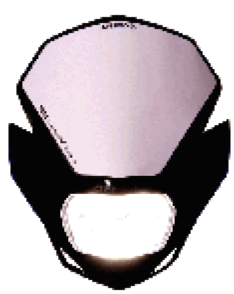
The circuit fades the LED ON and OFF at an equal rate. The 470k charging and 47k discharging resistors have been chosen to create equal on and off times.

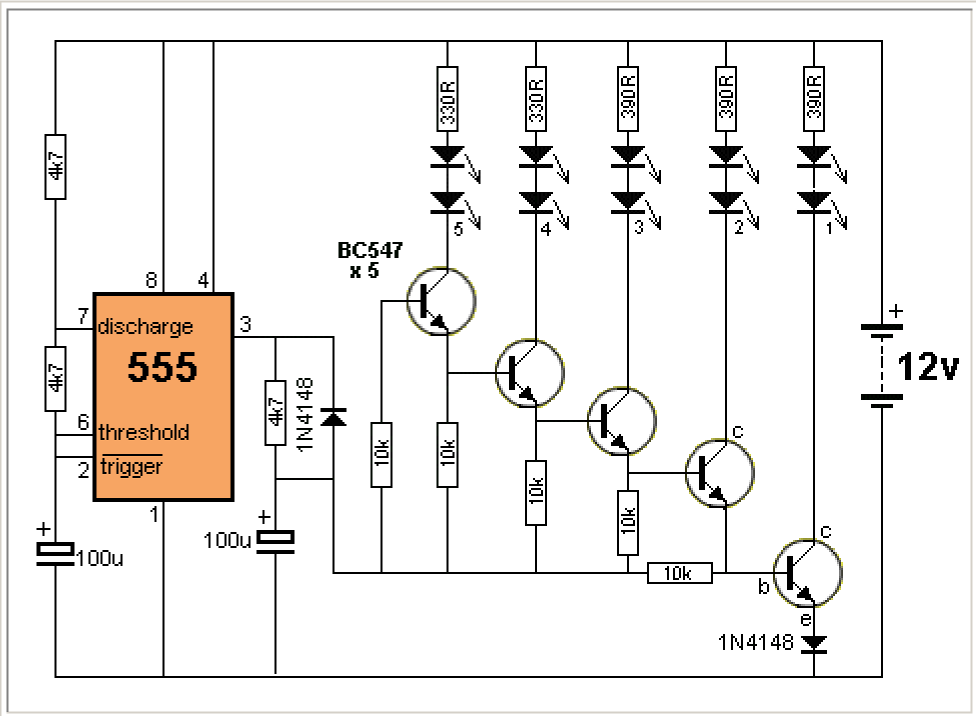


BIKE TURNING SIGNAL

This circuit can be used to indicate left and right turn on a motor-bike. Two identical circuits will be needed, one for left and one for right.

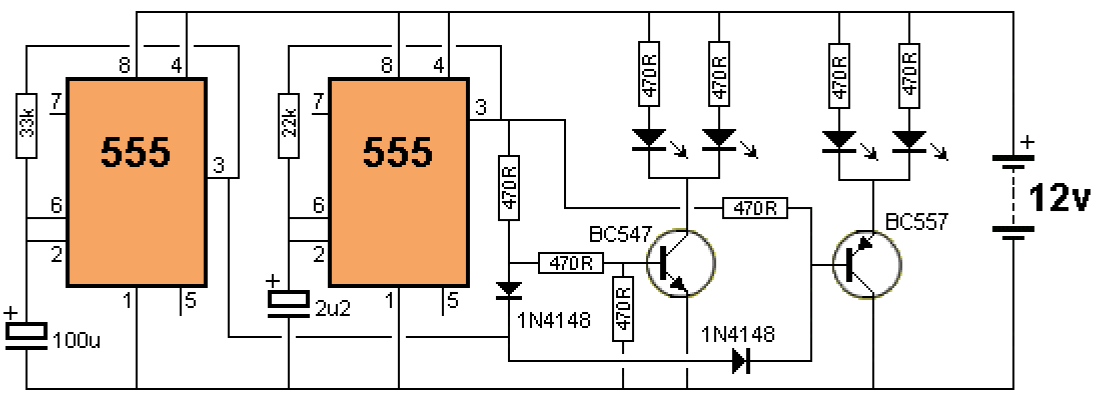




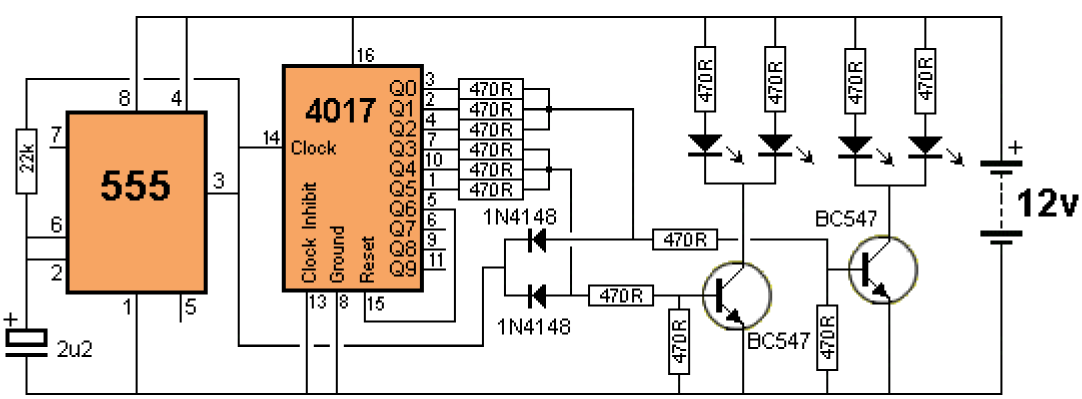


POLICE LIGHTS

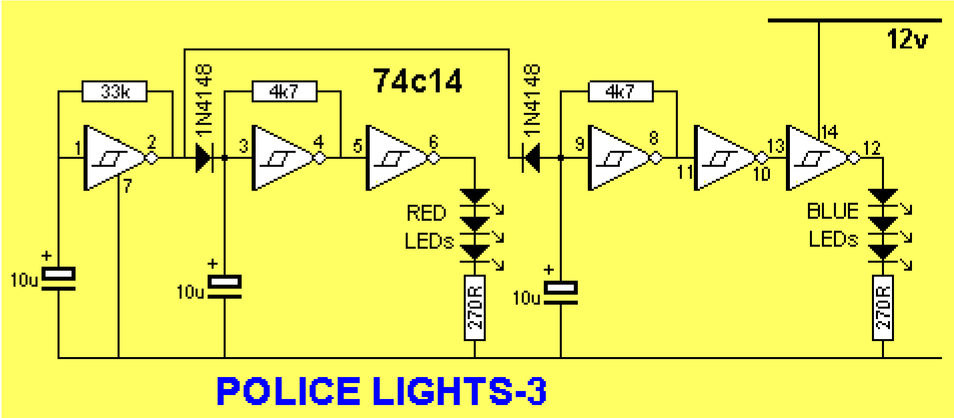
These three circuits flash the left LEDs 3 times then the right LEDs 3 times, then repeats. The only difference is the choice of chips.



POLICE LIGHTS

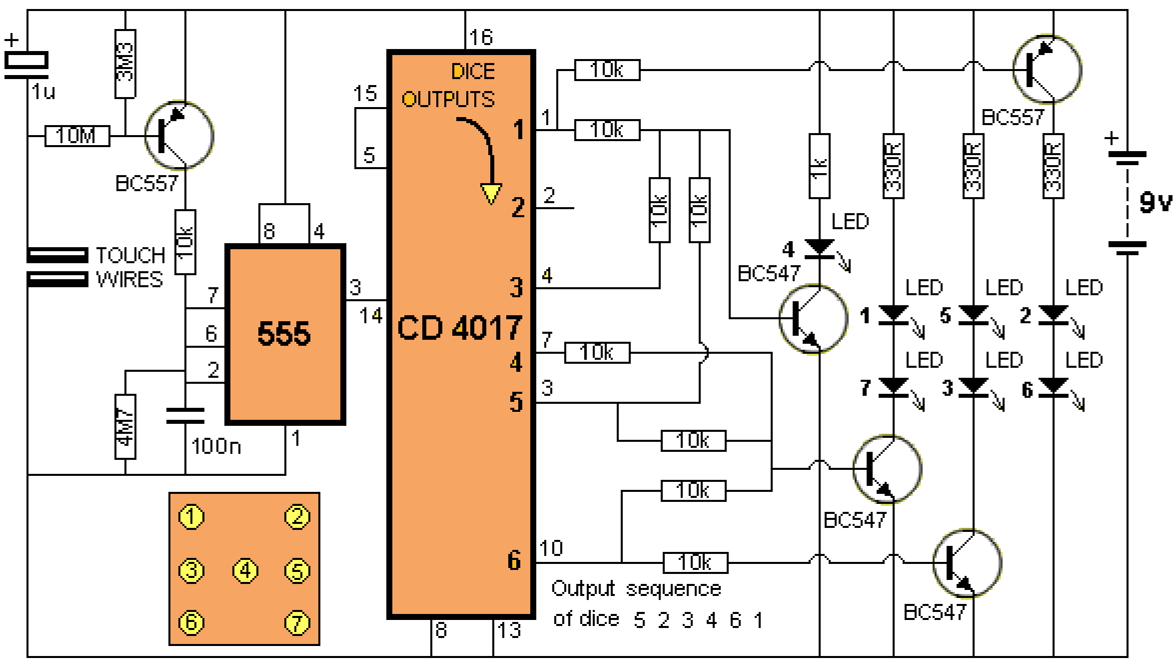


POLICE LIGHTS - 2



LED DICE with Slow Down

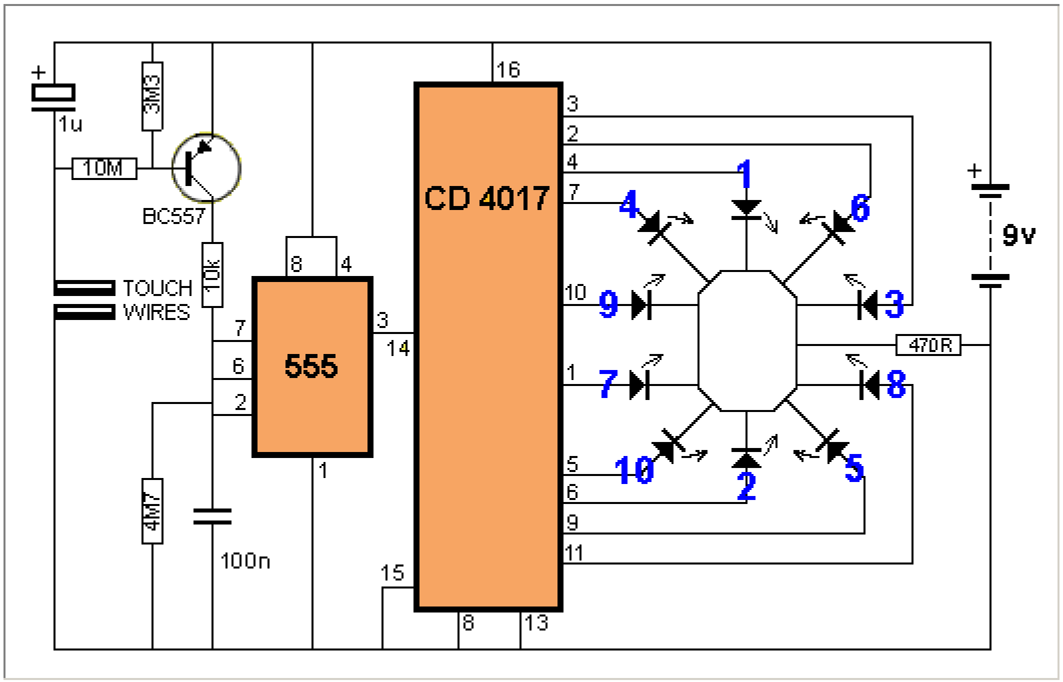
This circuit produces a random number from 1 to 6 on LEDs that are similar to the pips on the side of a dice. When the two TOUCH WIRES are touched with a finger, the LEDs flash very quickly and when the finger is removed, they gradually slow down and come to a stop. **LED Dice with Slow Down kit** is available from Talking Electronics.



The **LED Dice with Slow Down kit** is available for $16.00 plus $6.50 postage.
The kit includes the parts and PC board.

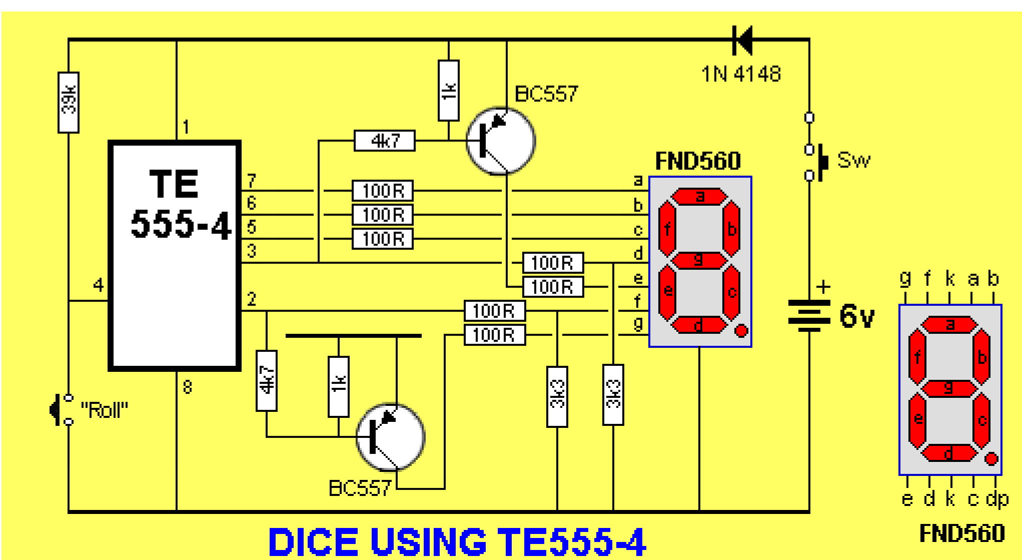
ROULETTE

This circuit creates a rotating LED that starts very fast when a finger touches the TOUCH WIRES. When the finger is removed, the rotation slows down and finally stops.



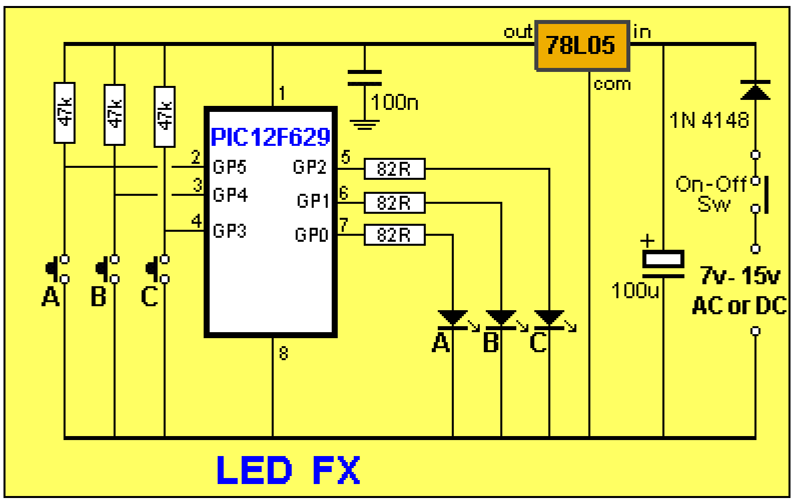
DICE TE555-4

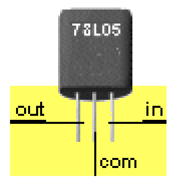
This circuit uses the latest [TE555-4](#) **DICE** chip from Talking Electronics. This 8-pin chip is available for $2.50 and drives a 7-Segment display. The circuit can be assembled on proto-type board. For more help on the list of components, email Colin Mitchell: talking@tpg.com.au

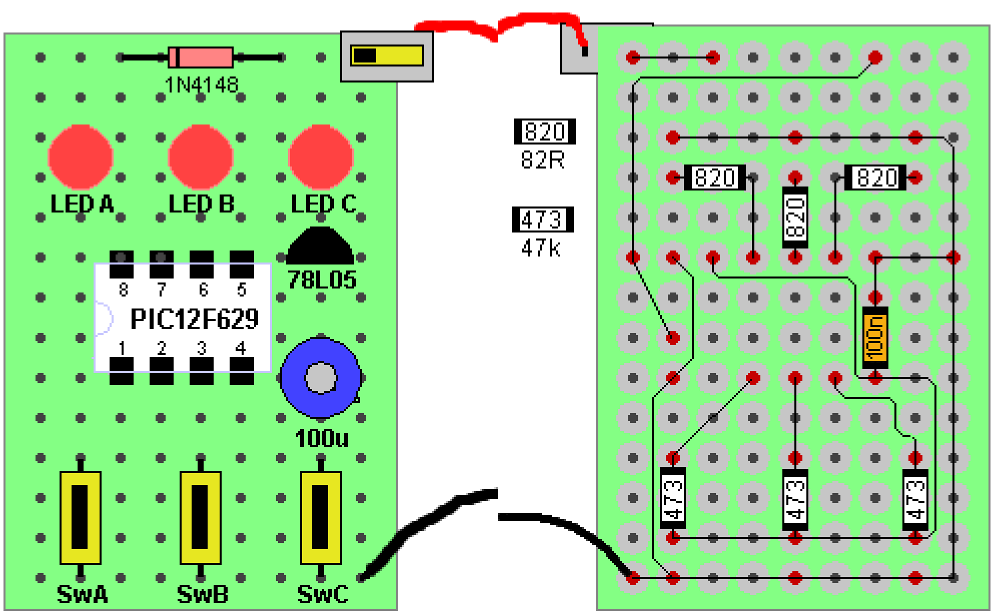


LED FX TE555-5

This circuit uses the latest **TE555-5** **LED FX** chip from Talking Electronics. This 8-pin chip is available for $2.50 and drives 3 LEDs. The circuit can be assembled on matrix board.
The circuit produces 12 different sequences including flashing, chasing, police lights and flicker. It also has a feature where you can create your own sequence and it will show each time the chip is turned on. The kit of components and matrix board can be purchased for $15.00 plus postage.
Email Colin Mitchell: talking@tpg.com.au for more details.

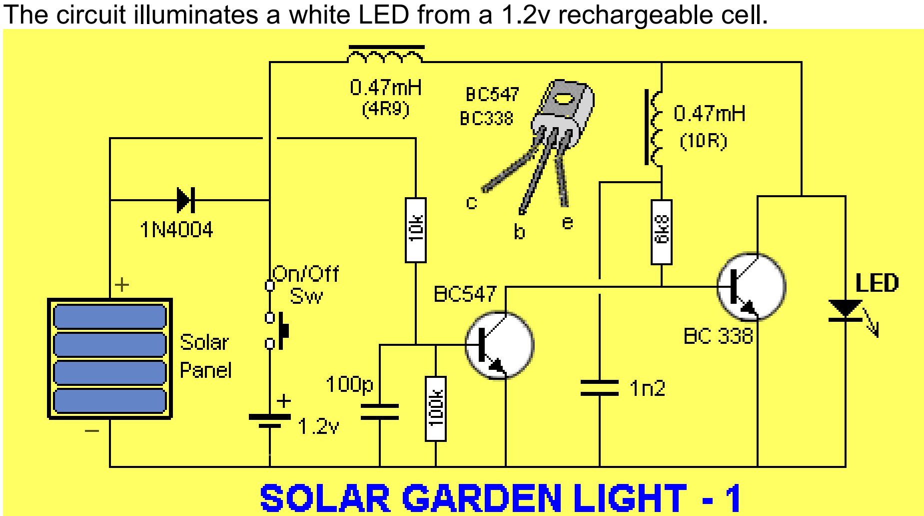






SOLAR GARDEN LIGHT

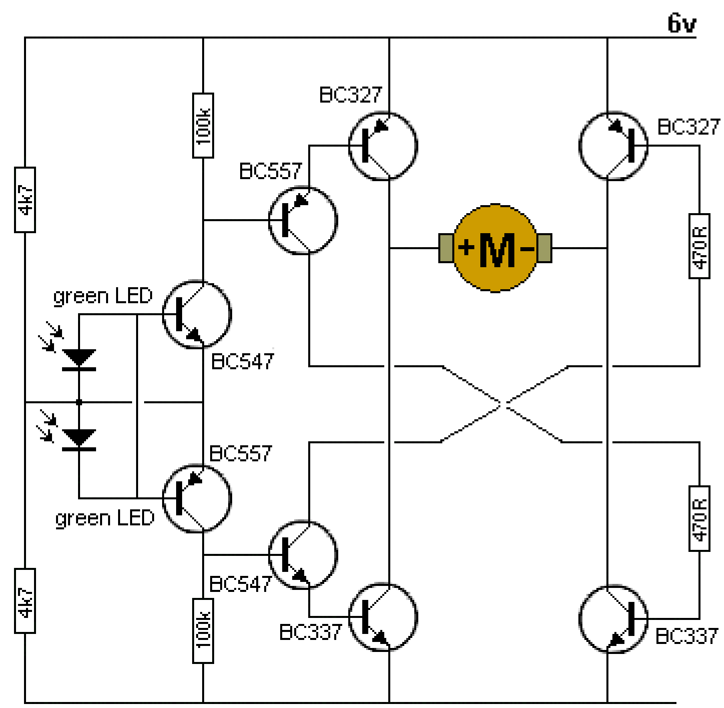
This is the circuit in a $2.00 Solar Garden Light.
The circuit illuminates a white LED from a 1.2v rechargeable cell.



SOLAR TRACKER

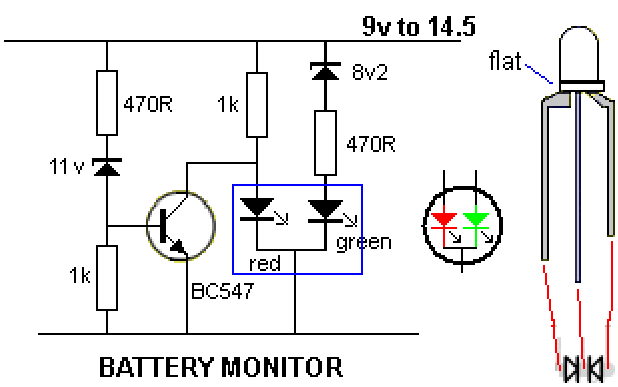
This circuit is a SOLAR TRACKER. It uses green LEDs to detect the sun and an H-Bridge to drive the motor. A green LED produces nearly 1v but only a fraction of a milliamp when sunlight is detected by the crystal inside the LED and this creates an

imbalance in the circuit to drive the motor either clockwise or anticlockwise. The circuit will deliver about 300mA to the motor. The circuit was designed by RedRok and kits for the **Solar Tracker** are available from:
http://www.redrok.com/electron.htm#tracker This design is called: **LED5S5V Simplified LED low power tracker.**



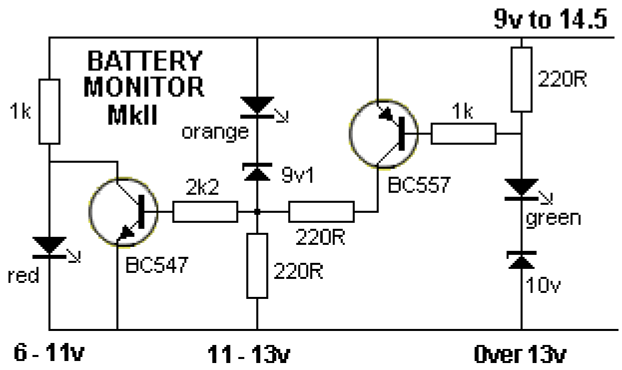
BATTERY MONITOR MkI

A very simple battery monitor can be made with a dual-colour LED and a few surrounding components. The LED produces orange when the red and green LEDs are illuminated.
The following circuit turns on the red LED below 10.5v
The orange LED illuminates between 10.5v and 11.6v.
The green LED illuminates above 11.6v



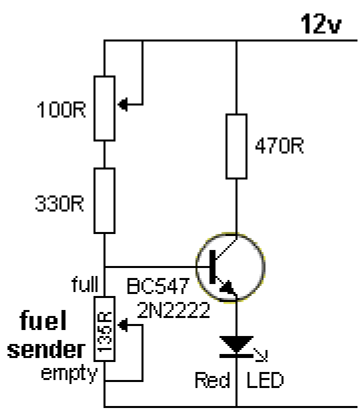
BATTERY MONITOR MkII

This battery monitor circuit uses 3 separate LEDs.
The red LED turns on from 6v to below 11v.
It turns off above 11v and
The orange LED illuminates between 11v and 13v.
It turns off above 13v and
The green LED illuminates above 13v



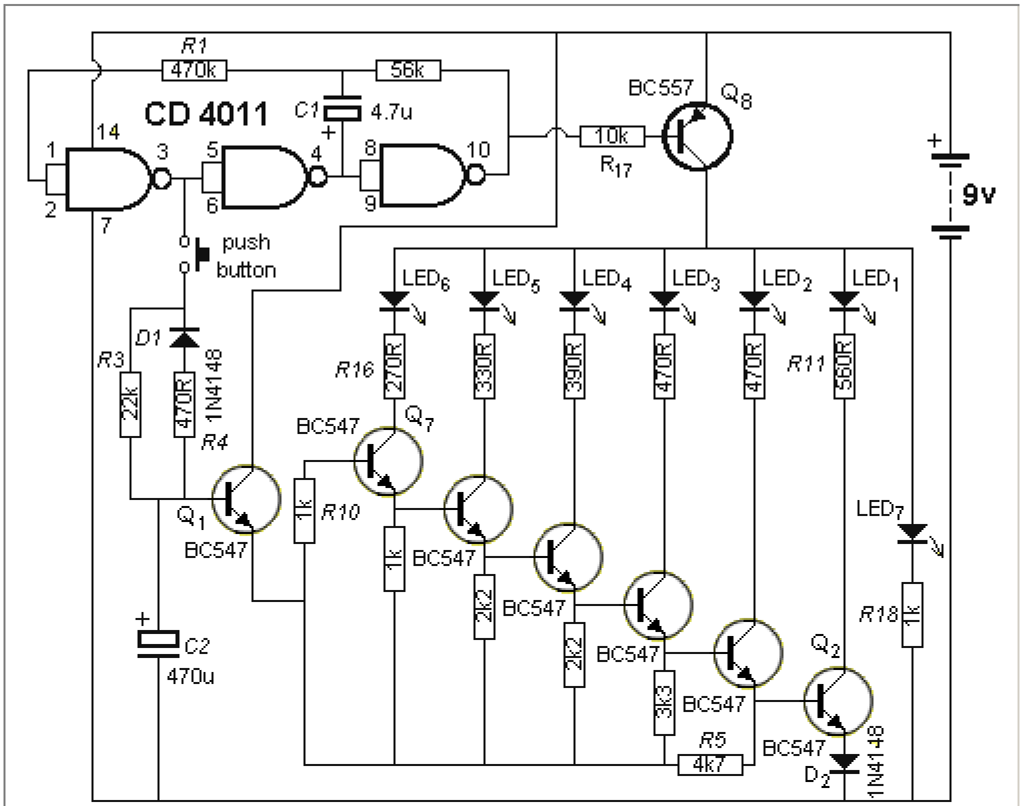
LOW FUEL INDICATOR

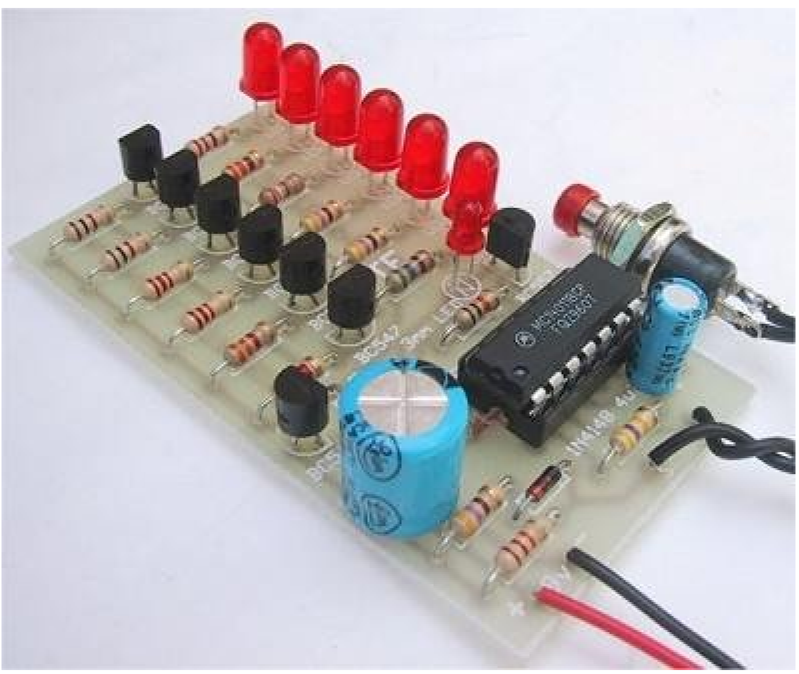
This circuit has been designed from a request by a reader. He wanted a low fuel indicator for his motorbike. The LED illuminates when the fuel gauge is 90 ohms. The tank is empty at 135 ohms and full at zero ohms. To adapt the circuit for an 80 ohm fuel sender, simply reduce the 330R to 150R. (The first thing you have to do is measure the resistance of the sender when the tank is amply.)



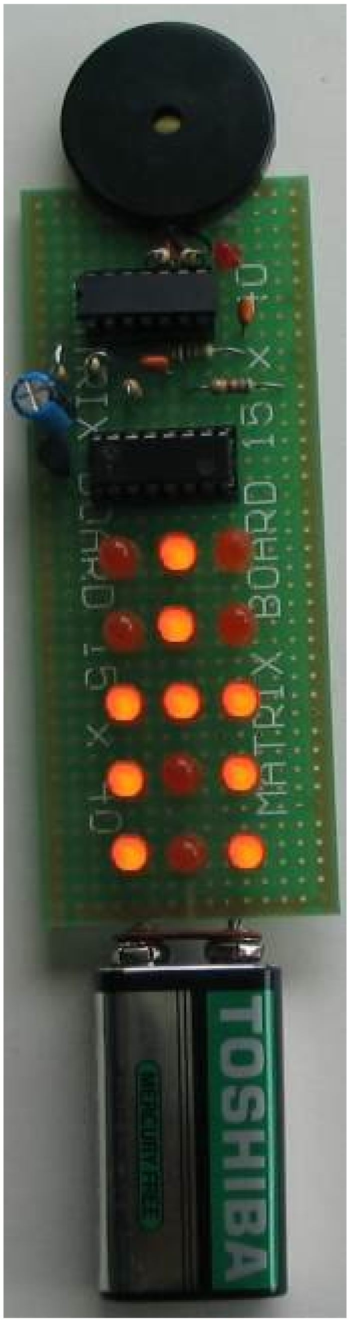
LED ZEPPELIN

This circuit is a game of skill. See full article: LED Zeppelin. The kit is available from talking electronics for $15.50 plus postage. Email HERE for details.
The game consists of six LEDs and an indicator LED that flashes at a rate of about 2 cycles per second. A push button is the "Operations Control" and by carefully pushing the button in synchronisation with the flashing LED, the row of LEDs will gradually light up.
But the slightest mistake will immediately extinguish one, two or three LEDs. The aim of the game is to illuminate the 6 LEDs with the least number of pushes.
We have sold thousands of these kits. It's a great challenge.

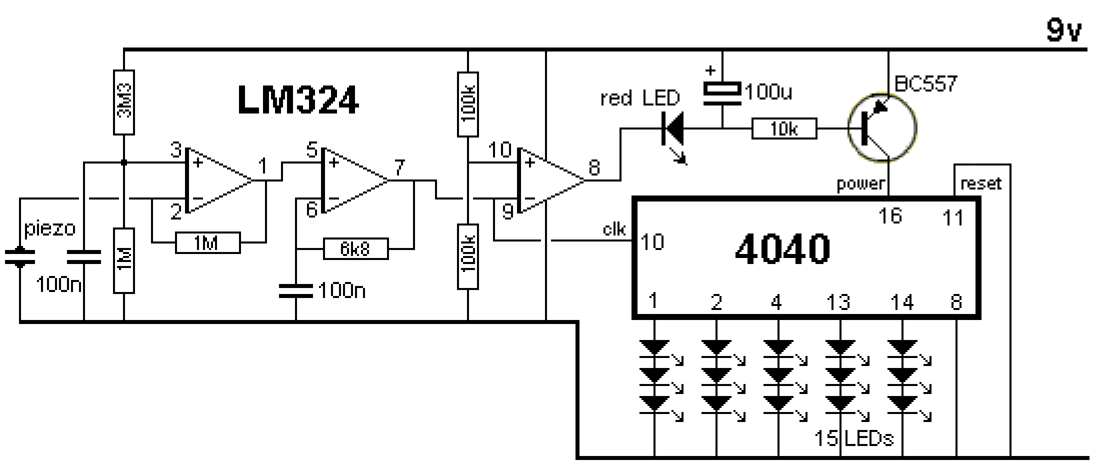

R1
470k
56k
CD 4011
C1
4.7u
BC557
Q8
10k
R17
9v
push
button
D1
1N4148
R3
22k
470R
R4
LED6
LED5
LED4
LED3
LED2
LED1
R16
270R
330R
390R
470R
470R
R11
560R
BC547
Q7
Q1
BC547
1k
R10
1k
BC547
2k2
BC547
2k2
BC547
3k3
BC547
LED7
R18
1k
Q2
C2
470u
R5
4k7
BC547
D2
1N4148



THE DOMINO EFFECT

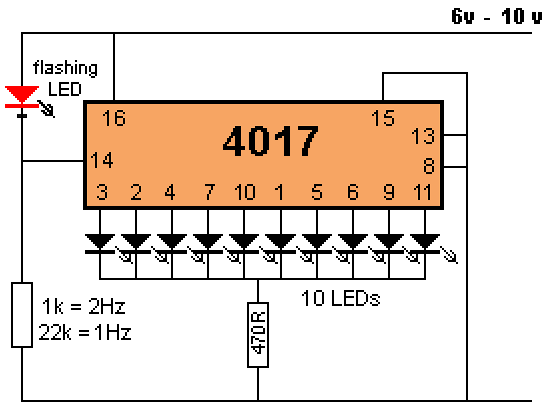


Here's a project with an interesting name. The original design was bought over 40yearsa ago, before the introduction of the electret microphone. They used a crystal earpiece.
We have substituted it with a piezo diaphragm and used a quad op-amp to produce two building blocks. The first is a high-gain amplifier to take the few millivolts output of the piezo and amplify it sufficiently to drive the input of a counter chip. This requires a waveform of at least 6v for a 9v supply and we need a gain of about 600.
The other building block is simply a buffer that takes the high-amplitude waveform and delivers the negative excursions to a reservoir capacitor (100u electrolytic). The charge on this capacitor turns on a BC557 transistor and this effectively takes the power pin of the counter-chip to the positive rail via the collector lead.
The chip has internal current limiting and some of the outputs are taken to sets of three LEDs.
The chip is actually a counter or divider and the frequency picked up by the piezo is divided by 128 and delivered to one output and divided by over 8,000 by the highest-division output to three more LEDs The other lines have lower divisions.
This creates a very impressive effect as the LEDs are connected to produce a balanced display that changes according to the beat of the music.
The voltage on the three amplifiers is determined by the 3M3 and 1M voltage-divider on the first op-amp. It produces about 2v. This makes the output go HIGH and it takes pin 2 with it until this pin see a few millivolts above pin3. At this point the output stops rising.
Any waveform (voltage) produced by the piezo that is lower than the voltage on pin 3 will make the output go HIGH and this is how we get a large waveform.
This signal is passed to the second op-amp and because the voltage on pin 6 is delayed slightly by the 100n capacitor, is also produces a gain.
When no signal is picked up by the piezo, pin 7 is approx 2v and pin 10 is about 4.5v. Because pin 9 is lower than pin 10, the output pin 8 is about 7.7v (1.3v below the supply rail) as this is as high as the output will go - it does not go full rail-to-rail.
The LED connected to the output removes 1.7v, plus 0.6v between base and emitter and this means the transistor is not turned on.
Any colour LEDs can be used and a mixture will give a different effect.

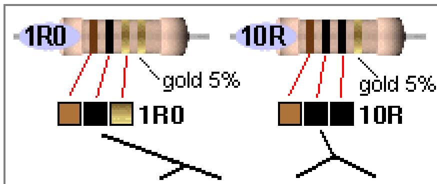


10 LED CHASER

Here's an interesting circuit that creates a clock pulse for a 4017 from a flashing LED. The flashing LED takes almost no current between flashes and thus the clock line is low via the 1k to 22k resistor. When the LED flashes, the voltage on the clock line is about 2v -3v below the rail voltage (depending on the value of the resistor) and this is sufficient for the chip to see a HIGH.



(circuit designed on 9-10-2010)

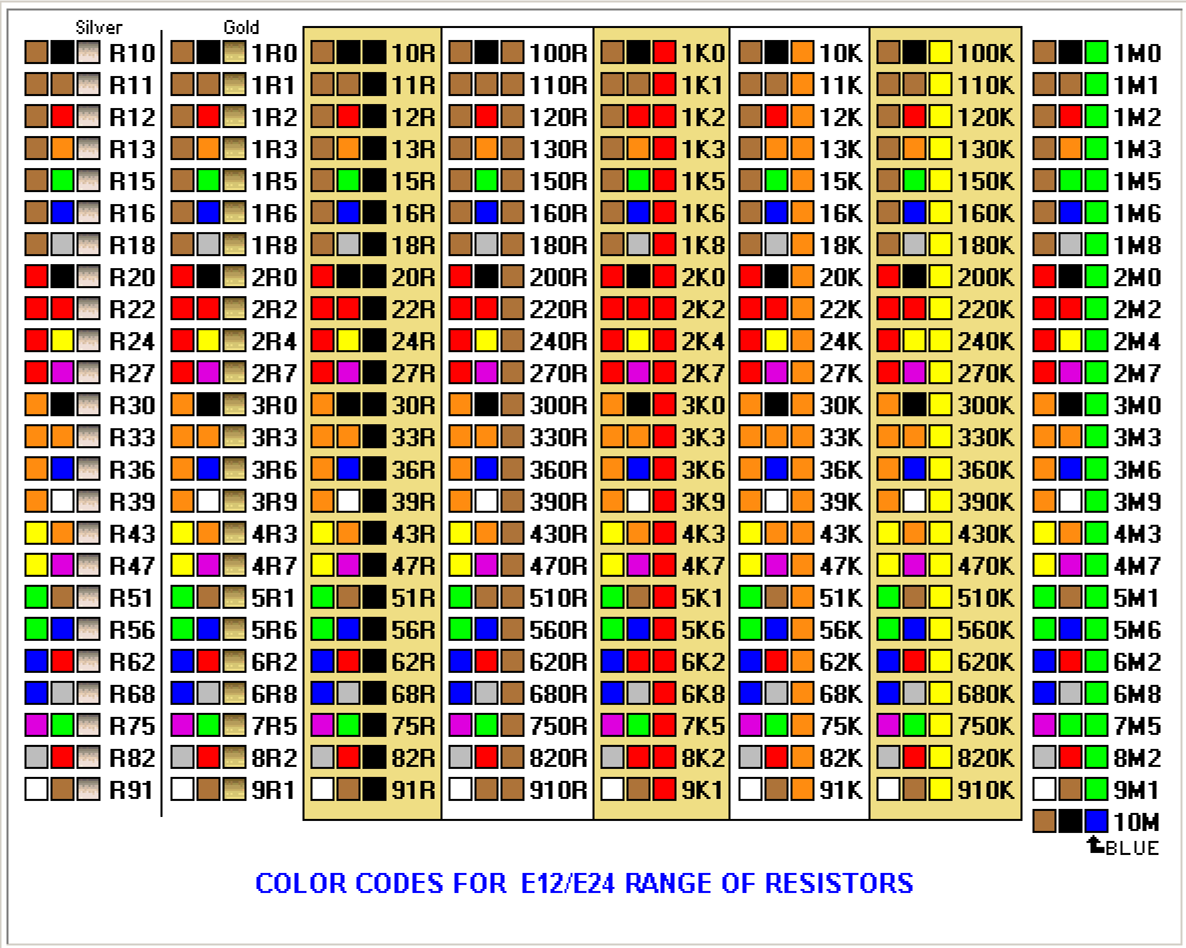


If 3rd band is gold, Divide by 10
If 3rd band is silver, Divide by 100
(to get 0.22ohms etc)

Silver	Gold						
R10	1R0	10R	100R	1K0	10K	100K	1M0
R11	1R1	11R	110R	1K1	11K	110K	1M1
R12	1R2	12R	120R	1K2	12K	120K	1M2
R13	1R3	13R	130R	1K3	13K	130K	1M3
R15	1R5	15R	150R	1K5	15K	150K	1M5
R16	1R6	16R	160R	1K6	16K	160K	1M6
R18	1R8	18R	180R	1K8	18K	180K	1M8
R20	2R0	20R	200R	2K0	20K	200K	2M0
R22	2R2	22R	220R	2K2	22K	220K	2M2
R24	2R4	24R	240R	2K4	24K	240K	2M4
R27	2R7	27R	270R	2K7	27K	270K	2M7
R30	3R0	30R	300R	3K0	30K	300K	3M0
R33	3R3	33R	330R	3K3	33K	330K	3M3
R36	3R6	36R	360R	3K6	36K	360K	3M6
R39	3R9	39R	390R	3K9	39K	390K	3M9
R43	4R3	43R	430R	4K3	43K	430K	4M3
R47	4R7	47R	470R	4K7	47K	470K	4M7
R51	5R1	51R	510R	5K1	51K	510K	5M1
R56	5R6	56R	560R	5K6	56K	560K	5M6
R62	6R2	62R	620R	6K2	62K	620K	6M2
R68	6R8	68R	680R	6K8	68K	680K	6M8
R75	7R5	75R	750R	7K5	75K	750K	7M5
R82	8R2	82R	820R	8K2	82K	820K	8M2
R91	9R1	91R	910R	9K1	91K	910K	9M1
							10M

BLUE

COLOR CODES FOR E12/E24 RANGE OF RESISTORS


Silver
Gold
R10 1R0 10R 100R 1K0 10K 100K 1M0
R11 1R1 11R 110R 1K1 11K 110K 1M1
R12 1R2 12R 120R 1K2 12K 120K 1M2
R13 1R3 13R 130R 1K3 13K 130K 1M3
R15 1R5 15R 150R 1K5 15K 150K 1M5
R16 1R6 16R 160R 1K6 16K 160K 1M6
R18 1R8 18R 180R 1K8 18K 180K 1M8
R20 2R0 20R 200R 2K0 20K 200K 2M0
R22 2R2 22R 220R 2K2 22K 220K 2M2
R24 2R4 24R 240R 2K4 24K 240K 2M4
R27 2R7 27R 270R 2K7 27K 270K 2M7
R30 3R0 30R 300R 3K0 30K 300K 3M0
R33 3R3 33R 330R 3K3 33K 330K 3M3
R36 3R6 36R 360R 3K6 36K 360K 3M6
R39 3R9 39R 390R 3K9 39K 390K 3M9
R43 4R3 43R 430R 4K3 43K 430K 4M3
R47 4R7 47R 470R 4K7 47K 470K 4M7
R51 5R1 51R 510R 5K1 51K 510K 5M1
R56 5R6 56R 560R 5K6 56K 560K 5M6
R62 6R2 62R 620R 6K2 62K 620K 6M2
R68 6R8 68R 680R 6K8 68K 680K 6M8
R75 7R5 75R 750R 7K5 75K 750K 7M5
R82 8R2 82R 820R 8K2 82K 820K 8M2
R91 9R1 91R 910R 9K1 91K 910K 9M1
10M
BLUE
COLOR CODES FOR E12/E24 RANGE OF RESISTORS