200 Transistor Circuits

Colin Mitchell

Contents

INTRODUCTION

This e-book contains 200+ transistor circuits. Most of them can be made with components from your "junk box" and hopefully you can put them together in less than an hour. The idea of this book is to get you into the fun of putting things together and there's nothing more rewarding than seeing something work. It's amazing what you can do with a few transistors and some additional components. And this is the place to start. Most of the circuits are "stand-alone" and produce a result with as little as 5 parts.

We have even provided a simple way to produce your own speaker transformer by winding turns on a piece of ferrite rod. Many components can be obtained from transistor radios, toys and other pieces of discarded equipment you will find all over the place.

To save space we have not provided lengthy explanations of how 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) See Talking Electronics website for more details. Transistor data is at the bottom of this page and a transistor tester circuits are also provided.

There are lots of categories and I am sure many of the circuits will be new to you, because some of them have been designed recently by me. Basically there are two types of transistor: PNP and NPN. We have labelled the NPN transistor as BC547. This means you can use ANY NPN transistor, such as 2N2222, BC108, 2N3704, BC337 and hundreds of others. Some circuits use TUN for Transistor Universal NPN and this is the same as our reasoning - the transistor-type is just to let you know it is not critical. BC557 can be replaced by: 2N3906, BC327 and many others. Don't worry too much about the transistor-type. Just make sure it is NPN, it this is the type needed. If it is an unknown transistor-type, you need to identify the leads then put it in the circuit.

You have a choice of building a circuit "in the air," or using a experimenter board (solderless breadboard) or a matrix board or even a homemade printed circuit board. The choice is up to you but the idea is to keep the cost to a minimum - so don't buy anything expensive. If you take parts from old equipment it will be best to solder them together "in the air" (as they will not be suitable for placing on a solderless breadboard as the leads will be bent and very short). This way they can be re-used again and again.

No matter what you do, I know you will be keen to hear some of the "noisy" circuits in operation. Before you start, the HOME-MADE SPEAKER TRANSFORMER project and TRANSISTOR TESTER 1 are the first things you should look at. If you are starting in electronics, see the WORLDS SIMPLEST CIRCUIT. It shows how a transistor works and three transistors in the 8 Million Gain project will detect microscopic levels of static electricity! You can look through the Index but the names of the projects don't give you a full description of what they do. You need to look at the circuits. And I am sure you will.

KIT OF PARTS TO BUILD THE CIRCUITS

CLICK THIS LINK TO BUY/REQUEST A 15.00 DOLLAR KIT FROM COLIN MITCHEL (SHIPPED by AIR MAIL)

Talking Electronics supplies a kit of parts that can be used to build the majority of the circuits in this book. The kit costs $15.00 plus postage. Email Colin Mitchell to get it.

The kit contains the following components:

- 3 - 47R
- 5 - 220R
- 5 - 470R
- 5 - 1k
- 5 - 4k7
- 5 - 10k
- 2 - 33k
- 4 - 100k
- 4 - 1M
- 1 - 10k mini pot
- 1 - 100k mini pot
- 2 - 10n
- 2 - 100n
- 5 - 10u electrolytics
- 5 - 100u electrolytics
- 5 - 1N4148 signal diodes
- 6 - BC547 transistors - NPN - 100mA
- 2 - BC557 transistors - PNP - 100mA
- 1 - BC338 transistor - NPN - 800mA
- 3 - BD679 Darlington transistors - NPN - 4amp
- 5 - red LEDs
- 5 - green LEDs
- 5 - orange LEDs
- 2 - super-bright WHITE LEDs - 20,000mcd
- 1 - 3mm or 5mm flashing LED
- 1 - mini 8R speaker
- 1 - mini piezo
- 1 - LDR (Light Dependent Resistor)
- 1 - electret microphone
- 1m - 0.25mm wire
- 1m - 0.5mm wire
- 1 - 10mH inductor
- 1 - push button
- 5 - tactile push buttons
- 1 - Experimenter Board (will take 8, 14 and 16 pin chips)
- 5 - mini Matrix Boards: 7 x 11 hole, 11 x 15 hole, 6 x 40 hole, surface-mount 6 x 40 hole board or others.

- plus extra 30 resistors and 10 capacitors for experimenting.

There are more components than you think. . . plus an extra bag of approx 30 components. The 8 little components are switches and the LDR and flashing LED is hiding.

In many cases, a resistor or capacitor not in the kit, can be created by putting two resistors or capacitors in series or parallel or the next higher or lower value can be used.

Don't think transistor technology is obsolete. Many complex circuits have one or more transistors to act as buffers, amplifiers or to connect one block to another. It is absolutely essential to understand this area of electronics if you want to carry out design-work or build a simple circuit to carry out a task.

We also have an eBook: THE TRANSISTOR AMPLIFIER with over 100 different transistor circuits - proving the transistor can be connected in so many ways.

THEORY

Read the full article HERE (the Transistor Amplifier eBook)

The first thing you will want to know is:

HOW DOES A TRANSISTOR WORK?

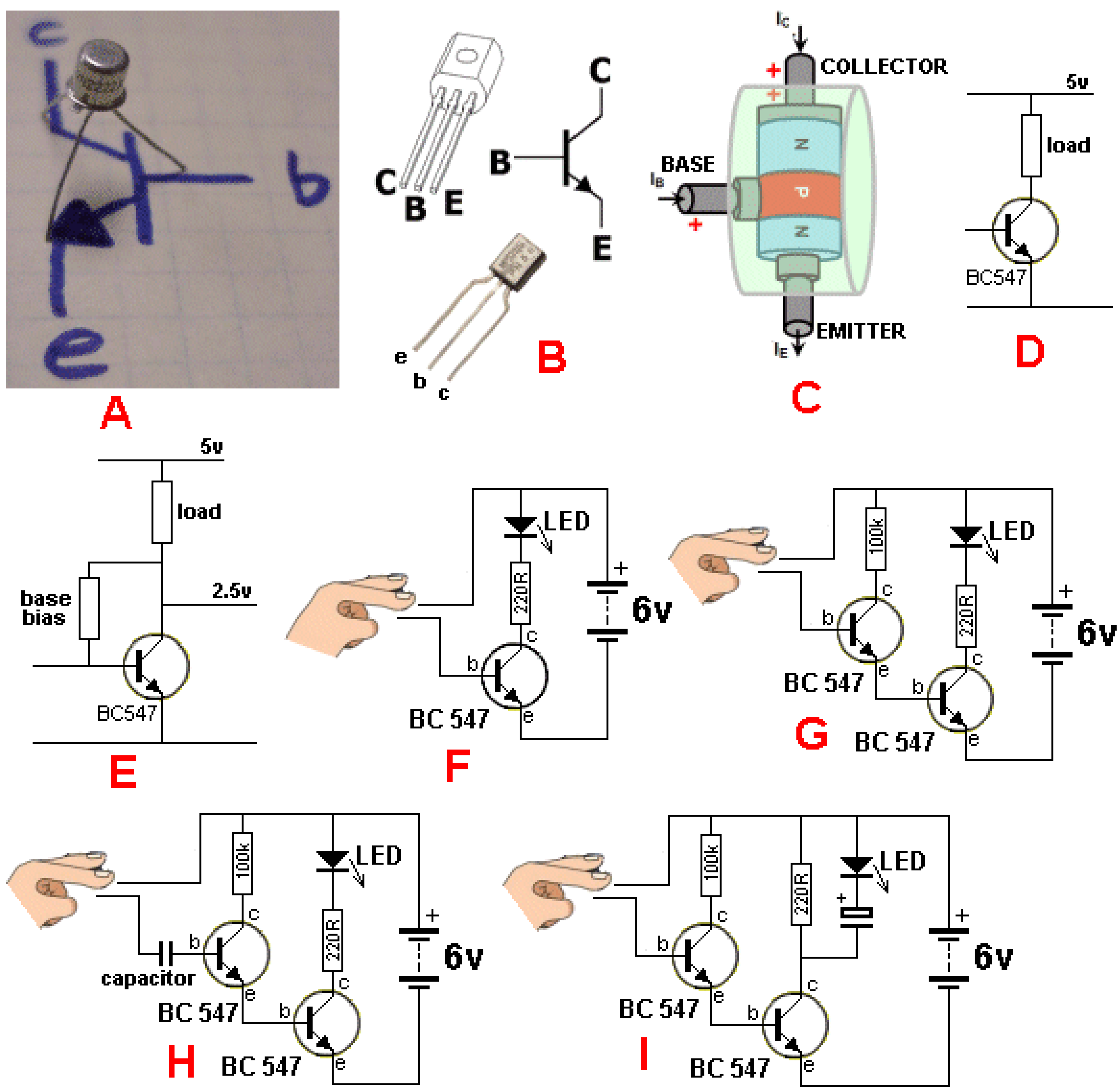


Diagram "A" shows an NPN transistor with the legs covering the symbol showing the name for each lead.

The transistor is a “general purpose” type and and is the smallest and cheapest type you can get. The number on the transistor will change according to the country where the circuit was designed but the types we refer to are all the SAME.

Diagram “B” shows two different “general purpose” transistors and the different pinouts. You need to refer to data sheets or test the transistor to find the correct pinout.

Diagram “C” shows the equivalent of a transistor as a water valve. As more current (water) enters the base, more water flows from the collector to the emitter.

Diagram “D” shows the transistor connected to the power rails. The collector connects to a resistor called a LOAD and the emitter connects to the 0v rail or earth or “ground.”

Diagram “E” shows the transistor in SELF BIAS mode. This is called a COMMON EMITTER stage and the resistance of the BASE BIAS RESISTOR is selected so the voltage on the collector is half-rail voltage. In this case it is 2.5v.

To keep the theory simple, here’s how you do it. Use 22k as the load resistance. Select the base bias resistor until the measured voltage on the collector 2.5v. The base bias will be about 2M2.

This is how the transistor reacts to the base bias resistor:

- The base bias resistor feeds a small current into the base and this makes the transistor turn on and create a current-flow though the collector-emitter leads.
- This causes the same current to flow through the load resistor and a voltage-drop is created across this resistor. This lowers the voltage on the collector.
- The lower voltage causes a lower current to flow into the base and the transistor stops turning on a slight amount. The transistor very quickly settles down to allowing a certain current to flow through the collector-emitter and produce a voltage at the collector that is just sufficient to allow the right amount of current to enter the base.

Diagram “F” shows the transistor being turned on via a finger. Press hard on the two wires and the LED will illuminate brighter. As you press harder, the resistance of your finger decreases. This allows more current to flow into the base and the transistor turns on harder.

Diagram “G” shows a second transistor to “amplify the effect of your finger” and the LED illuminates about 100 times brighter. Diagram “H” shows the effect of putting a capacitor on the base lead. The capacitor must be uncharged and when you apply pressure, the LED will flash brightly then go off. This is because the capacitor gets charged when you touch the wires. As soon as it is charged NO MORE CURRENT flows though it. The first transistor stops receiving current and the circuit does not keep the LED illuminated. To get the circuit to work again, the capacitor must be discharged. This is a simple concept of how a capacitor works. A large-value capacitor will keep the LED illuminated for a longer period of time.

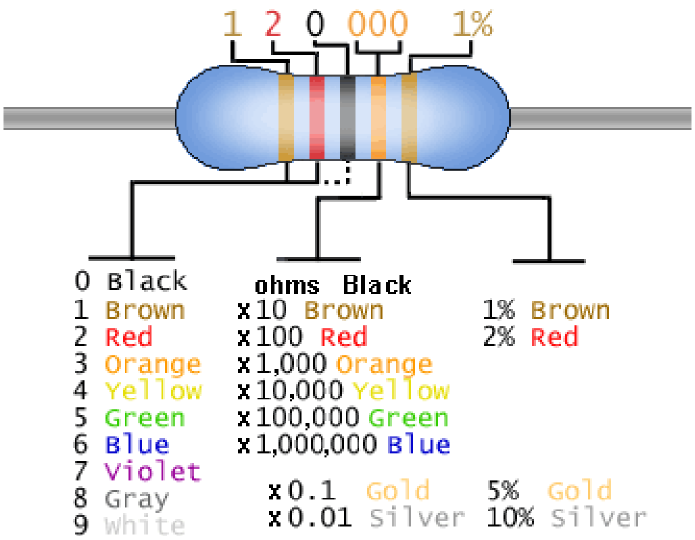
Diagram “I” shows the effect of putting a capacitor on the output. It must be uncharged for this effect to work. We know from Diagram G that the circuit will stay on when the wires are touched but when a capacitor is placed in the output, it gets charged when the circuit turns ON and only allows the LED to flash.

1. This is a simple explanation of how a transistor works. It amplifies the current going into the base about 100 times and the higher current flowing through the collector-emitter leads will illuminate a LED.
2. A capacitor allows current to flow through it until it gets charged. It must be discharged to see the effect again.

INCREASING THE VOLTAGE

You can change the voltage of many circuits from 6v to 12v or 3v to 6v without altering any of the values. I can see instantly if this is possible due to the value of the components and here’s how I do it: Look at the value of the resistors driving the load(s). Work out the current entering each load and see if it is less than the maximum allowable. Then, take a current reading on the lower voltage. Increase the voltage to the higher value and take another reading. In most cases the current will increase to double the value (or a little higher than twice the original value). If it is over 250% higher, you need to feel each of the components and see if any are getting excessively hot. If any LEDs are taking excessive current, double the value of the current-limiting resistor. If any transistor is getting hot, increase the value of the load resistor. In most cases, when the voltage is doubled, the current will will crease to double the original. This means the circuit will consume 4 times the original energy. This is just a broad suggestion to answer the hundreds of emails I get on this topic.

RESISTOR COLOUR CODE



TRANSISTOR CIRCUITS, Part I

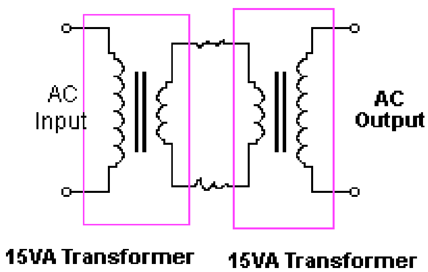
SAFE 240v SUPPLY

When working on any project that connects to the "mains," it is important to take all precautions to prevent electrocution.

This project provides 240v AC but the current it limited to 60mA if a 15 watt transformer is used. Although the output can produce a nasty shock and the voltage will kill you, the circuit provides isolation from the mains and if a short-circuit occurs, it will not blow a fuse, but the transformers will get very hot as start to buzz.

You can use any two identical transformers and the wattage of either transformer will determine the maximum output wattage.

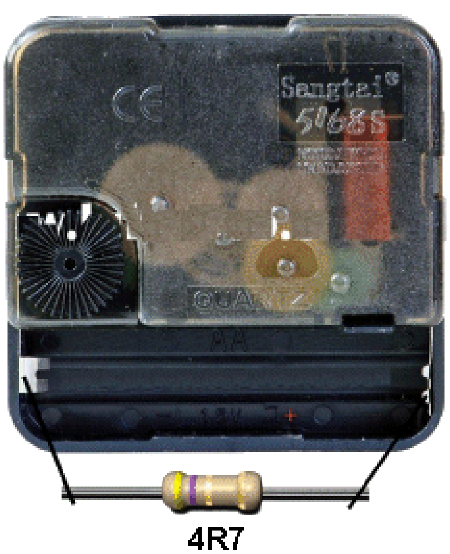
If you don't use identical transformers, the output voltage will be higher or lower than the "mains" voltage and the wattage will be determined by the smaller transformer.



This arrangement is not perfectly safe, but is the best you can get when working on projects such as switch-mode power supplies, capacitor-fed down-lights etc.

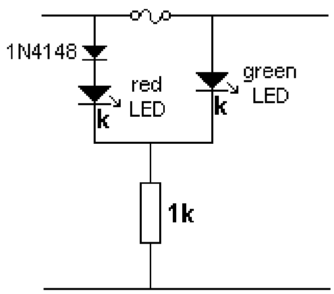
RECHARGEABLE BATTERY CAPACITY

This simple circuit tests the capacity of a rechargeable cell. Connect a 4R7 (yellow-purple-gold-gold) resistor across the terminals of a clock mechanism and fit a fully charged rechargeable cell. Set the hands to 12 O'Clock and the clock will let you know how long the cell lasted until the voltage reached about 0.8v. Now fit another cell and see how long it lasts. You cannot work out the exact capacity of a cell but you can compare one cell with another. The initial current is about 250mA for a 1.2v cell.



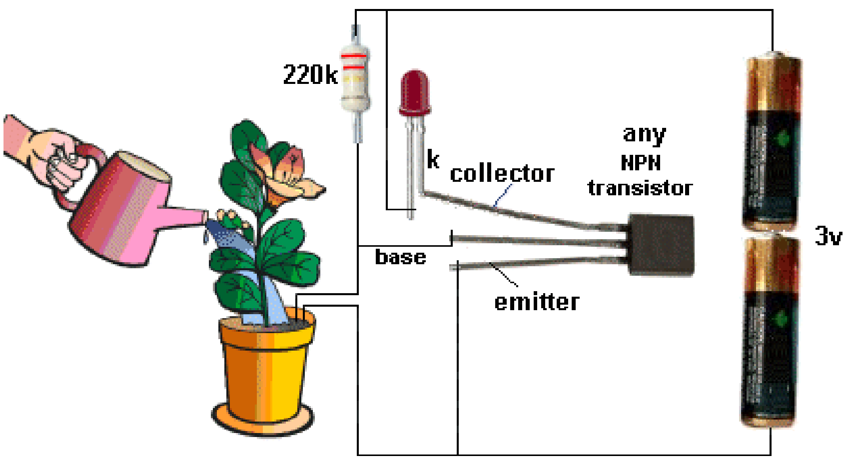
BLOWN FUSE INDICATOR

This circuit indicates when a fuse is "blown".



PLANT NEEDS WATERING

This circuit indicates when the soil is dry and the plant needs watering. The circuit does not have a current-limiting resistor because the base resistor is very high and the current through the transistor is only 2mA. Don't change the supply voltage or the 220k as these two values are correct for this circuit.



THE SOLAR PANEL

This will clear-up a lot of mysteries of the solar panel.

Many solar panels produce 16v - 18v when lightly loaded, while other 12v solar panels will not charge a 12v battery.

Some panels say "nominal voltage," some do not give any value other than 6v or 12v, and some specify the wrong voltage. You can't work with vague specifications. You need to know accurate details to charge a battery from a solar panel.

There are 3 things you have to know before buying a panel or connecting a panel to a battery:

1. The **UNLOADED VOLTAGE**.
2. The voltage of the panel when delivering the rated current. Called the **RATED VOLTAGE**.
3. The **CURRENT**.

- The **UNLOADED VOLTAGE** is the voltage produced by the panel when it is lightly loaded. This voltage is very important because a 12v battery will produce a "floating voltage" of about 15v when it is fully charged and it will gradually rise to this voltage during the charging period. This means the panel must be able to deliver more than 15v so it will charge a 12v battery.

  Sometimes there is a diode and a charging circuit between the panel and battery and these devices will drop a small voltage, so the panel must produce a voltage high enough to allow for them.

  The **Unloaded Voltage** can sometimes be determined by counting the number of cells on the panel as each cell will produce 0.6v.

  If you cannot see the individual cells, use a multimeter to read the voltage under good illumination and watch the voltage rise. You can place a 100 ohm resistor across the panel to take readings.

- The **RATED VOLTAGE** is the guaranteed voltage the panel will deliver when full current is flowing.

  This can also be called the Nominal Voltage, however don't take anything for certain. Take readings of your own. The Rated Voltage (and current) is produced when the panel receives bright sunlight. This may occur for only a very small portion of the day.

  You can clearly see the 11 cells of this panel and it produces 6.6v when lightly loaded. It will barely produce 6v when loaded and this is **NOT ENOUGH** to charge a 6v battery.

  This panel claims to be 18v, but it clearly only produces 14.4v. This is not suitable for charging a 12v battery. When you add a protection diode, the output voltage will be 13.8v. A flat battery being charged will reach 13.8v very quickly and it will not be charged any further. That's why the output voltage of a panel is so important.

  This is a genuine 18v panel:

  The panel needs to produce 17v to 18v so it will have a small "overhead" voltage when the battery reaches 14.4v and it will still be able to supply energy into the battery to complete the charging process.

- The **RATED CURRENT** is the maximum current the panel will produce when receiving full sunlight. The current of a panel can be worked out by knowing the wattage and dividing by the unloaded voltage. A 20 watt 18v panel will deliver about 1 amp.

Charging a Battery

A solar panel can be used to directly charge a battery without any other components. Simply connect the panel to the battery and it will charge when the panel receives bright sunlight - providing the panel produces a voltage least 30% to 50% more than the battery you are charging.

The voltage of the panel does not matter and the voltage of the battery does not matter. You can connect any panel to any battery - providing the panel can produce a voltage least 30% to 50% more than the battery you are charging.

The output voltage of the panel will simply adapt to the voltage of the battery. Even though there is a voltage mismatch, there is NO "lost" or wasted energy. An 18v panel "drives into" a 12v battery with the maximum current it can produce when the intensity of the sun is a maximum.

To prevent too-much mismatch, it is suggested you keep the panel voltage to within 150% of the battery voltage, for example:

- 6v battery - 9v max panel
- 12v battery - 18v max panel
- 24v battery - 36v max panel

But here's the important point: to prevent overcharging the battery, the wattage of the panel is important. If the wattage of an 18v panel is 6watts, the current is 6/18 = 0.33 amps = 330mA. To prevent overcharging a battery, the charging current should not be more than one-tenth its amp-hr capacity.

For instance, a 2,000mAhr set of cells should not be charged at a rate higher than 200mA for 14 hours. This is called its 14-hour rate. But this rating is a CONSTANT RATING and since a solar panel produces an output for about 8 hours per day, you can increase the charging current to 330mA for 8 hours. This will deliver the energy to fully charge the cells.

That's why a 6 watt panel can be directly connected to a set of (nearly fully discharged) 2,000mAhr cells. For a 12v 1.2AHr battery, the charging current will be 100mA for 12 hours or 330mA for 4 hours and a regulator circuit will be needed to prevent overcharging. For a 12v 4.5AHr battery, the charging current will be 375mA for 12 hours and a larger panel will be needed.

Adding a Diode

Some solar panels will discharge the battery (a small amount) when it is not receiving sunlight and a diode can be added to prevent discharge. This diode drops 0.6v when the panel is operating and will reduce the maximum current (slightly) when the panel is charging the battery. If the diode is Schottky, the voltage-drop is 0.35v. Some panels include this diode - called a BYPASS DIODE.

Preventing Overcharging

There are two ways to prevent overcharging the battery.

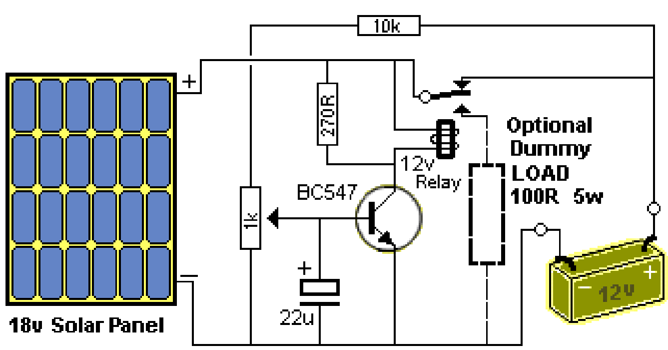
1. Discharge the battery nearly fully each night and use a panel that will only deliver 120% of the amp-hour capacity of the battery the following day.
2. Add a **VOLTAGE REGULATOR**.

Here is the simplest and cheapest regulator to charge a 12v battery. Full details of how the circuit works and setting up the circuit is HERE. The solar panel must be able to produce at least 16v on NO LOAD (25-28 cells). The diagram only shows a 24 cell panel - it should be 28 cells.

The only other thing you have to consider is the wattage of the panel. This will depend on how fast you want to charge the battery and/or how much energy you remove from the battery each day and/or the amp-Hr capacity of the battery. For instance, a 12v 1.2A-Hr battery contains 14watt-hours of energy. An 6watt panel (16v to 18v) will deliver 18watt-hours (in bright sunlight) in 3 hours. The battery will be fully charged in 3 hours.

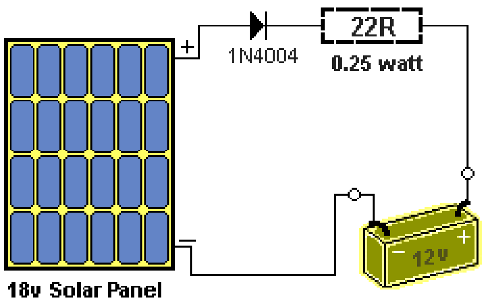
Solar Battery Charger/Regulator

The pot is adjusted so the relay drops-out at 13.7v. The charger will turn ON when the voltage drops to about 12.5v. The 100R Dummy LOAD will absorb 3.25 watts and that is the maximum wattage the panel will produce with 100R load.



Charge Current

Here is a very clever circuit to find the charging current, if you don't have a multimeter.



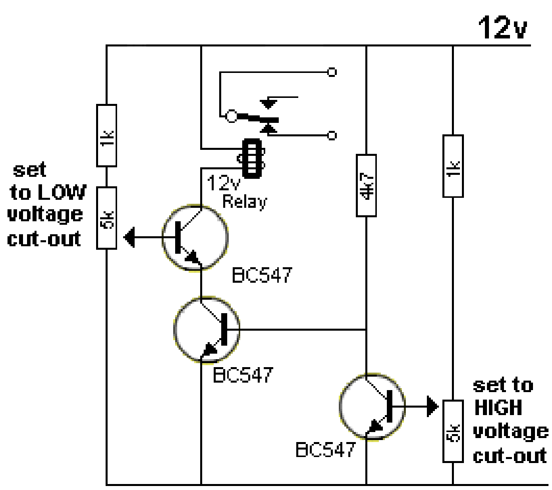
Connect a 22R 0.25 watt resistor in series with the battery and hold your finger on the resistor. The resistor will get very hot if 100mA or more is flowing. **This resistor will indicate ONE WATT** of energy is flowing into the battery, but we are using a 0.25 watt resistor to measure the heat as this represents "LOST ENERGY" and we want to keep the losses to a minimum. To get some idea of 0.25watt of heat, place a 560R 0.25watt resistor across the terminals of a battery. This is 250mW of heat and is your reference.

A 1.2A-Hr 12 volt battery has 14 watts of energy and if you are charging at ONE WATT, it will take about 16 hours to fully charge the battery.

This circuit can be used when charging a battery from your car, from a solar panel, a battery charger or a pulsed solar-charging circuit. It is also a SAFETY CIRCUIT as it will limit the current to 100mA. If the current is higher than 130mA, the resistor will hot and start to smell.

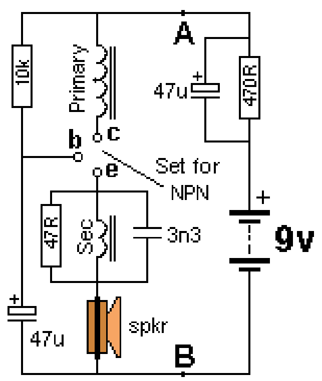
Note: when the 22R is removed, the current flowing into the battery WILL INCREASE. The increase may be only 10% from some chargers, but can be as high as 100% OR MORE if the battery is connected to the cigarette lighter plug in your car.

HIGH-LOW VOLTAGE CUT-OUT



This circuit will turn off the relay when the voltage is above or below the "set-points."; You need either a variable power supply or a 12v battery and an extra 1.5v battery. Turn the LOW voltage cutout trim pot to mid way and connect the 13.5v supply. Turn the HIGH voltage trim pot to the high end and the relay will turn off. Now turn the 1.5v battery around the other way and adjust the LOW voltage trim pot to the 10.5v supply.

TRANSISTOR TESTER 1



Transistor Tester - 1 project will test all types of transistors including Darlington and power. The circuit is set to test NPN types. To test PNP types, connect the 9v battery around the other way at points A and B.

The transformer in the photo is a 10mH choke with 150 turns of 0.01mm wire wound over the 10mH winding. The two original pins (with the red and black leads) go to the primary winding and the fine wires are called the Sec.

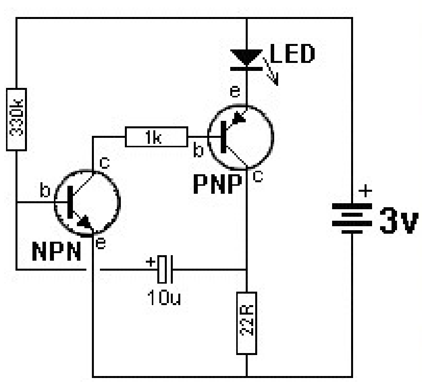
Connect the transformer either way in the circuit and if it does not work, reverse either the primary or secondary (but not both).

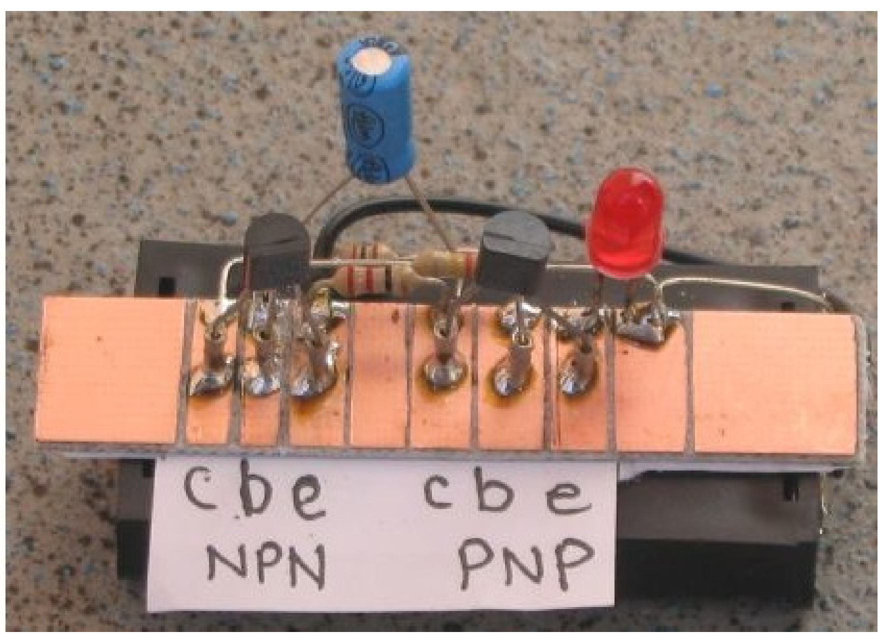
Almost any transformer will work and any speaker will be suitable. If you use the speaker transformer described in the HOME-MADE SPEAKER TRANSFORMER article, use one-side of the primary.

TRANSISTOR TESTER 2

Here is another transistor tester. This is basically a high gain amplifier with feedback that causes the LED to flash at a rate determined by the 10u and 330k resistor.

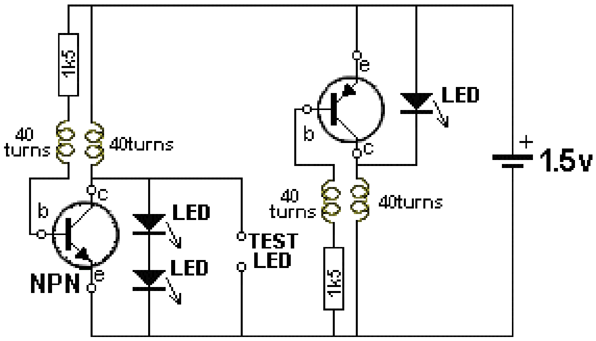
Remove one of the transistors and insert the unknown transistor. When it is NPN with the pins as shown in the photo, the LED will flash. To turn the unit off, remove one of the transistors.



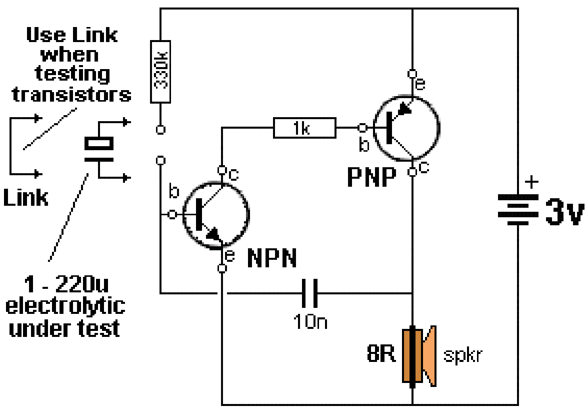


TRANSISTOR and LED TESTER 3

Here is another transistor tester. And it also tests LEDs. See the full project: Transistor Tester. This circuit is basically a Joule Thief design with the coil (actually a transformer) increasing the 1.5v supply to a higher voltage to illuminate one or two LEDs in series. The "LED Test" terminals uses the full voltage produced by the circuit and it will test any colour LED including a white LED. The two "coils" are wound on a 10mm dia pen with 0.1mm wire (very fine wire). All the components fit on a small PC board. A kit of parts for the project is a available from Talking Electronics for $4.00 plus $3.00 postage.



TRANSISTOR TESTER - 4 with ELECTROLYTIC TESTER



This circuit will test transistors and electrolytic capacitors from 1u to 220u for leakage, open, shorts and approx capacitance.

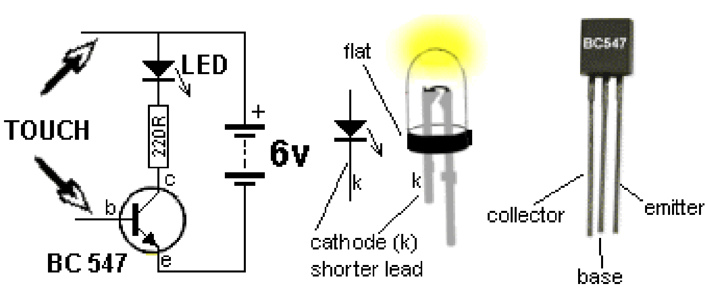
Build the circuit on a strip of PC board as shown in Transistor Tester-2 so the transistors can be replaced with a suspect transistor and an electrolytic can be fitted in place of the link for the capacitor.

When an electrolytic is fitted to the circuit, it will produce a wailing and eventually stop. If the tone continues, the electrolytic is leaky.

If the tone is not produced, the electrolytic is open. If the tone does not change, the electrolytic is shorted.

WORLDS SIMPLEST CIRCUIT

This is the simplest circuit you can get. Any NPN transistor can be used.



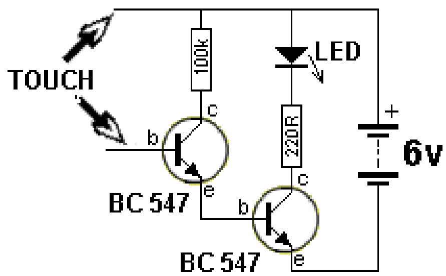
Connect the LED, 220 ohm resistor and transistor as shown in the photo.

Touch the top point with two fingers of one hand and the lower point with fingers of the other hand and squeeze.

The LED will turn on brighter when you squeeze harder.

Your body has resistance and when a voltage is present, current will flow though your body (fingers). The transistor is amplifying the current through your fingers about 200 times and this is enough to illuminate the LED.

SECOND SIMPLEST CIRCUIT

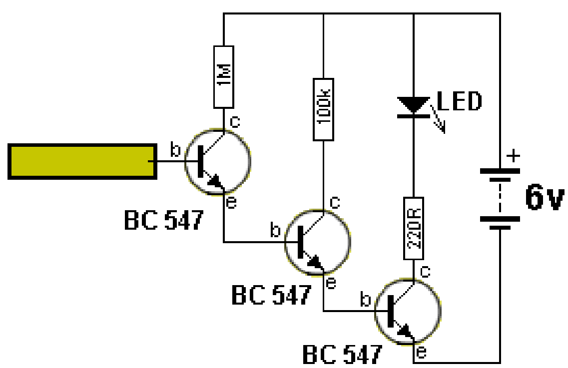


This the second simplest circuit in the world. A second transistor has been added in place of your fingers. This transistor has a gain of about 200 and when you touch the points shown on the diagram, the LED will illuminate with the slightest touch. The transistor has amplified the current (through your fingers) about 200 times.

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!

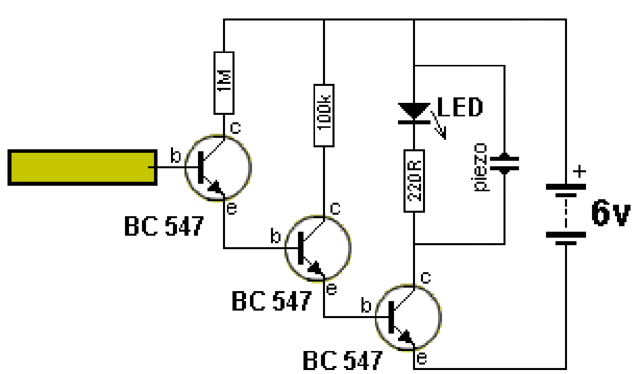
There is static electricity EVERYWHERE! The input of this circuit is classified as very high impedance.



MAINS HUM DETECTOR

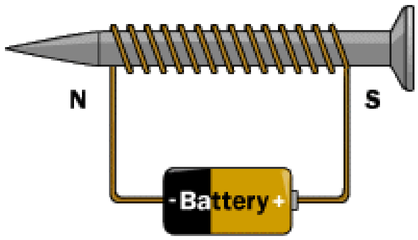
This simple circuit will detect if a cable is carrying the “Mains.” The piezo diaphragm is will let you hear the hum:

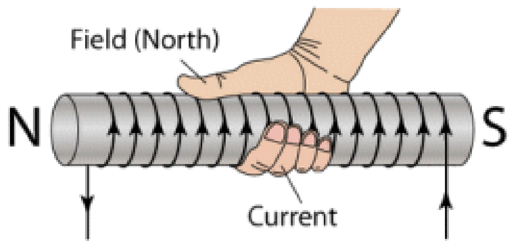
Do not touch the copper wire. Only place the detector near the plastic covering. It will work at 2cm from the cable



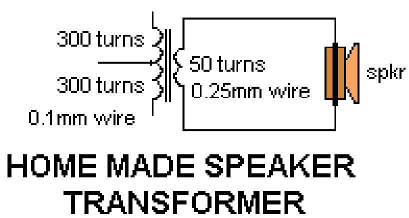
FINDING THE NORTH POLE

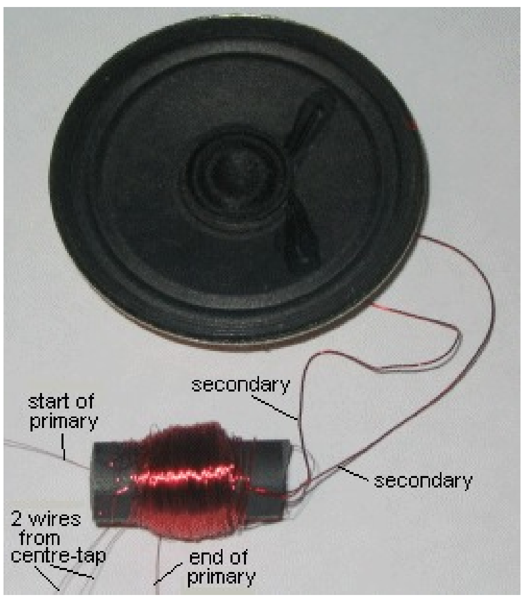
The diagrams show that a North Pole will be produced when the positive of a battery is connected to wire wound in the direction shown. This is Flemmings Right Hand Rule and applies to motors, solenoids and coils and anything wound like the turns in the diagram.





HOME-MADE SPEAKER TRANSFORMER





The **speaker transformer** is made by winding 50 turns of 0.25mm wire on a small length of 10mm dia ferrite rod.

The size and length of the rod does not matter - it is just the number of turns that makes the transformer work. This is called the secondary winding.

The primary winding is made by winding 300 turns of 0.1mm wire (this is very fine wire) over the secondary and ending with a loop of wire we call the centre tap.

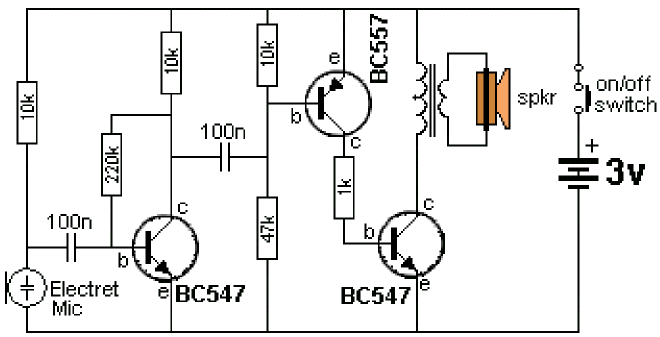
Wind another 300 turns and this completes the transformer.

It does not matter which end of the secondary is connected to the top of the speaker and it does not matter which end of the primary is connected to the collector of the transistor in the circuits in this book.

SUPER EAR

This circuit is a very sensitive 3-transistor amplifier using a speaker transformer. This can be wound on a short length of ferrite rod as show above or 150 turns on a 10mH choke. The biasing of the middle transistor is set for 3v supply. The second and third transistors are not turned on during idle conditions and the quiescent current is just 5mA.

The project is ideal for listening to conversations or TV etc in another room with long leads connecting the microphone to the amplifier.

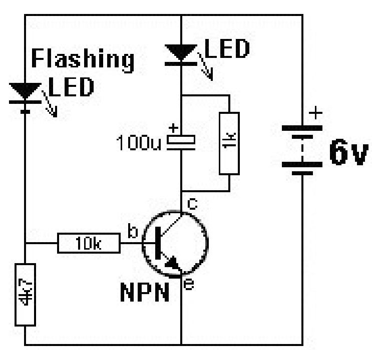


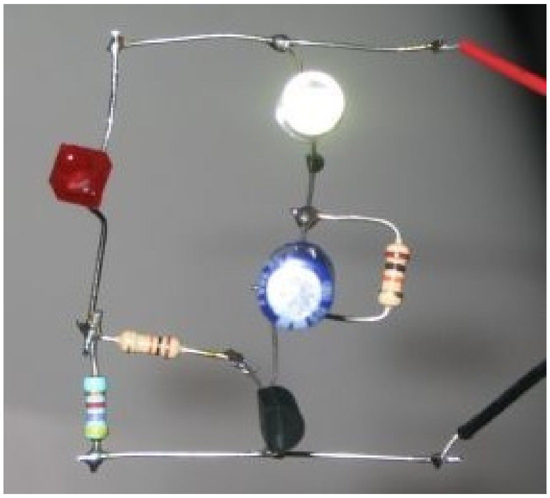
LED FLASHER WITH ONE TRANSISTOR!

This is a novel flasher circuit using a single driver transistor that takes its flash-rate from a flashing LED. The flasher in the photo is 3mm. An ordinary LED will not work.

The flash rate cannot be altered, but the brightness of the high-bright white LED can be adjusted by altering the 1k resistor across the 100u electrolytic to 4k7 or 10k.

The 1k resistor discharges the 100u so that when the transistor turns on, the charging current into the 100u illuminates the white LED. If a 10k discharge resistor is used, the 100u is not fully discharged and the LED does not flash as bright. All the parts in the photo are in the same places as in the circuit diagram to make it easy to see how the parts are connected.

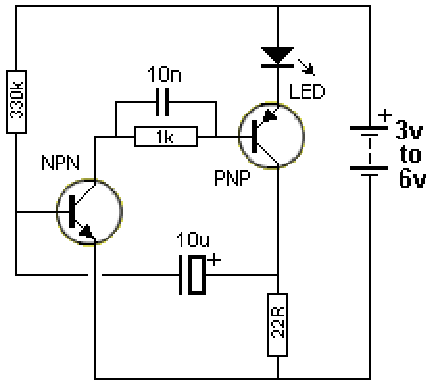


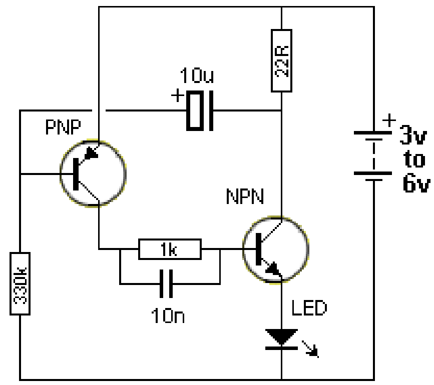


The circuit uses a flashing LED to flash a super-bright 20,000mcd white LED

LED FLASHER

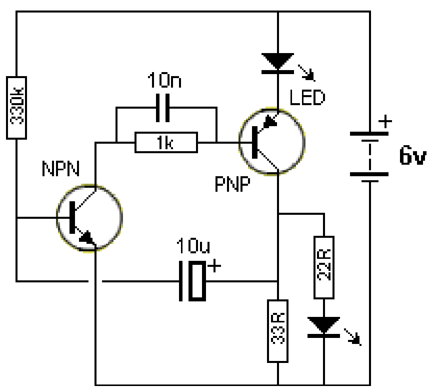
These two circuits will flash a LED very bright and consume less than 2mA average current. Both circuits can use a transistor with a larger current capability for the second transistor. The first circuit needs a PNP transistor and the second circuit needs an NPN transistor if a number of LEDs need to be driven. The second circuit is the basis for a SIMPLE MOTOR SPEED CONTROL. See the note on how the 330k works, in Flashing Two LEDs below.

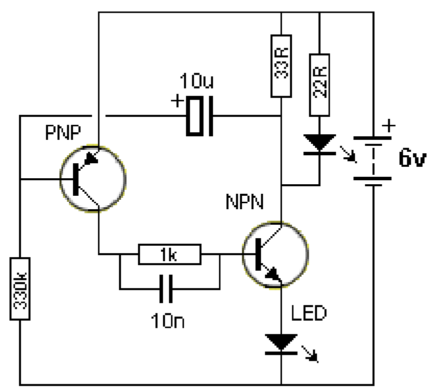




FLASHING TWO LEDS

These two circuits will flash two LEDs very bright and consume less than 2mA average current. They require 6v supply. The 330k may need to be 470k to produce flashing on 6v as 330k turns on the first transistor too much and the 10u does not turn the first transistor off a small amount when it becomes fully charged and thus cycling is not produced.

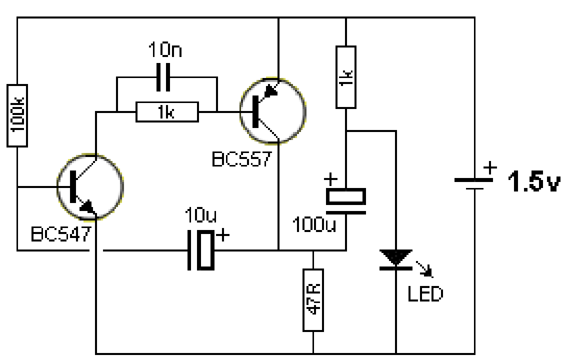




1.5v LED FLASHER

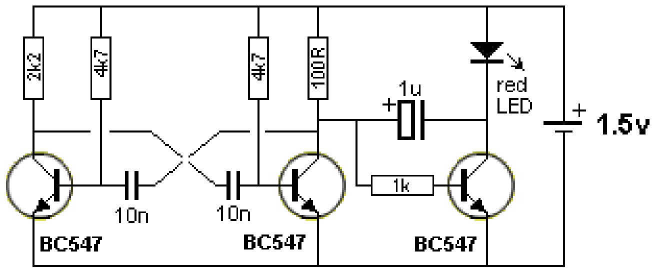
This will flash a LED, using a single 1.5v cell. It may even flash a white LED even though this type of LED needs about 3.2v to 3.6v for operation. The circuit takes about 2mA but produces a very bright flash.

My circuit has been copied by Eleccircuit.com but my layout makes it much easier to see how the circuit works.

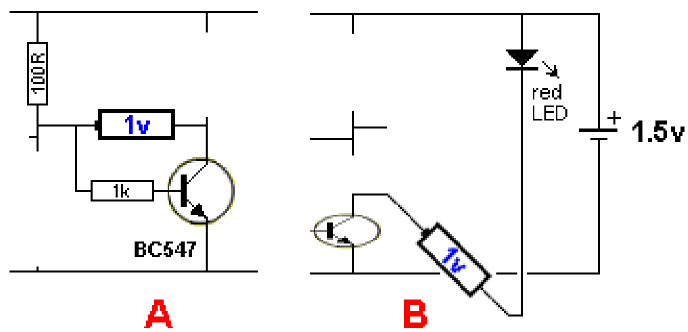


1.5v LED FLASHER

LED on 1.5v SUPPLY



LED ON 1.5v SUPPLY



A red LED requires about 1.7v before it will start to illuminate - below this voltage - NOTHING! This circuit takes about 12mA to illuminate a red LED using a single cell, but the interesting feature is the way the LED is illuminated.

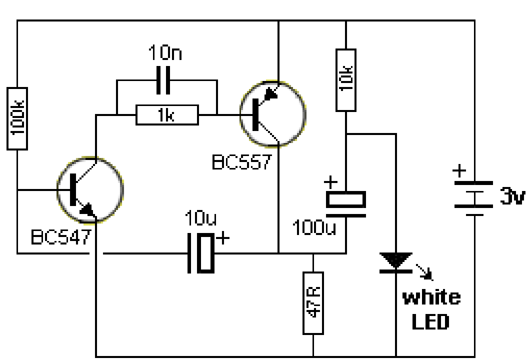
The 1u electrolytic can be considered to be a 1v cell. (If you want to be technical: it charges to about 1.5v - 0.2v loss due to collector-emitter = 1.3v and a lost of about 0.2v via collector-emitter in diagram B.)

It is firstly charged by the 100R resistor and the 3rd transistor (when it is fully turned ON via the 1k base resistor). This is shown in diagram "A."

During this time the second transistor is not turned on and that's why we have omitted it from the diagram. When the second transistor is turned ON, the 1v cell is pulled to the 0v rail and the negative of the cell is actually 1v below the 0v rail as shown in diagram "B."

The LED sees 1.5v from the battery and about 1v from the electrolytic and this is sufficient to illuminate it. Follow the two voltages to see how they add to 2.5v.

3v WHITE LED FLASHER

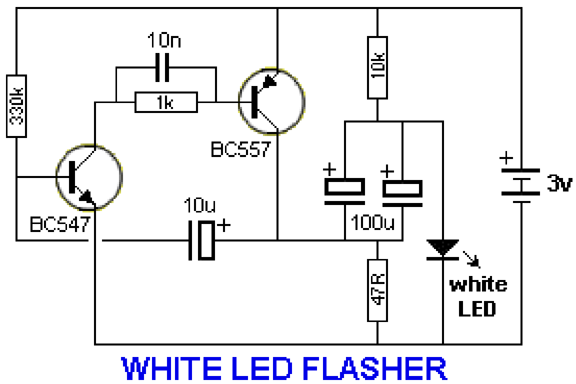


3v WHITE LED FLASHER

This will flash a white LED, on 3v supply and produce a very bright flash. The circuit produces a voltage higher than 5v if the LED is not in circuit but the LED limits the voltage to its characteristic voltage of 3.2v to 3.6v. The circuit takes about 2mA an is actually a voltage-doubler (voltage incrementer) arrangement.

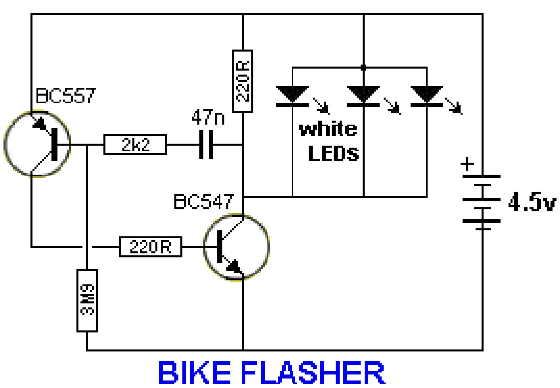
Note the 10k charges the 100u. It does not illuminate the LED because the 100u is charging and the voltage across it is always less than 3v. When the two transistors conduct, the collector of the BC557 rises to rail voltage and pulls the 100u HIGH. The negative of the 100u effectively sits just below the positive rail and the positive of the electro is about 2v higher than this. All the energy in the electro is pumped into the LED to produce a very bright flash.

BRIGHT FLASH FROM FLAT BATTERY



This circuit will flash a white LED, on a supply from 2v to 6v and produce a very bright flash. The circuit takes about 2mA and old cells can be used. The two 100u electros in parallel produce a better flash when the supply is 6v.

BIKE FLASHER



This circuit will flash a white LED (or 2,3 4 LEDs in parallel) at 2.7Hz, suitable for the rear light on a bike.

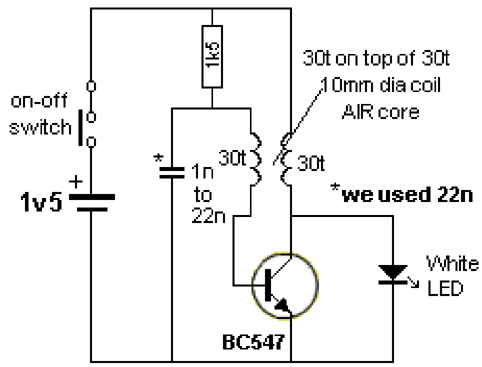
BIKE FLASHER - Amazing!

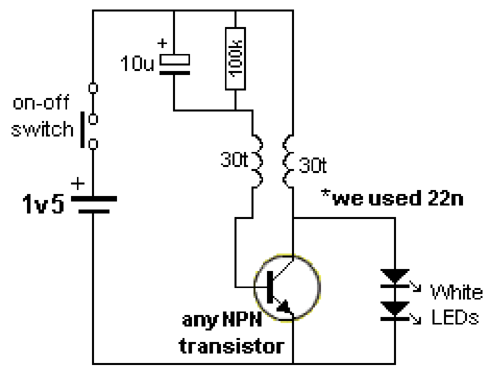
This bike flasher uses a single transistor to flash two white LEDs from a single cell. And it has no core for the transformer - just AIR!

All Joule Thief circuits you have seen, use a ferrite rod or toroid (doughnut) core and the turns are wound on the ferrite material. But this circuit proves the collapsing magnetic flux produces an increased voltage, even when the core is AIR. The fact is this: When a magnetic filed collapses quickly, it produces a higher voltage in the opposite direction and in this case the magnetic field surrounding the coil is sufficient to produce the energy we need.

Wind 30 turns on 10mm (1/2" dia) pen or screwdriver and then another 30 turns on top. Build the first circuit and connect the wires. You can use 1 or two LEDs. If the circuit does not work, swap the wires going to the base.

Now add the 10u electrolytic and 100k resistor (remove the 1k5). The circuit will now flash. You must use 2 LEDs for the flashing circuit.





THE IMPROVED BIKE FLASHER CIRCUIT

The secret to getting the maximum energy from the coil (to flash the LEDs) is the maximum amount of air in the centre of the coil. Air cannot transfer a high magnetic flux (density) so we provide a large area (volume) of low flux (density) to provide the energy. The larger (20mm) coil reduced the current from 20mA to 11mA for the same brightness. This could be improved further but the coil gets too big. The two 30-turn windings must be kept together because the flux from the main winding must cut the feedback winding to turn ON the transistor HARD.

When the transistor starts to turn on via the 100k, it creates magnetic flux in the main winding that cuts the feedback winding and a positive voltage comes out the end connected to the base and a negative voltage comes out the end connected to the 100k and 10u. This turns the transistor ON more and it continues to turn ON until fully turned ON. At this point the magnetic flux is not expanding and the voltage does not appear in the feedback winding.

During this time the 10u has charged and the voltage on the negative lead has dropped to a lower voltage than before. This effectively turns OFF the transistor and the current in the main winding ceases abruptly. The magnetic flux collapses and produces a voltage in the opposite direction that is higher than the supply and this is why the two LEDs illuminate. This also puts a voltage through the feedback winding that keeps the transistor OFF. When the magnetic flux has collapsed, the voltage on the negative lead of the 10u is so low that the transistor does not turn on. The 100k discharges the 10u and the voltage on the base rises to start the next cycle.

You can see the 100k and 1k5 resistors and all the other parts in a “birds nest” (in the photo above), to allow easy experimenting.

This is the first circuit you should build to flash a white LED from a single cell.

It covers many features and shows how the efficiency of a LED increases when it is pulsed very briefly with a high current.

The two coils form a TRANSFORMER and show how a collapsing magnetic field produces a high voltage (we use 6v of this high voltage).

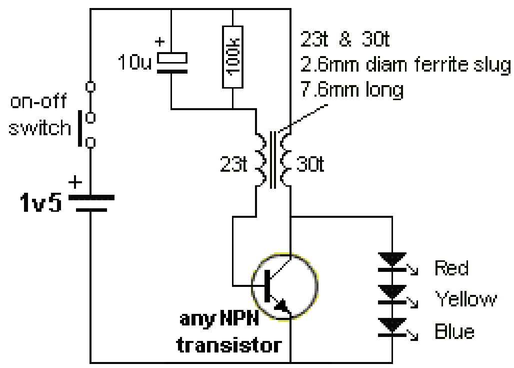
The 10u and 100k form a delay circuit to produce the flashing effect.

You can now go to all the other Joule Thief circuits and see how they “missed the boat” by not experimenting fully to simply their circuits. That’s why a “birds nest” arrangement is essential to encourage experimenting.

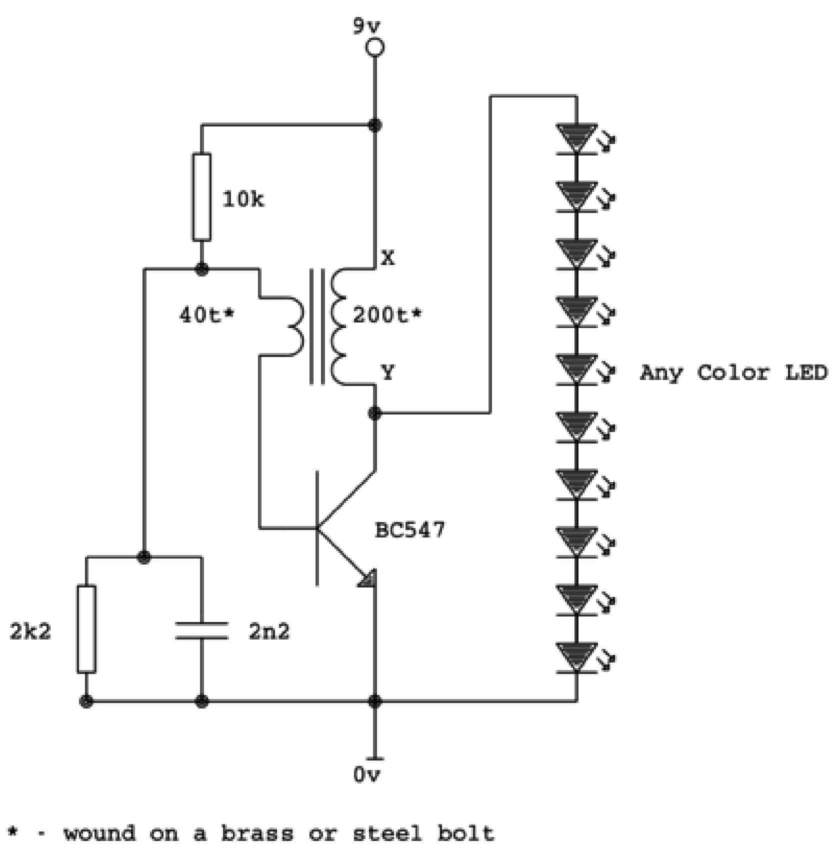
Note: Changing the turns to 40t for the main winding and 20t for the feedback (keeping the turns tightly wound together by winding wire around them) reduced the current to 8-9mA.

The circuit can be made small by using a ferrite slug 2.6mm diam x 7.6mm long. The inductance of this transformer is quite critical and the voltage across the LEDs must be over 6v for the circuit to work. It will not work with one or two LEDs. It needs THREE LEDs!!!

If the author not not keep experimenting, he would have missed this amazing feature !!

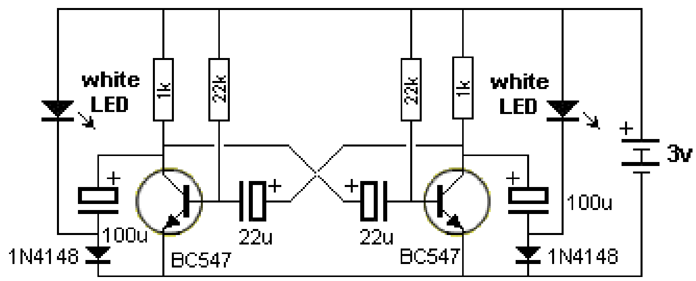


10 LEDs - any colour - ON 9v BATTERY



A very high efficiency circuit; for the transformer use 0.25mm wire, wind 200 turns around any nut and bolt (M5, 25mm long); for a **good** brightness use 10k resistor (curren 25mA); use 3k3 for a very bright light (50 mA). If LEDs do not illuminate, reverse leads X and Y of the inductor

DUAL 3v WHITE LED FLASHER



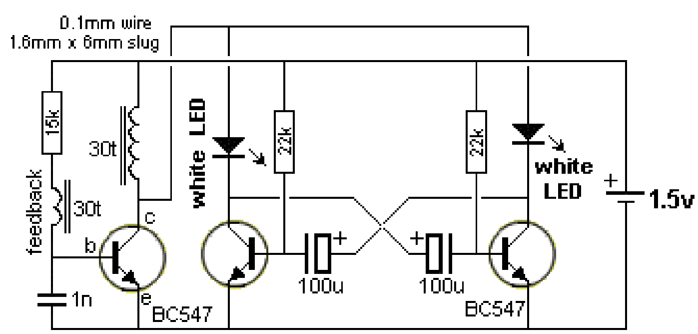
DUAL 3V WHITE LED FLASHER

This circuit alternately flashes two white LEDs, on a 3v supply and produces a very bright flash. The circuit produces a voltage higher than 5v if the LED is not in circuit but the LED limits the voltage to its characteristic voltage of 3.2v to 3.6v.

The circuit takes about 2mA and is actually a voltage-doubler (voltage incrementer) arrangement. The 1k charges the 100u and the diode drops 0.6v to prevent the LED from starting to illuminate on 3v. When a transistor conducts, the collector pulls the 100u down towards the 0v rail and the negative of the electro is actually about 2v below the 0v rail. The LED sees 3v + 2v and illuminates very brightly when the voltage reaches about 3.4v.

All the energy in the electro is pumped into the LED to produce a very bright flash.

DUAL 1v5 WHITE LED FLASHER



DUAL 1.5v WHITE LED FLASHER

This circuit alternately flashes two white LEDs, on a 1.5v supply and produces a very bright flash. The circuit produces a voltage of about 25v when the LEDs are not connected, but the LEDs reduce this as they have a characteristic voltage-drop across them when they are illuminated. Do not use a supply voltage higher than 1.5v.

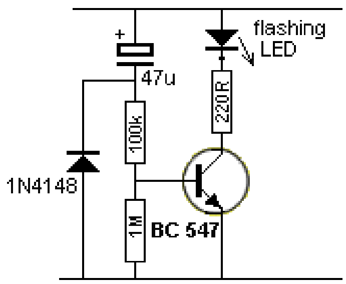
The circuit takes about 10mA.

The transformer consists of 30 turns of very fine wire on a 1.6mm slug 6mm long, but any ferrite bead or slug can be used. The number of turns is not critical.

The 1n is important and using any other value or connecting it to the positive line will increase the supply current.

Using LEDs other than white will alter the flash-rate considerably and both LEDs must be the same colour.

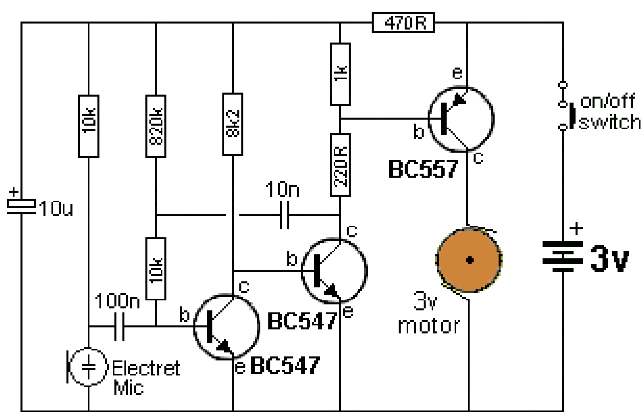
LED FLASHES 3 TIMES WHEN POWER IS APPLIED



This circuits uses a FLASHING LED - not an ordinary LED.

- When the circuit turns ON, the electrolytic is uncharged and the charging-current turns on the transistor. This makes the LED flash.
- The value of the 47u and 100k will depend on how many times you want the LED to flash.
- The 1N4148 diode discharges the electrolytic when the power is turned off so the circuit will start immediately the power is applied. This diode is not needed if the circuit is turned off for a long time.

DANCING FLOWER

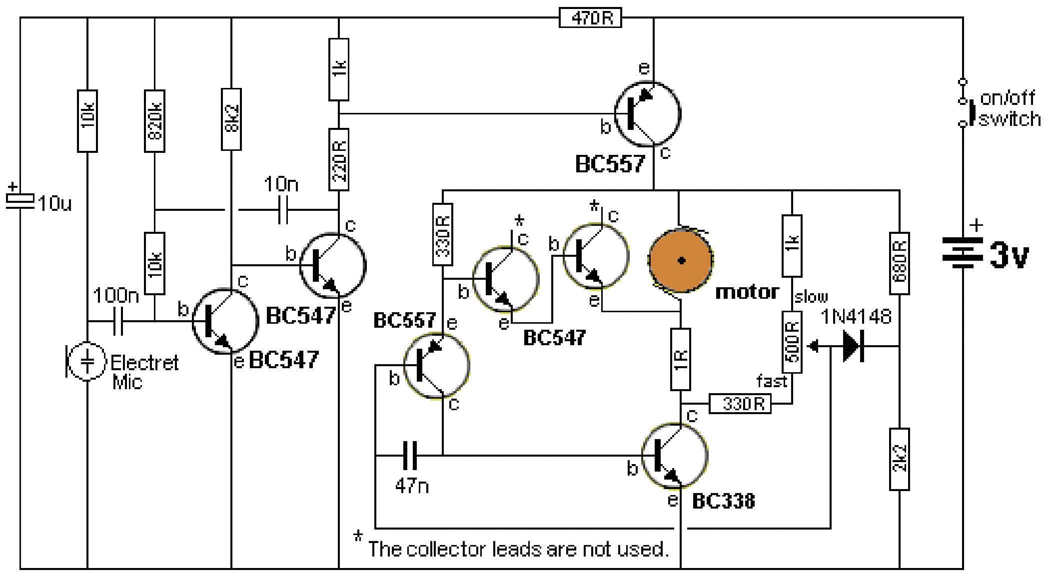


This circuit was taken from a dancing flower.

A motor at the base of the flower had a shaft up the stem and when the microphone detected music, the bent shaft made the flower wiggle and move.

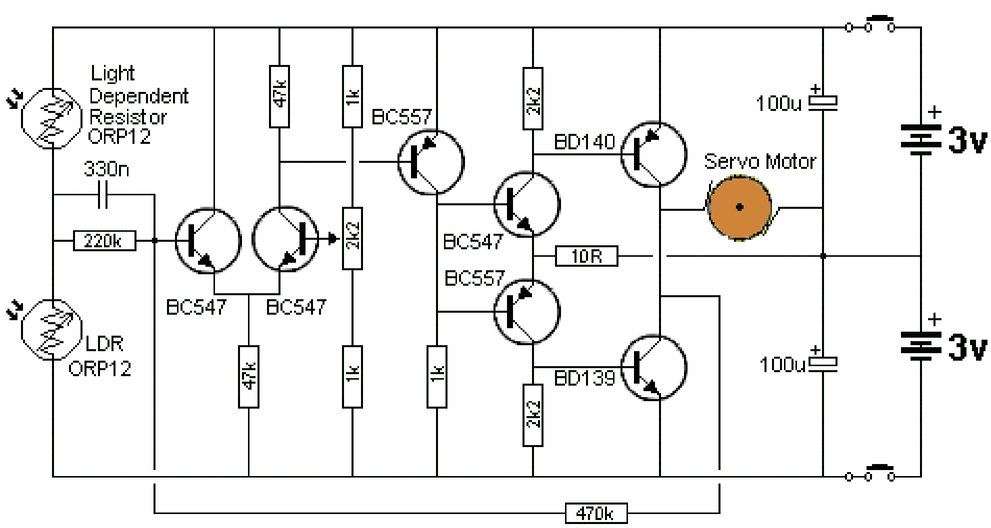
The circuit will respond to a whistle, music or noise.

DANCING FLOWER with SPEED CONTROL



The Dancing Flower circuit can be combined with the Motor Speed Control circuit to produce a requirement from one of the readers.

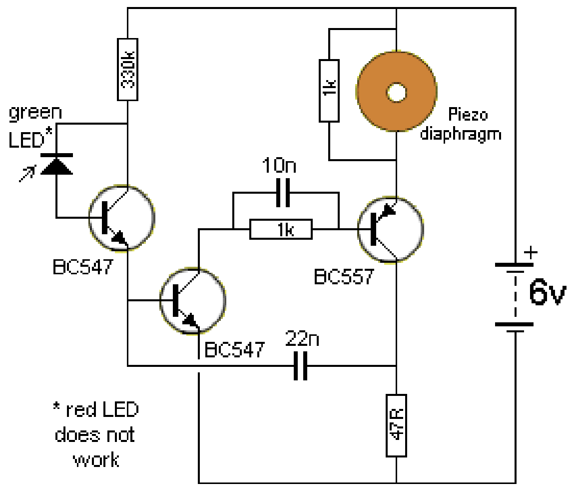
WHITE LINE FOLLOWER



This circuit can be used for a toy car to follow a white line. The motor is either a 3v type with gearing to steer the car or a rotary actuator or a servo motor.

When equal light is detected by the photo resistors the voltage on the base of the first transistor will be mid rail and the circuit is adjusted via the 2k2 pot so the motor does not receive any voltage. When one of the LDR's receives more (or less) light, the motor is activated. And the same thing happens when the other LDR receives less or more light.

LED DETECTS LIGHT



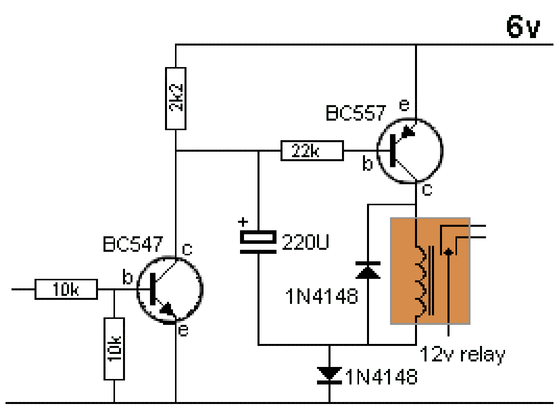
All LEDs give off light of a particular colour but some LEDs are also able to detect light. Obviously they are not as good as a device that has been specially made to detect light; such as solar cell, photocell, photo resistor, light dependent resistor, photo transistor, photo diode and other photo sensitive devices.

A green LED will detect light and a high-bright red LED will respond about 100 times better than a green LED, but the LED in this position in the circuit is classified as very high impedance and it requires a considerable amount of amplification to turn the detection into a worthwhile current-source.

All other LEDs respond very poorly and are not worth trying.

The accompanying circuit amplifies the output of the LED and enables it to be used for a number of applications. The LED only responds when the light enters the end of the LED and this makes it ideal for solar trackers and any time there is a large difference between the dark and light conditions. It will not detect the light in a room unless the lamp is very close.

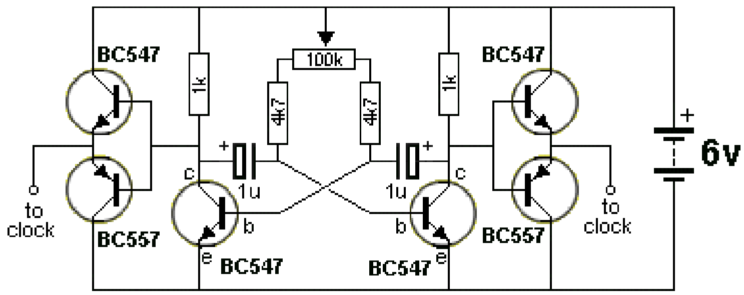
12v RELAY ON 6V SUPPLY



This circuit allows a 12v relay to operate on a 6v or 9v supply. Most 12v relays need about 12v to "pull-in" but will "hold" on about 6v. The 220u charges via the 2k2 and bottom diode. When an input above 1.5v is applied to the input of the circuit, both transistors are turned ON and the 5v across the electrolytic causes the negative end of the electro to go below the 0v rail by about 4.5v and this puts about 10v across the relay.

Alternatively you can rewind a 12v relay by removing about half the turns. Join up what is left to the terminals. Replace the turns you took off, by connecting them in parallel with the original half, making sure the turns go the same way around

MAKE TIME FLY!



Connect this circuit to an old electronic clock mechanism and speed up the motor 100 times!

The “motor” is a simple “stepper-motor” that performs a half-rotation each time the electromagnet is energised. It normally takes 2 seconds for one revolution. But our circuit is connected directly to the winding and the frequency can be adjusted via the pot.

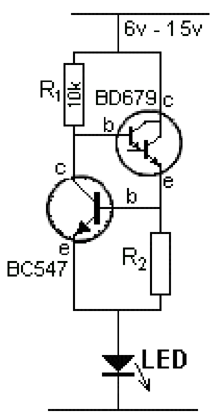
Take the mechanism apart, remove the 32kHz crystal and cut one track to the electromagnet. Connect the circuit below via wires and re-assemble the clock.

As you adjust the pot, the “seconds hand” will move clockwise or anticlockwise and you can watch the hours “fly by” or make “time go backwards.”

The multivibrator section needs strong buffering to drive the 2,800 ohm inductive winding of the motor and that’s why push-pull outputs have been used. The flip-flop circuit cannot drive the highly inductive load directly (it upsets the waveform enormously).

From a 6v supply, the motor only gets about 4v due to the voltage drops across the transistors. Consumption is about 5mA.

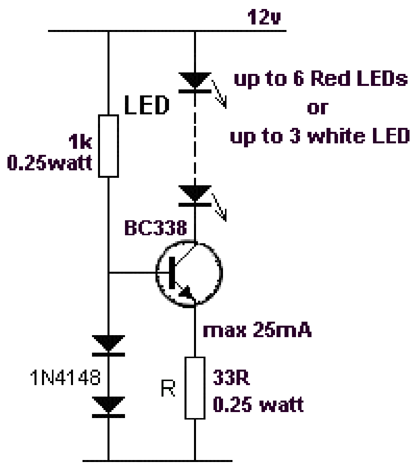
CONSTANT CURRENT SOURCE



This circuit provides a constant current to the LED. The LED can be replaced by any other component and the current through it will depend on the value of R2. Suppose R2 is 560R. When 1mA flows through R2, 0.56v will develop across this resistor and begin to turn on the BC547. This will rob the base of BD 679 with turn-on voltage and the transistor turns off slightly. If the supply voltage increases, this will try to increase the current through the circuit. If the current tries to increase, the voltage across R2 increases and the BD 679 turns off more and the additional voltage appears across the BD 679.

If R2 is 56R, the current through the circuit will be 10mA. If R2 is 5R6, the current through the circuit will be 100mA - although you cannot pass 100mA through a LED without damaging it.

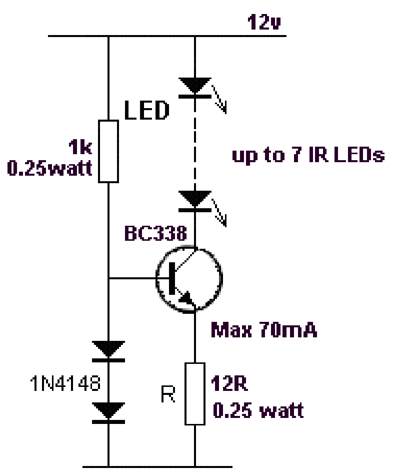
LED driver for 12v CAR



Here is a simple circuit that will drive any number of LEDs in a single string with a constant 25mA without having to work out the value of the dropper resistor. You can use up to 6 red LED or up to 3 white LEDs with the same circuit.

The supply can be 12v to 16v without the brightness altering.

LED driver IR LEDs in a 12v CAR

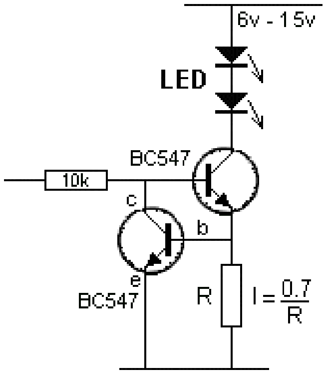


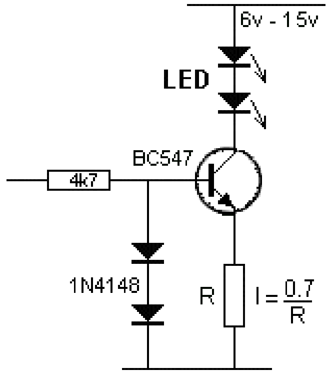
This circuit will drive up to 7 IR LEDs at a constant current of 70mA from a 12v supply.

These LEDs will illuminate ultra-violet sensitive paint to produce a white glow.

CONSTANT CURRENT SOURCE: circuits 2 & 3

By rearranging the components in the circuit above, it can be designed to turn ON or OFF via an input.

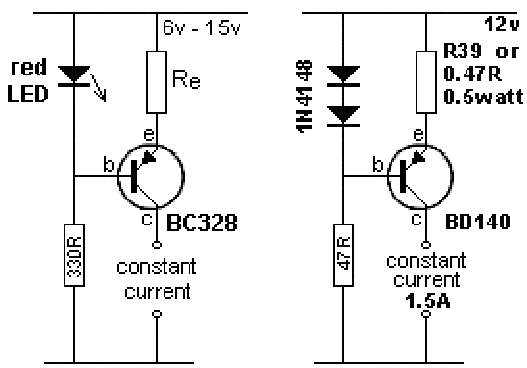




The current through the LED (or LEDs) is determined by the value of *R*:

- 5mA: R = 120R or 150R
- 10mA: R = 68R
- 15mA: R = 47R
- 20mA: R = 33R
- 25mA: R = 22R or 33R
- 30mA: R = 22R

CONSTANT CURRENT SOURCE - Circuit 4



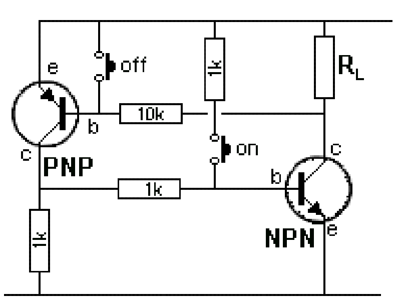
The output will be limited to 100mA by using a red LED and 10R for Re. The output will be limited to 500mA by using a red LED and 2R2 for Re.

BC328 - 800mA max

Use a BD140 in the first circuit and the output will be limited to 1A by using a red LED and 1R0 for Re.

5watt LEDs (sometimes called “White Big Chip LEDs”) have a characteristic voltage across them of 3.2v and draw 1.75amp. 1, 2 or 3 can be connected in series to the second circuit using a heatsinked BD140 transistor.

ON - OFF VIA MOMENTARY PUSH-BUTTONS



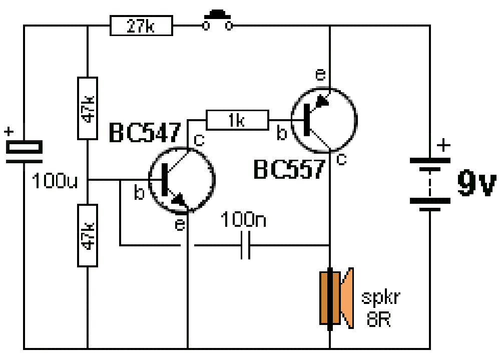
See Also Push-ON Push-OFF (in 101-200 Circuits)

This circuit will supply current to the load RL. The maximum current will depend on the second transistor. The circuit is turned on via the “ON” push button and this action puts a current through the load and thus a voltage develops across the load. This voltage is passed to the PNP transistor and it turns ON. The collector of the PNP keeps the power transistor ON.

To turn the circuit OFF, the “OFF” button is pressed momentarily. The 1k between base and emitter of the power transistor prevents the base floating or receiving any slight current from the PNP transistor that would keep the circuit latched ON.

The circuit was originally designed by a Professor of Engineering at Penn State University. It had 4 mistakes - so much for testing a circuit!!

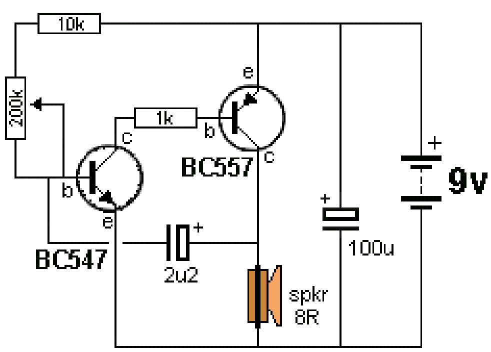
SIREN



This circuit produces a wailing or siren sound that gradually increases and decreases in frequency as the 100u charges and discharges when the push-button is pressed and released.

In other words, the circuit is not automatic. You need to press the button and release it to produce the up/down sound.

TICKING BOMB

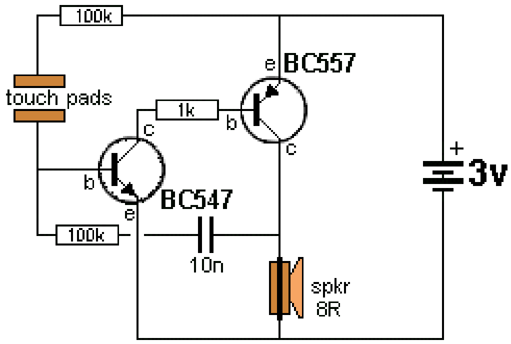


This circuit produces a sound similar to a loud clicking clock. The frequency of the tick is adjusted by the 220k pot.

The circuit starts by charging the 2u2 and when 0.65v is on the base of the NPN transistor, it starts to turn on. This turns on the BC 557 and the voltage on the collector rises. This pushes the small charge on the 2u2 into the base of the BC547 to turn it on more.

This continues when the negative end of the 2u2 is above 0.65v and now the electro starts to charge in the opposite direction until both transistors are fully turned on. The BC 547 receives less current into the base and it starts to turn off. Both transistors turn off very quickly and the cycle starts again.

LIE DETECTOR-1

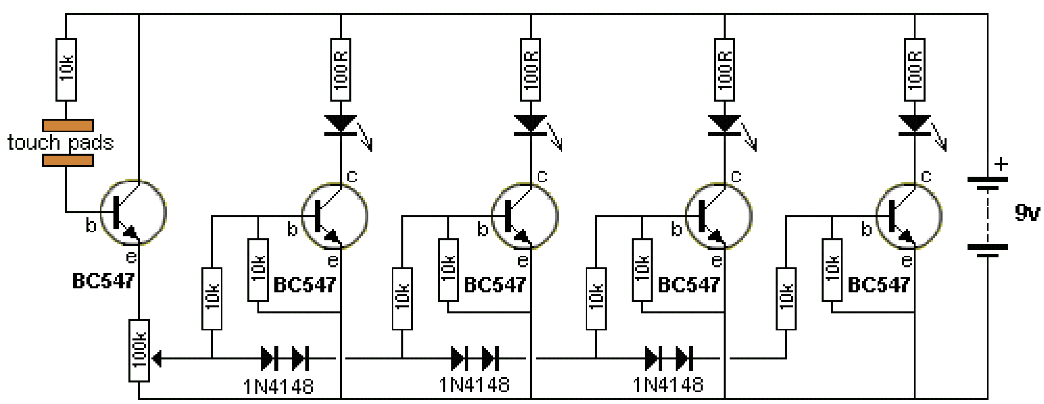


This circuit detects the resistance between your fingers to produce an oscillation. The detection-points will detect resistances as high as 300k and as the resistance decreases, the frequency increases.

Separate the two touch pads and attach them to the back of each hand. As the subject feels nervous, he will sweat and change the frequency of the circuit.

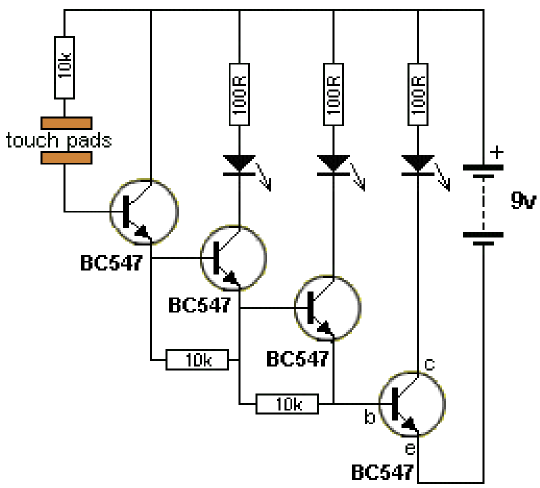
The photos show the circuit built on PC boards with separate touch pads.

LIE DETECTOR-2



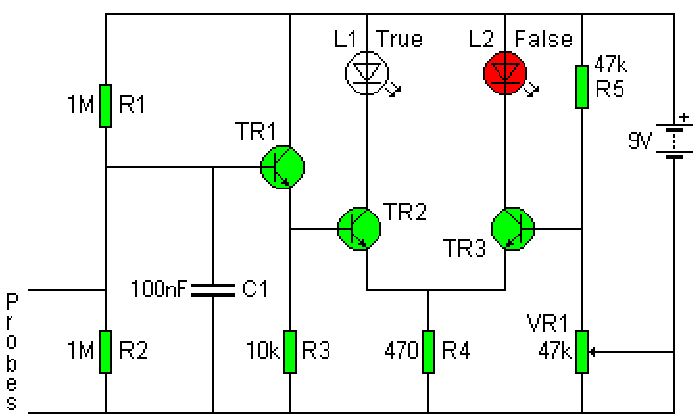
This circuit detects the resistance between your fingers to turn on the FALSE LED. The circuit sits with the TRUE LED illuminated. The 47k pot is adjusted to allow the LEDs to change state when touching the probes.

LIE DETECTOR-3



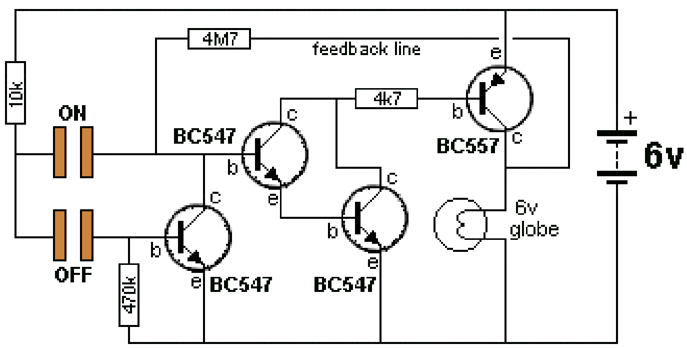
This circuit detects the resistance between your fingers to turn the 4 LEDs. As you press harder, more LEDs are illuminated.

LIE DETECTOR-4



This circuit detects the resistance between your fingers to turn the 3LEDs. As you press harder, more LEDs are illuminated. The circuit is simpler than Lie Detector-3.

TOUCH SWITCH - globe

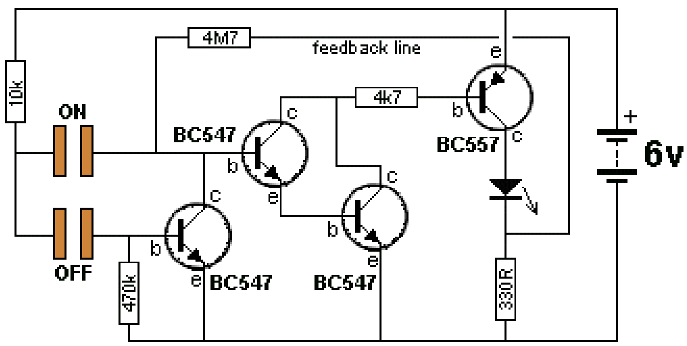


This circuit detects the skin resistance of a finger to deliver a very small current to the super-alpha pair of transistors to turn the circuit ON. The output of the "super transistor" turns on the BC 557 transistor. The voltage on the top of the globe is passed to the front of the circuit via the 4M7 to take the place of your finger and the circuit remains ON.

To turn the circuit OFF, a finger on the OFF pads will activate the first transistor and this will rob the "super transistor" of voltage and the circuit will turn OFF.

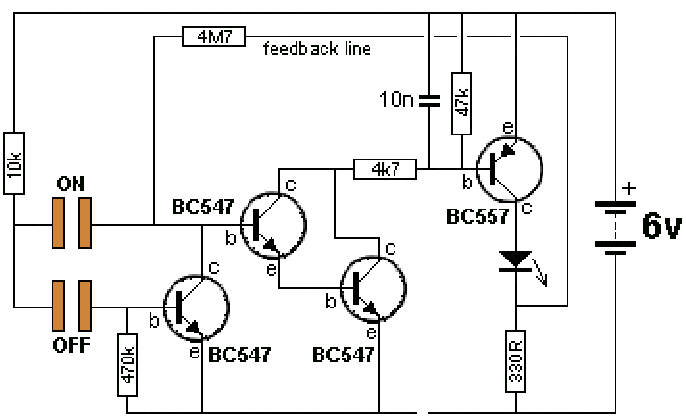
This project is available as a kit of parts from Talking Electronics for $6.00 plus $4.00 postage.

TOUCH SWITCH - LED



This circuit turns a LED on and off.

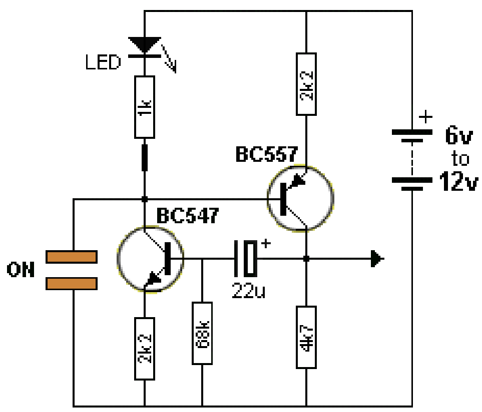
TOUCH SWITCH - LED - modification by Mike Grozak



To make the circuit come ON with the LED not illuminated, you need to put a "set" on the circuit. A "set" is a particular condition that may be ON or OFF but the fact is the circuit ALWAYS starts in a particular way.

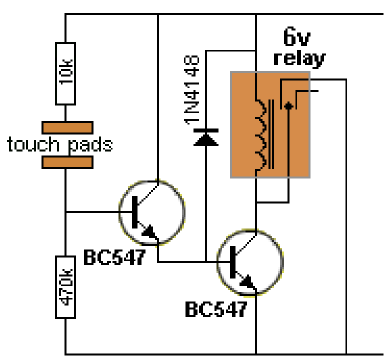
The 10n prevents a voltage appearing on the base of the BC557 transistor when the circuit is turned ON and this means the transistor is OFF. The feedback line will not have any voltage on it and thus the second and third transistor will not be turned ON. Thus the circuit will come ON with the LED not illuminated.

TOUCH SWITCH-2



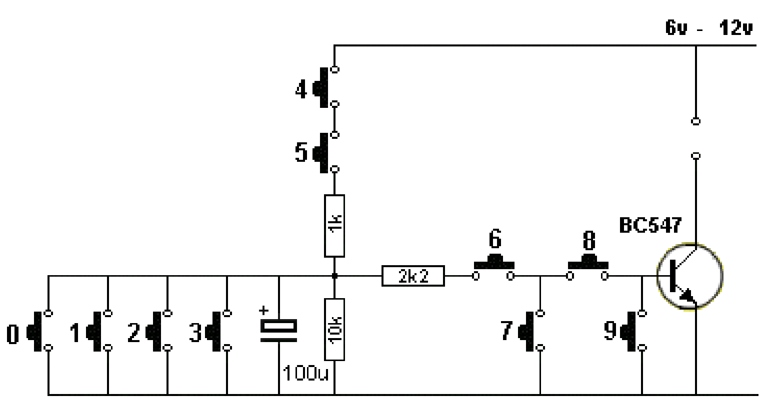
This circuit detects the skin resistance of a finger to turn the circuit ON for about 1 second. The output can be taken to a counting circuit. The circuit consumes no current when in quiescent mode:

TOUCH SWITCH-3



This circuit stays ON.

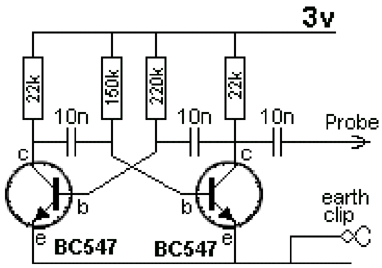
CODE PAD



Here is a simple CODE PAD to add to your alarm. It consists of 10 buttons and they must be pressed in a certain order for the output to change. You can see from the circuit how the buttons are pressed and two buttons must be pressed at the same time, the two other buttons at the same time,

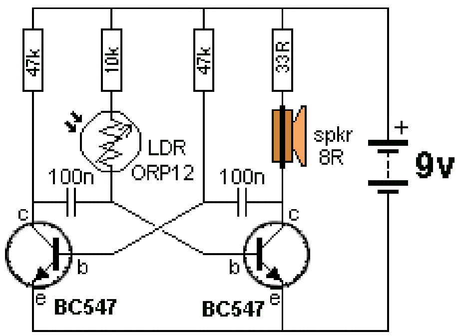
to gain entry. The operation of this type of pad is very unusual as anyone pressing the buttons by incrementing numbers will not be able to produce the code.

SIGNAL INJECTOR



This circuit is rich in harmonics and is ideal for testing amplifier circuits. To find a fault in an amplifier, connect the earth clip to the 0v rail and move through each stage, starting at the speaker. An increase in volume should be heard at each preceding stage. This Injector will also go through the IF stages of radios and FM sound sections in TV's.

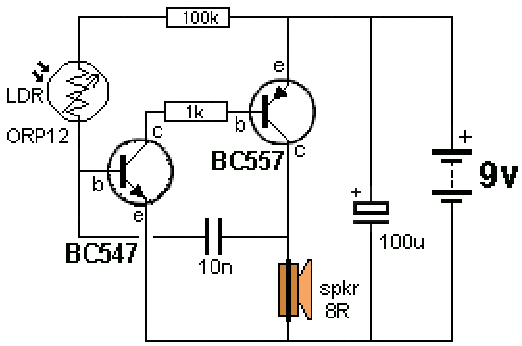
LIGHT ALARM 1



This circuit operates when the Light Dependent Resistor receives light. When no light falls on the LDR, its resistance is high and the transistor driving the speaker is not turned on.

When light falls on the LDR its resistance decreases and the collector of the second transistor falls. This turns off the first transistor slightly via the second 100n and the first 100n puts an additional spike into the base of the second transistor. This continues until the second transistor is turned on as hard as it can go. The first 100n is now nearly charged and it cannot keep the second transistor turned on. The second transistor starts to turn off and both transistors swap conditions to produce the second half of the cycle.

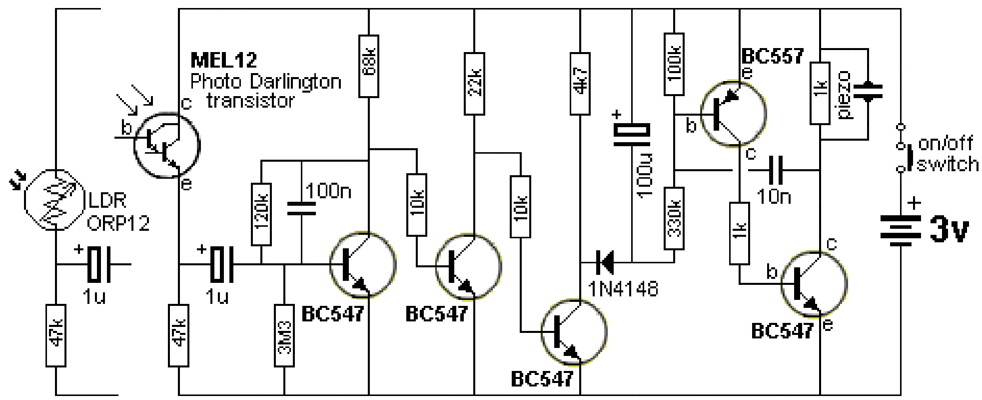
LIGHT ALARM 2



This circuit is similar to Light Alarm -1 but produces a louder output due to the speaker being connected directly to the circuit.

The circuit is basically a high-gain amplifier that is turned on initially by the LDR and then the 10n keeps the circuit turning on until it can turn on no more. The circuit then starts to turn off and eventually turns off completely. The current through the LDR starts the cycle again.

LIGHT ALARM 3 (MOVEMENT DETECTOR)

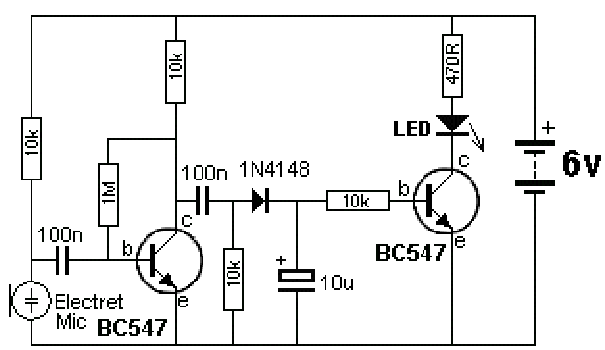


This circuit is very sensitive and can be placed in a room to detect the movement of a person up to 2 metres from the unit.

The circuit is basically a high-gain amplifier (made up of the first three transistors) that is turned on by the LDR or photo Darlington transistor. The

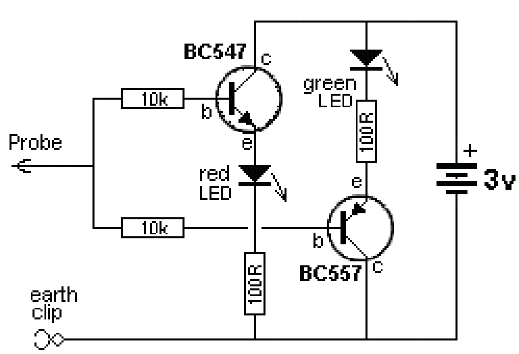
third transistor charges the 100u via a diode and this delivers turn-on voltage for the oscillator. The LDR has equal sensitivity to the photo transistor in this circuit.

SOUND TRIGGERED LED



This circuit turns on a LED when the microphone detects a loud sound. The "charge-pump" section consists of the 100n, 10k, signal diode and 10u electrolytic. A signal on the collector of the first transistor is passed to the 10u via the diode and this turns on the second transistor, to illuminate the LED.

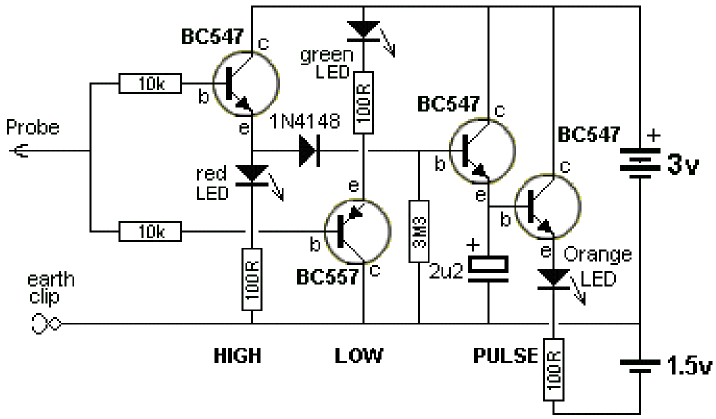
SIMPLE LOGIC PROBE



This circuit consumes no current when the probe is not touching any circuitry. The reason is the voltage across the green LED, the base-emitter junction of the BC557, plus the voltage across the red LED and base-emitter junction of the BC547 is approx: 2.1v + 0.6v + 1.7v + 0.6v = 5v and this is greater than the supply voltage.

When the circuit detects a LOW, the BC557 is turned on and the green LED illuminates. When a HIGH (above 2.3v) is detected, the red LED is illuminated.

SIMPLE LOGIC PROBE with PULSE

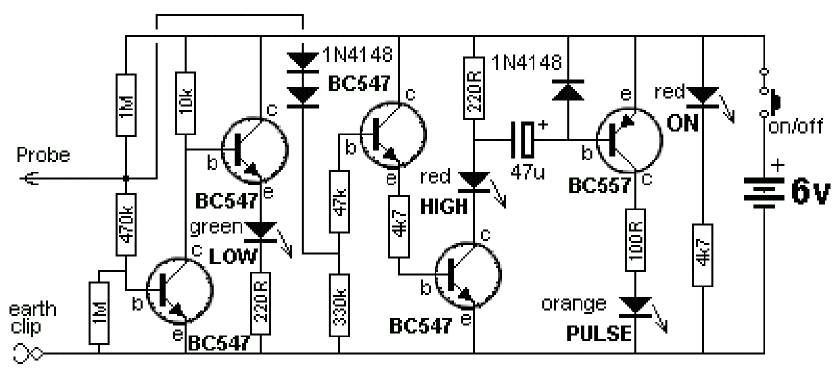


This circuit consumes no current when the probe is not touching any circuitry and the input has a surprisingly HIGH IMPEDANCE.

Keep the probe away from stray signals (especially mains hum) as the orange LED will illuminate.

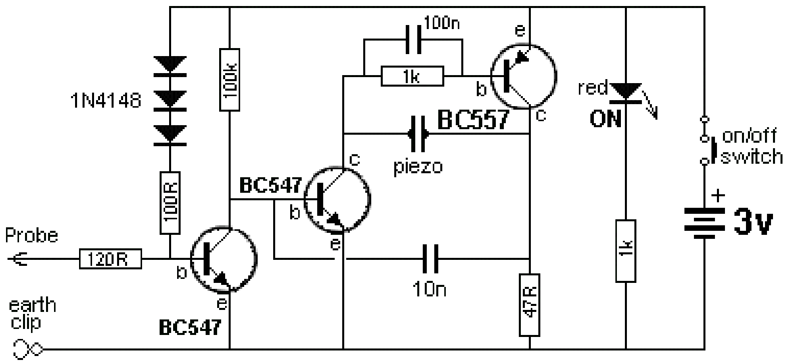
When the red LED illuminates, the HIGH is passed through the 1N4148 diode and the third transistor is an emitter-follower. It increases the current-capability of the pulse and charges a 2u2. The 4th transistor increases the capacity of the 2u2 by about 100 times to make it a 220u electro to keep the orange LED illuminated for a few milliseconds after the pulse has ceased. The voltage-drop across the diode and base-emitter junctions of the transistors reduces the voltage on the emitter of the 4th transistor to less than 1v and an extra 1.5v is needed from the supply to illuminate the orange LED.

LOGIC PROBE with PULSE



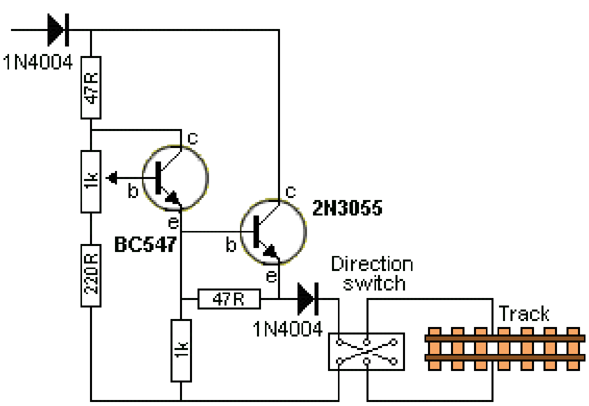
This circuit has the advantage of providing a PULSE LED to show when a logic level is HIGH and pulsing at the same time. It can be built for less than $5.00 on a piece of matrix board or on a small strip of copper clad board if you are using surface mount components. The probe will detect a HIGH at 3v and thus the project can be used for 3v, 5v and CMOS circuits.

CONTINUITY TESTER



This circuit has the advantage of providing a beep when a short-circuit is detected but does not detect the small voltage drop across a diode. This is ideal when testing logic circuits as it is quick and you can listen for the beep while concentrating on the probe. Using a multimeter is much slower.

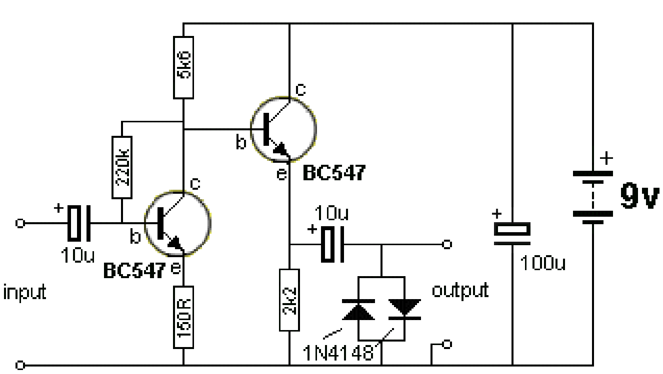
TRAIN THROTTLE



This circuit is for model train enthusiasts. By adding this circuit to your speed controller box, you will be able to simulate a train starting slowly from rest.

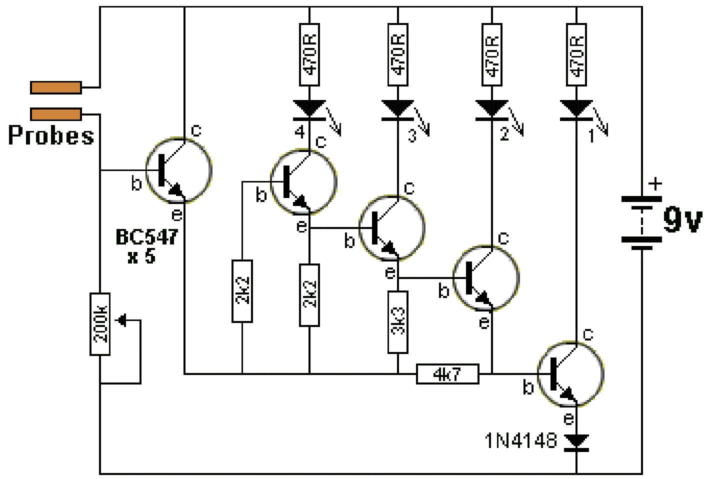
Remove the wire-wound rheostat and replace it with a 1k pot. This controls the base of the BC547 and the 2N3055 output is controlled by the BC547. The diodes protect the transistors from reverse polarity from the input and spikes from the rails.

GUITAR FUZZ



The output of a guitar is connected to the input of the Fuzz circuit. The output of this circuit is connected to the input of your amplifier. With the guitar at full volume, this circuit is overdriven and distorts. The distorted signal is then clipped by the diodes and your power amp amplifies the Fuzz effect.

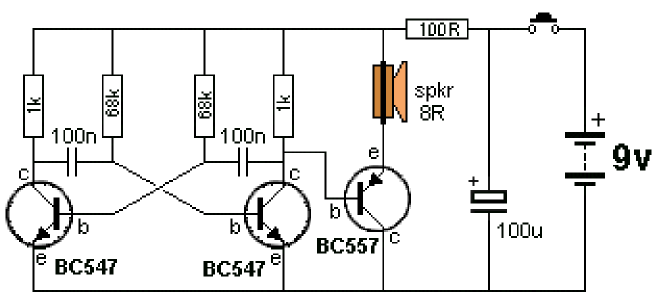
STRENGTH TESTER



This is a simple “staircase” circuit in which the LEDs come on as the resistance between the probes decreases.

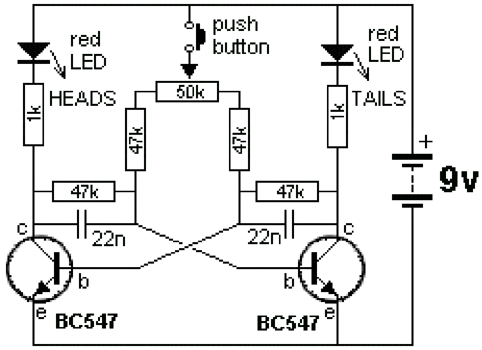
When the voltage on the base of the first transistor sees 0.6v + 0.6v + 0.6v = 1.8v, LED1 comes on. LEDs 1&2 will come on when the voltage rises a further 0.6v. The amount of pressure needed on the probes to produce a result, depends on the setting of the 200k pot.

FOG HORN



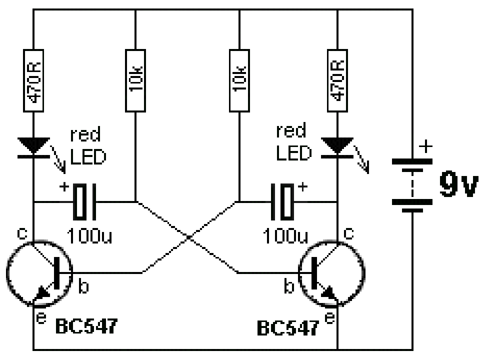
When the push-button is pressed, the 100u will take time to charge and this will provide the rising pitch and volume. When the push-button is released, the level and pitch will die away. This is the characteristic sound of a ship’s fog horn.

HEADS OR TAILS



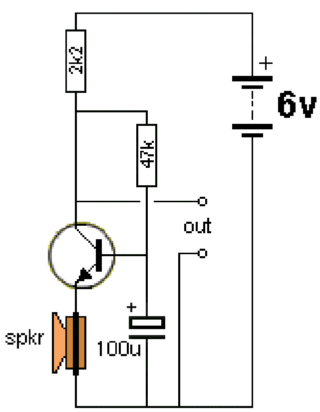
When the push-button is pressed, the circuit will oscillate at a high rate and both LEDs will illuminate. When the push button is released, one of the LEDs will remain illuminated. The 50k is designed to equalise the slightly different values on each half of the circuit and prevent a "bias."

ROBOT MAN



This multivibrator circuit will flash the Robot Man's eyes as shown in the photo. The kit of components is available from Talking Electronics for $8.50 plus postage. Send an email to find out the cost of postage: talking@tpg.com.au

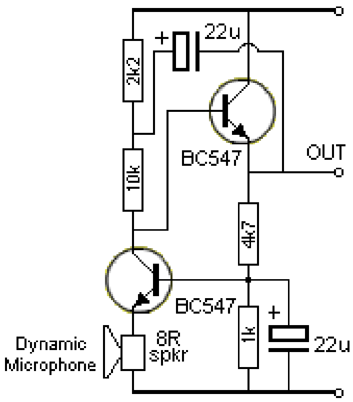
DYNAMIC MICROPHONE AMPLIFIER



This circuit takes the place of an electret microphone. It turns an ordinary mini speaker into a very sensitive microphone.

Any NPN transistors such as BC 547 can be used. The circuit will work from 3v to 9v. It is a common-base amplifier and accepts the low impedance of the speaker to produce a gain of more than 100.

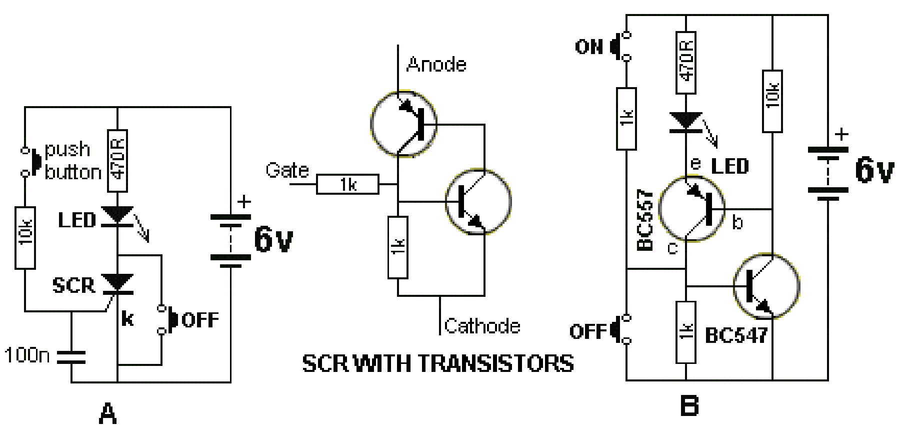
DYNAMIC MICROPHONE AMPLIFIER-2



This circuit is a BOOTSTRAP design. It turns an ordinary mini speaker into a very sensitive microphone.

Any NPN transistors such as BC 547 can be used. The circuit will work from 6v to 12v. It has been taken from our Stereo VU Meter project.

SCR WITH TRANSISTORS

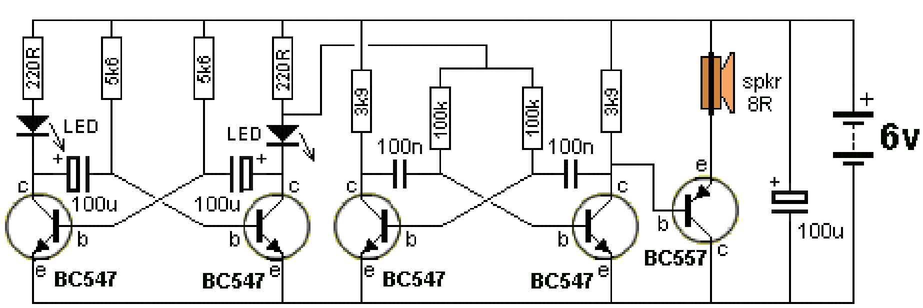


The SCR in circuit A produces a 'LATCH.' When the button is pressed, the LED remains illuminated.

The SCR can be replaced with two transistors as shown in circuit B.

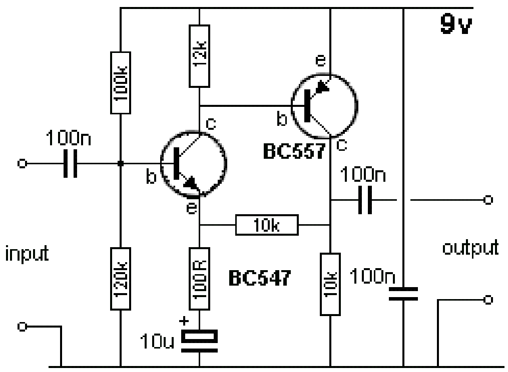
To turn off circuit A, the current through the SCR is reduced to zero by the action of the OFF button. In circuit B the OFF button removes the voltage on the base of the BC547. The OFF button could be placed across the two transistors and the circuit will turn off.

HEE HAW SIREN



The circuit consists of two multivibrators. The first multi-vibrator operates at a low frequency and this provides the speed of the change from Hee to Haw. It modifies the voltage to the tone multivibrator, by firstly allowing full voltage to appear at the bottom of the 220R and then a slightly lower voltage when the LED is illuminated.

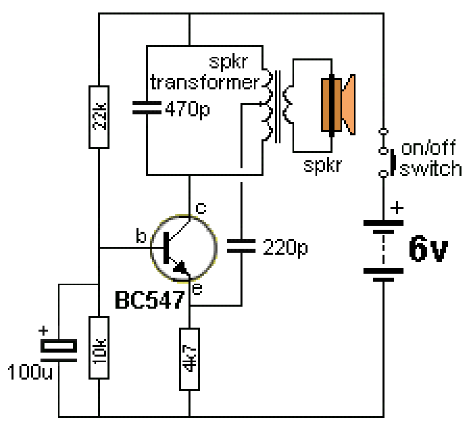
MICROPHONE PRE-AMPLIFIER



This circuit consists of two directly coupled transistors operating as common-emitter amplifiers.

The ratio of the 10k resistor to the 100R sets the gain of the circuit at 100.

HARTLEY OSCILLATOR

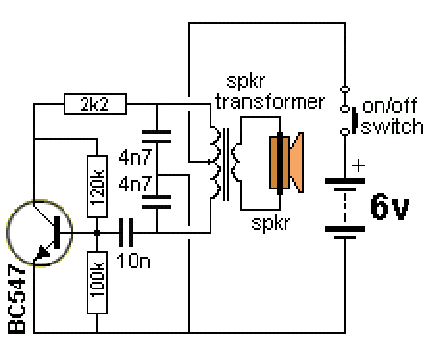


The Hartley Oscillator is characterised by an LC circuit in its collector. The base of the transistor is held steady and a small amount of signal is taken from a tapping on the inductor and fed to the emitter to keep the transistor in oscillation.

The transformer can be any speaker transformer with centre-tapped primary.

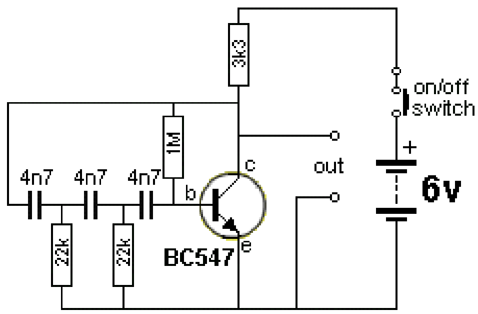
The frequency is adjusted by changing the 470p.

COLPITTS OSCILLATOR



The Colpitts Oscillator is characterised by tapping the mid-point of the capacitive side of the oscillator section. The inductor can be the primary side of a speaker transformer. The feedback comes via the inductor.

PHASESHIFT OSCILLATOR

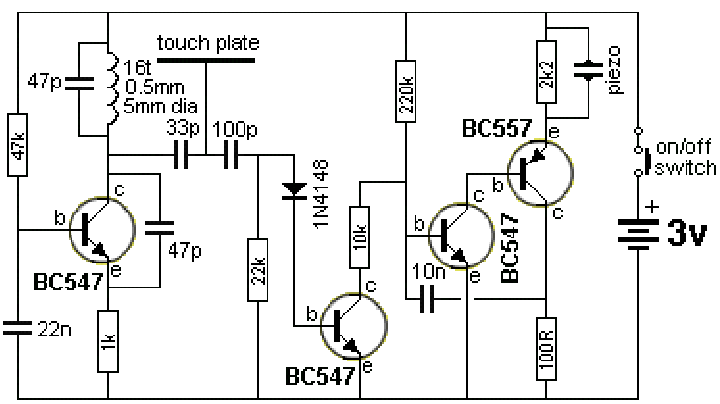


The Phaseshift Oscillator is characterised by 3 high-pass filters, creating a 180° phase shift.

The output is a sinewave. Take care not to load the output - this will prevent reliable start-up and may stop the circuit from oscillating.

Reduced the 3k3 load resistor if the load prevents the circuit oscillating. See Phase Shift Oscillator in second section of 200 Transistor Circuits for a better design.

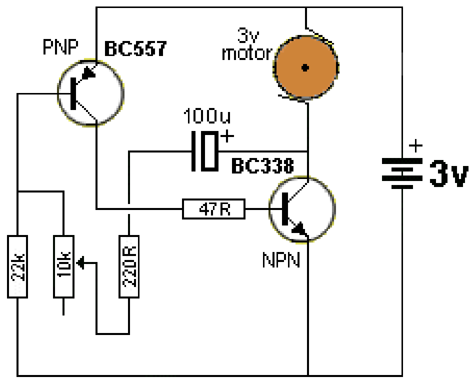
DOOR-KNOB ALARM



This circuit can be used to detect when someone touches the handle of a door. A loop of bare wire is connected to the point “touch plate” and the project is hung on the door-knob. Anyone touching the metal door-knob will kill the pulses going to the second transistor and it will turn off. This will activate the “high-gain” amplifier/oscillator.

The circuit will also work as a “Touch Plate” as it does not rely on mains hum, as many other circuits do.

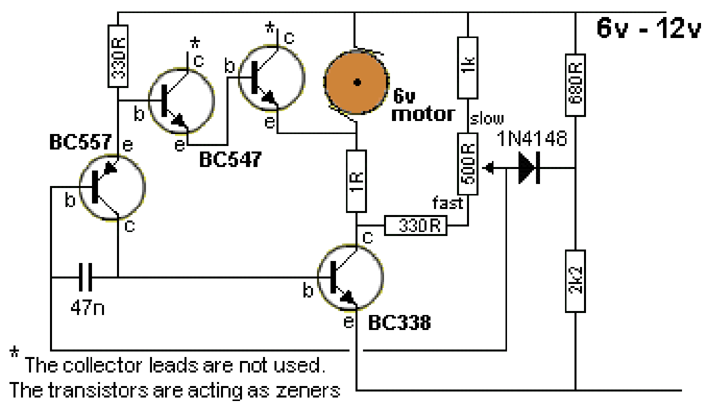
SIMPLE MOTOR SPEED CONTROL



This circuit is better than reducing the RPM of a motor via a resistor. Firstly it is more efficient. And secondly it gives the motor a set of pulses and this allows it to start at low RPM.

It's a simple Pulse-Width circuit or Pulse-Circuit.

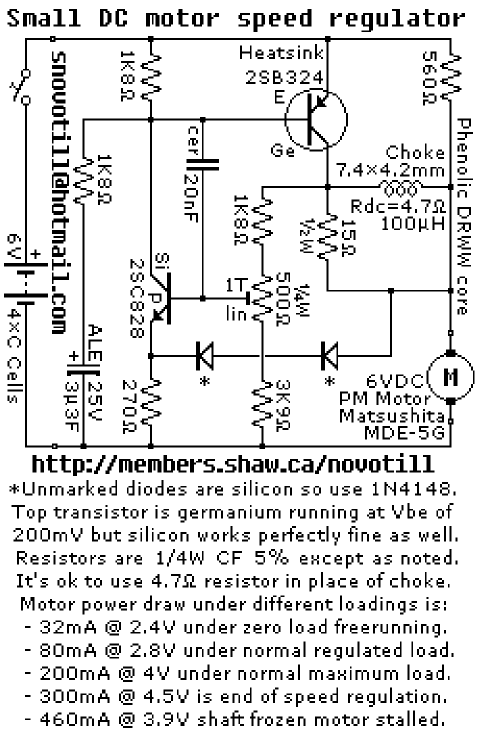
MOTOR SPEED CONTROLLER



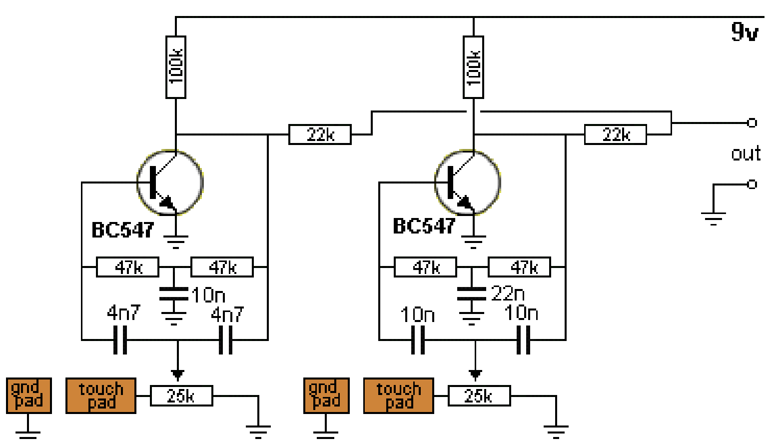
Most simple motor speed controllers simply reduce the voltage to a motor by introducing a series resistance. This reduces the motor's torque and if the motor is stopped, it will not start again.

This circuit detects the pulses of noise produced by the motor to turn the circuit off slightly. If the motor becomes loaded, the amplitude of the pulses decreases and the circuit turns on more to deliver a higher current.

MOTOR SPEED CONTROL - Circuit 3



ELECTRONIC DRUMS

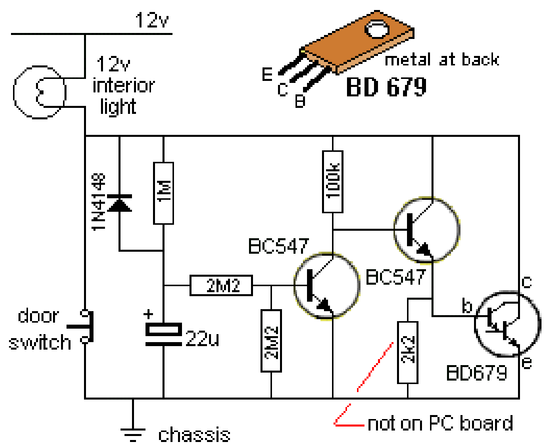


The circuit consists of two “twin-T” oscillators set to a point below oscillation. Touching a Touch Pad will set the circuit into oscillation. Different effects are produced by touching the pads in different ways and a whole range of effects are available.

The two 25k pots are adjusted to a point just before oscillation.

A “drum roll” can be produced by shifting a finger rapidly across adjacent ground and drum pads.

LIGHT EXTENDER



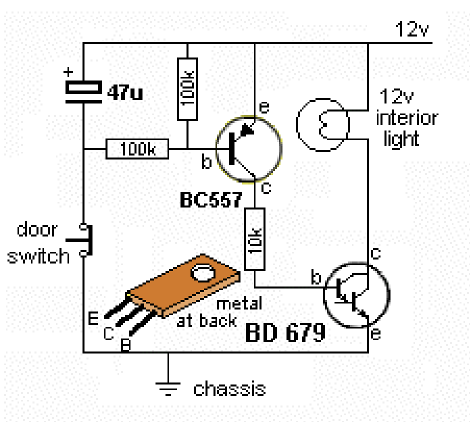
This circuit is a Courtesy Light Extender for cars. It extends the "ON" time when a door is closed in a car, so the passenger can see where he/she is sitting.

When the door switch is opened, the light normally goes off immediately, but the circuit takes over and allows current to flow because the 22u is not charged and the first BC 547 transistor is not turned ON. This turns on the second BC547 via the 100k and the BD679 is also turned on to illuminate the interior light.

The 22u gradually charges via the 1M and the first BC547 turns on, robbing the second BC547 of "turn-on" voltage and it starts to turn off the BD679.

The 1N4148 discharges the 22u when the door is opened. A 2k2 may needed to be added to completely turn off the globe.

LIGHT EXTENDER MkII

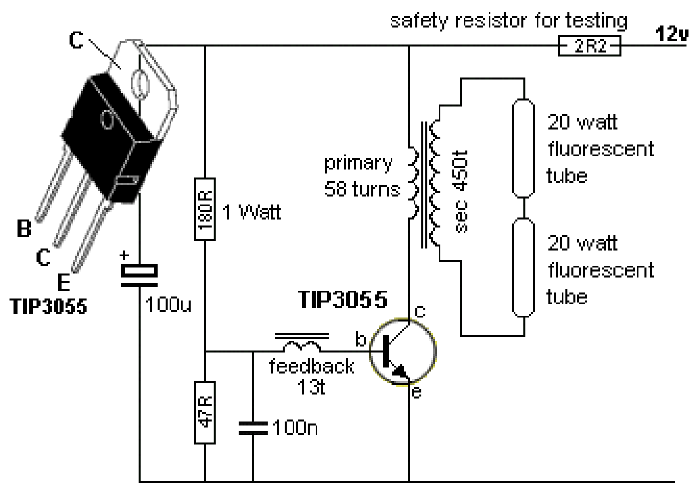


This circuit is a simpler Courtesy Light Extender for cars. It extends the "ON" time when a door is closed in a car. Both circuits perform exactly the same. This circuit is slightly simpler.

It uses only a single BC557 and BD679 transistor.

A Kit for this project is available from Talking Electronics for $5.20 plus postage. Click HERE

20 WATT FLUORO INVERTER



This circuit will drive a 40 watt fluoro or two 20-watt tubes in series. The transformer is wound on a ferrite rod 10mm dia and 8cm long.

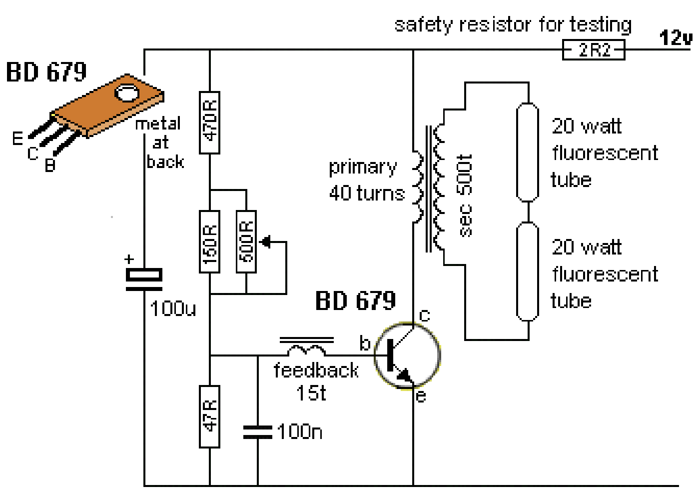
The wire diameters are not critical but our prototype used 0.61mm wire for the primary and 0.28mm wire for the secondary and feedback winding.

Do not remove the tube when the circuit is operating as the spikes produced by the transformer will damage the transistor.

The circuit will take approx 1.5amp on 12v, making it more efficient than running the tubes from the mains. A normal fluoro takes 20 watts for the tube and about 15 watts for the ballast.

A Kit for this project is available from Talking Electronics called Fluorescent Lamp Inverter for $12.50 plus postage. Click HERE

6 to 12 WATT FLUORO INVERTER



This circuit will drive a 40 watt fluoro or two 20-watt tubes in series but with less brightness than the circuit above and it will take less current.

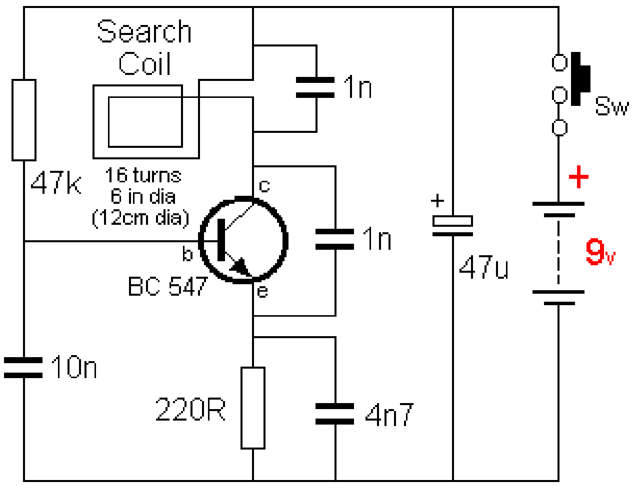
2 x 20 watt tubes = 900mA to 1.2A

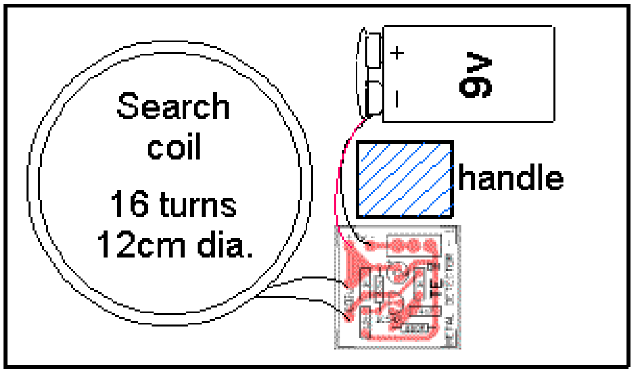
and 1 x 20 watt tube 450mA to 900mA depending on pot setting.

The transformer is wound on a ferrite rod 10mm dia and 8cm long. The wire diameter is fairly critical and our prototype used 0.28mm wire for all the windings.

Do not remove the tube when the circuit is operating as the spikes produced by the transformer will damage the transistor. The pot will adjust the brightness and vary the current consumption. Adjust the pot and select the base-bias resistor to get the same current as our prototype. Heat-sink must be greater than 40sq cm. Use heat-sink compound.

GOLD DETECTOR





The Layout of Metal Detector -1

see also:

- *BFO METAL DETECTOR* in “100 IC circuits”
- *SIMPLE BFO METAL LOCATOR* in “100 IC circuits”
- METAL DETECTORS - article

This very simple circuit will detect gold or metal or coins at a distance of approx 20cm - depending on the size of the object.

The circuit oscillates at approx 140kHz and a harmonic of this frequency is detected by an AM radio. Simply tune the radio until a squeal is detected.

When the search coil is placed near a metal object, the frequency of the circuit will change and this will be heard from the speaker.

The layout of the circuit is shown and the placement of the radio.

The TRUTH about Metal (GOLD) Detectors.

A Gold Detector’s club in the US created a challenge with 12 members with skills ranging from 12 months detection to over 25 years. They used 5 different detectors to find 30 different items, hidden in sand and under pieces of cardboard.

The results were these: all detectors performed almost equally but the interpretation of the beeps, sounds and readings on the detector were quite often mis-read and the winner was a member with 1 year experience. The moral of the story is to dig for anything that is detected as it may not be a "ring-pull."

With these findings you can clearly use a very simple, cheap, detector and get results equal to the most expensive equipment. The only thing you have to remember is this: You need the right frequency for the type of soil to cancel out the effects of minerals etc.

That's why there is a range of frequencies from 6kHz to 150Hz.

All the other modes of producing and injecting the pulse add only a very small improvement to the detection process.

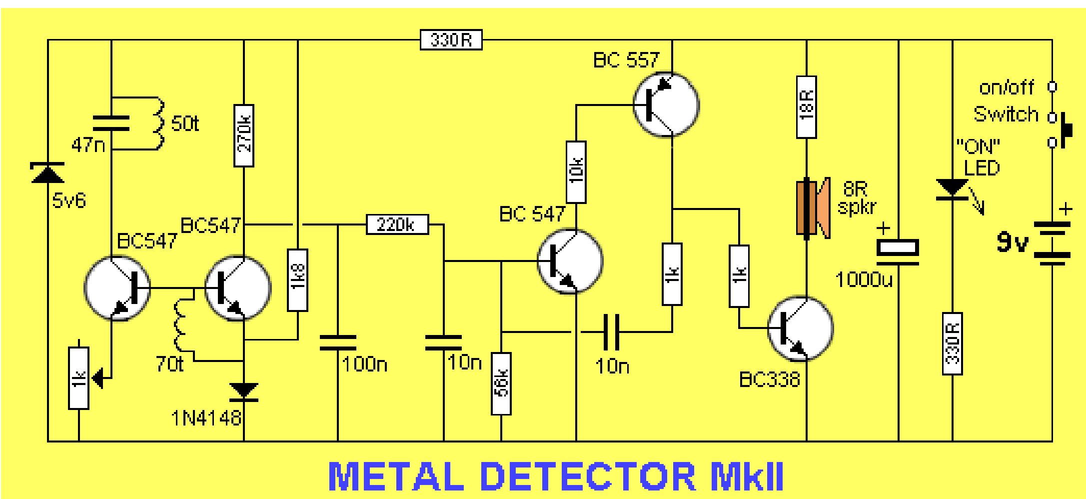
The energy put into the injecting pulse also has an influence of the depth of detection.

Buying Metal Detector kit: Even though this circuit is the simplest you can get, it performs just like the $50.00 metal detectors because you use an ordinary AM radio to produce the tone. It will detect a small coin at 10cm.

METAL DETECTOR MkII

see the full project: Metal Detector MkII

Metal Detector kit MkII $15.00 plus postage



This is a self-contained metal detector with about the same performance as Metal Detector-1 above.

All Metal detectors having the principle of detecting a metal object with a coil of about 12cm dia and operating at 100kHz, will have the same performance, no matter how complex the circuit.

They all rely on detecting the change in frequency as small as 1Hz or a voltage-change across a coil as small as 1uV.

The secret is to produce the largest waveform while loading the coil as lightly as possible. This allows the coil to detect metal at the furthest distance. See more details on Metal Detector MkII Nail Finder - see the full project: Metal Detector MkII Kits for Metal Detector kit - Nail Finder

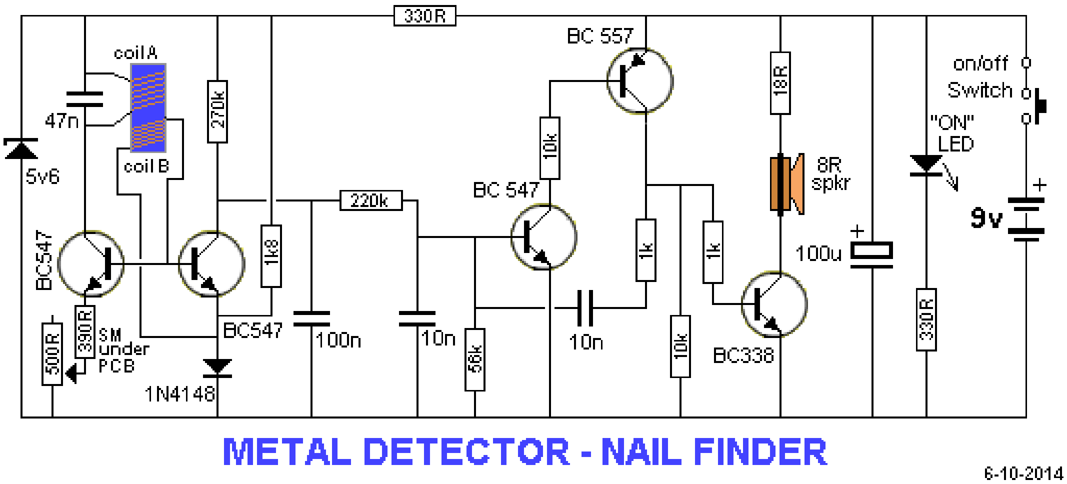
NAIL FINDER

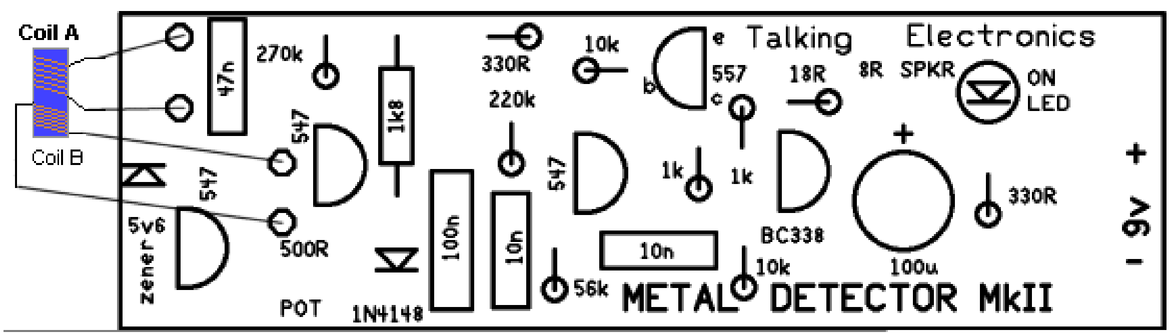
See the full project: Metal Detector MkII

This project is an extension of Metal Detector MkII, with a small detecting head to find tiny components such as nails and lost components.

This is an essential tool for servicemen and anyone trying to find a metal object hidden or buried in timber, soil or mud.

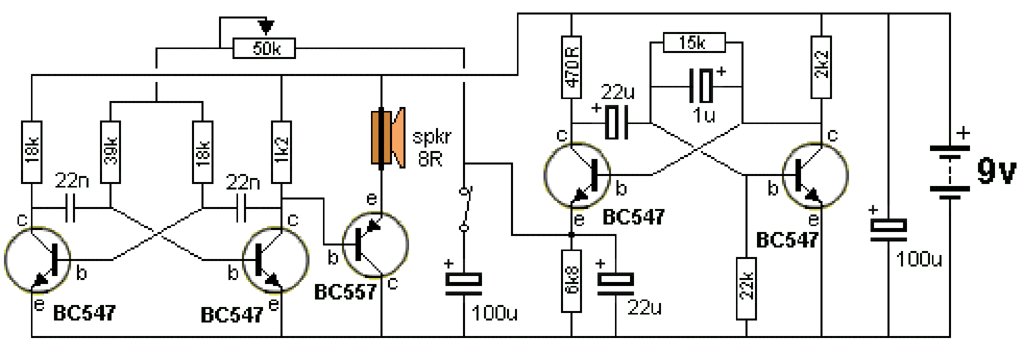
Kits for Metal Detector kit - Nail Finder $17.00 plus postage. This project is an extension of Metal Detector MkII, with a small detecting head to find tiny components such as nails and lost components.





The Nail Finder project is HERE

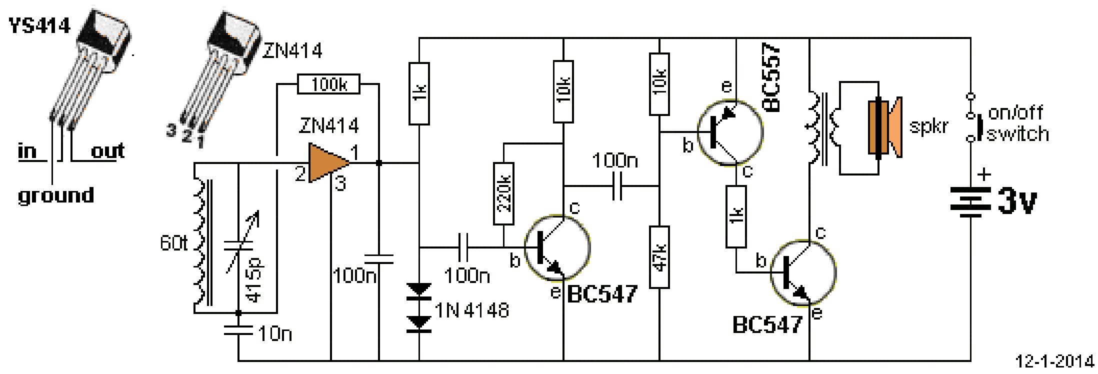
PHASER GUN



This is a very effective circuit. The sound is amazing. You have to build it to appreciate the range of effects it produces. The 50k pot provides the frequency of the sound while the switch provides fast or slow speed.

Hear the sounds (built by a reader).

IC RADIO



This circuit contains an IC but it looks like a 3-leaded transistor and that's why we have included it here.

The IC is called a "Radio in a Chip" and it contains 10 transistors to produce a TRF (tuned Radio Frequency) front end for our project.

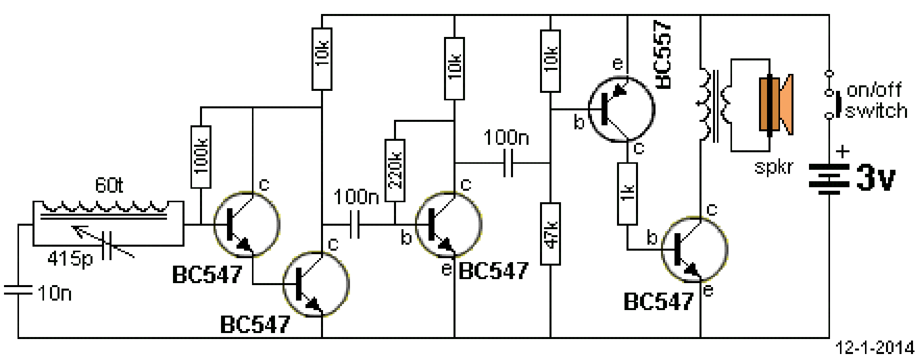
The 3-transistor amplifier is taken from our SUPER EAR project with the electret microphone removed.

The two 1N 4148 diodes produce a constant voltage of 1.3v for the chip as it is designed for a maximum of 1.5v.

The "antenna coil" is 60t of 0.25mm wire wound on a 10mm ferrite rod. The tuning capacitor can be any value up to 450p.

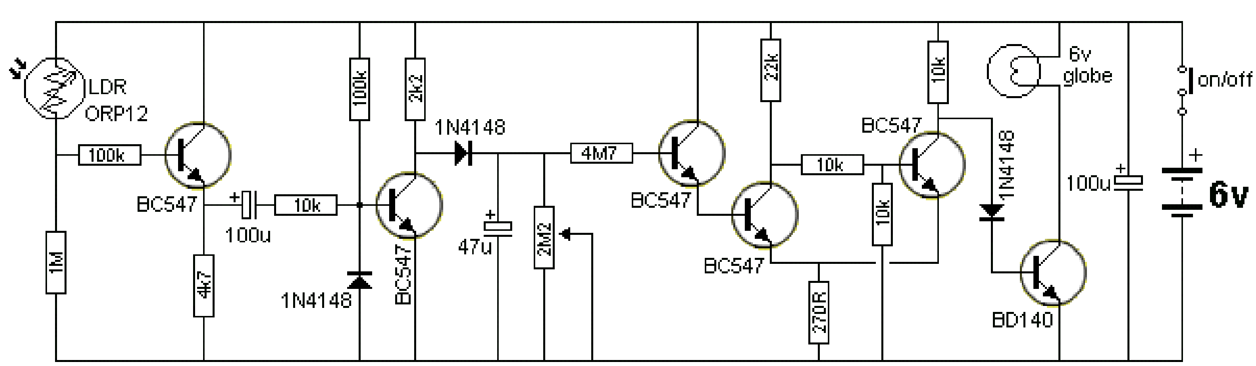
Note: The YS414 IC is identical to ZN414. See above.

5-TRANSISTOR RADIO



If you are not able to get the ZN414 IC, this circuit uses two transistors to take the place of the chip.

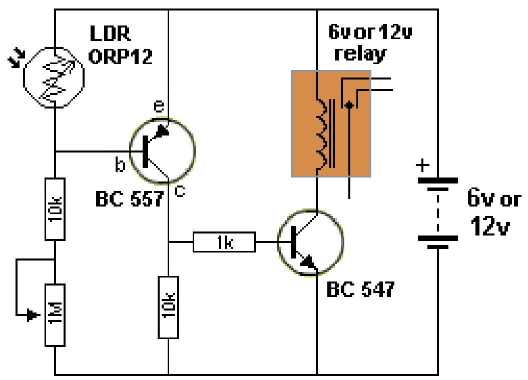
AUTOMATIC LIGHT



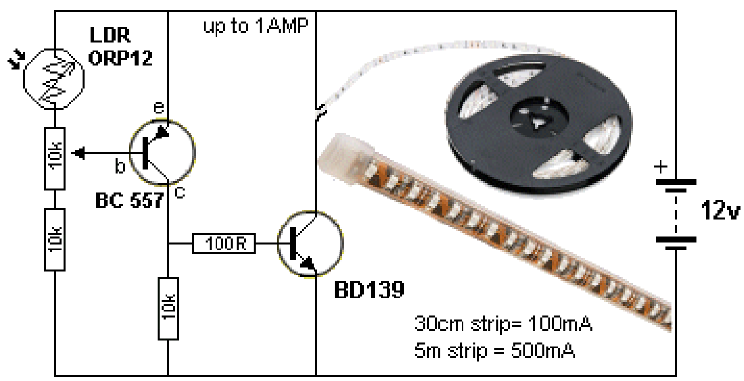
This circuit automatically turns on a light when illumination is removed from the LDR. It remains ON for the delay period set by the 2M2 pot.

The important feature of this circuit is the building blocks it contains - a delay circuit and Schmitt Trigger. These can be used when designing other circuits.

NIGHT LIGHT



This circuit activates a relay when illumination falls below a preset level on the Light Dependent Resistor (Photo Cell).

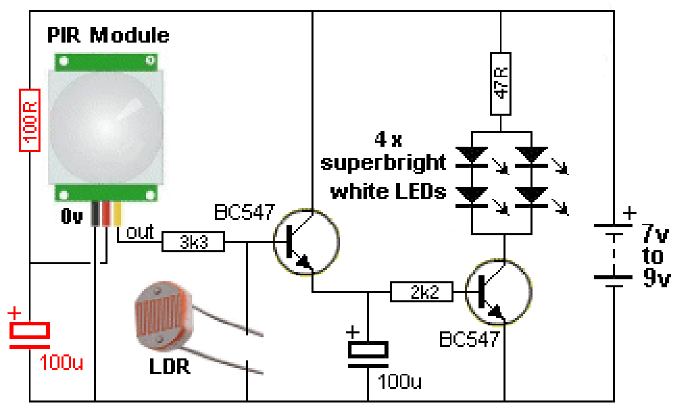


This circuit will drive 30cm strips to 5m strips. Two 5m strips have been tested with this circuit.

PIR LED LIGHT

PIR detectors make a wonderful detector to turn on LEDs to illuminate a passage, doorway or path.

It has an LDR that only allows the circuit to turn ON at night.



This circuit can use old cells as it requires less than 20mA to illuminate the 4 LEDs and less than 0.4mA when sitting around.

There are a number of different PIR detectors and most of them take 1 minute to settle before detecting IR and turn ON for a short period of time. The 100u increases the turn-ON time to about 4 seconds and some detectors keep outputting a signal while you are in front of the lens.

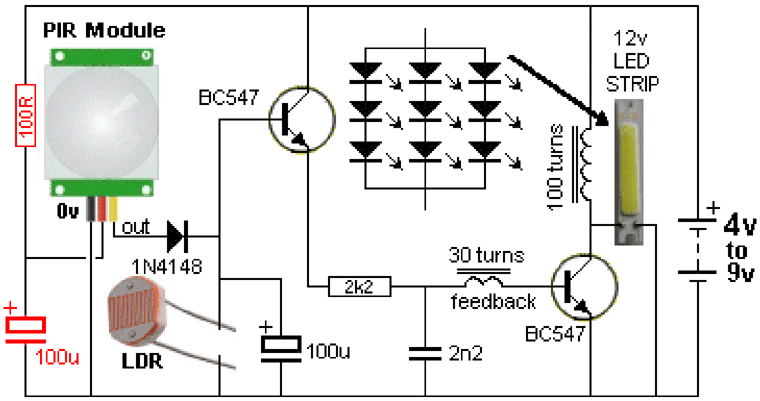
The first transistor increases the current from the PIR module so the 100u can be charged via the 1k and the second transistor acts as a buffer to deliver current to turn on the LEDs. The 100R and red 100u prevent the PIR re-triggering.

This is a great project for "using up" old batteries.

A kit for this project is available from Talking Electronics for $6.00 plus $4.50 postage.

It is built on a small piece of Matrix Board and includes 4 x super-bright LEDs. Email Colin Mitchell for details.

PIR LED LIGHT using LED STRIP



This circuit uses a home-made transformer, wound on a nut and bolt, and a 12v LED Strip or LED Panel.

You can use almost any nut and bolt and any wire from 0.2mm to 0.5mm diameter.

The main winding has 100 turns and the feedback winding has 30 turns.

All these LED panels have inbuilt resistors so they can be connected to 12v supplies. We do not need the inbuilt resistors in this circuit however the resistors cannot be removed. The LED strip shown in the circuit above contains 9 LEDs in groups of 3 with an inbuilt current liming resistor. The current-limiting resistor is not needed in this design but cannot be removed.

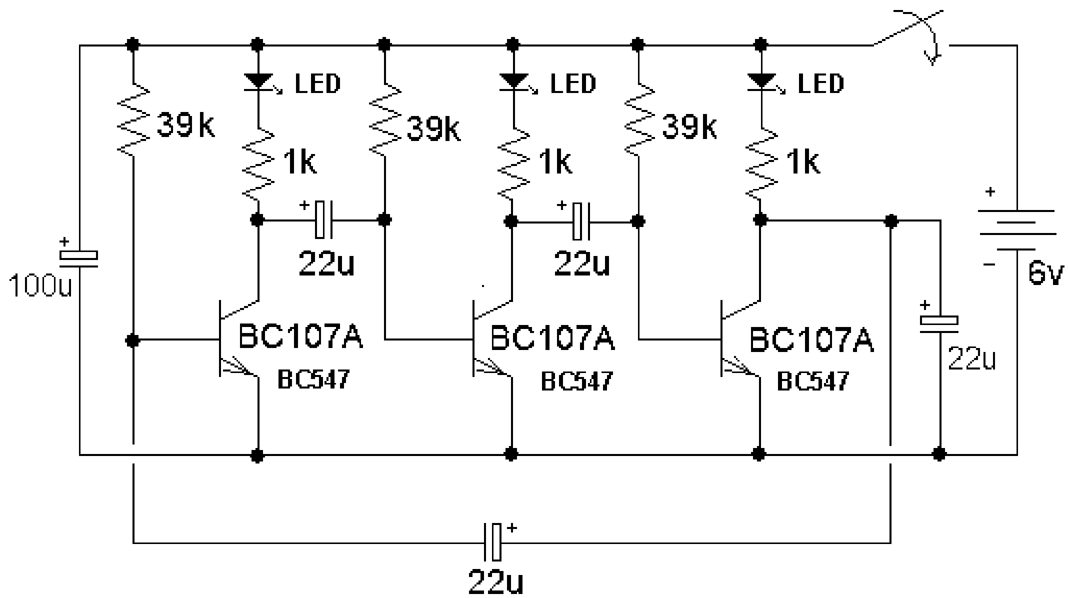
You can make your own LED strip by connecting three white LEDs in series (NO current-limiting resistor is needed). You can have a total of 9 LEDs. (3 strings of 3 LEDs) or you can use any of the 12v LED panels available on eBay.

If the circuit does not work, connect the feedback wires around the other way.

The LDR is included to turn the circuit ON only at night and the emitter-follower transistor increases the ON-time to about 4 seconds.

You can use old cells and make sure the supply is not higher than 9v as the LED Strip will remain illuminated because you will be supplying enough voltage to illuminate it !! You will need to experiment with the 2k2 resistor and 2n2 to get the best illumination with the transformer you use and the supply voltage.

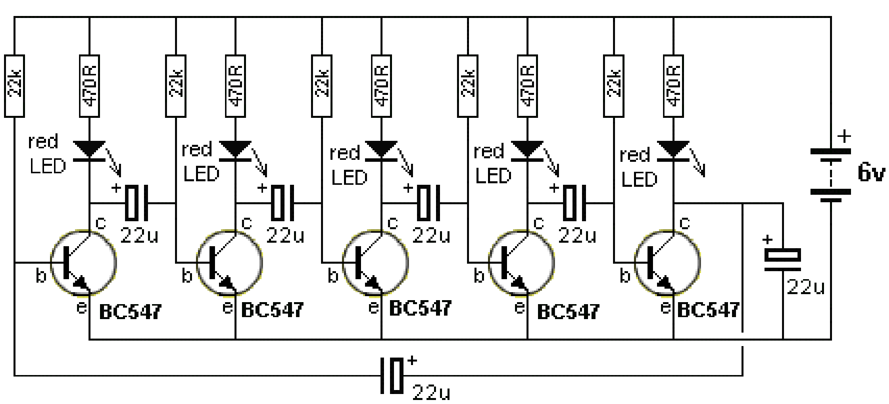
3-LED CHASER by Faraday (s.sh_butterfly@yahoo.com)



The LEDs in this circuit produce a chasing pattern similar the running LEDs display in video shops.

In fact the effect is called: "Running Hole." All transistors will try to come on at the same time when the power is applied, but some will be faster due to their internal characteristics and some will get a different turn-on current due to the exact value of the 22u electrolytics. The last 22u will delay the voltage-rise to the base of the first transistor and make the circuit start reliably. It is very difficult to see where the hole starts and that's why you should build the circuit and investigate it yourself. The circuit can be extended to any number of odd stages as shown in the next circuit, using 5 transistors.

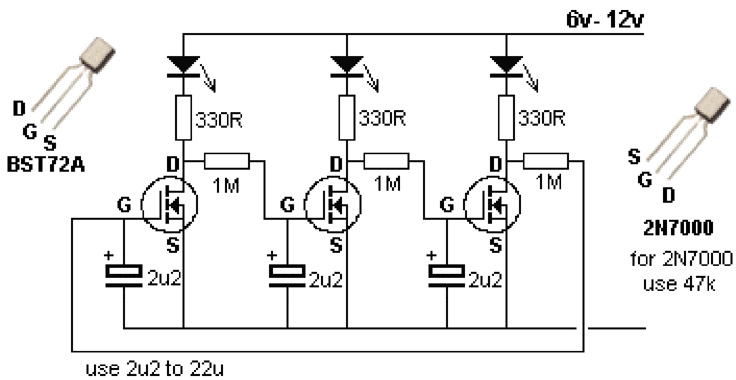
5-LED CHASER



This is an extension of the 3-LED Chaser above.

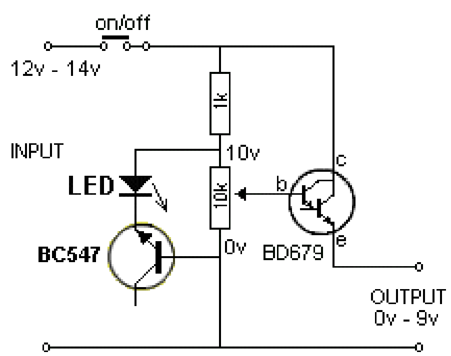
The following circuit produces a slightly different effect because the LEDs are in the emitter. You cannot mix the LED colours.

3-LED CHASER using FETs



This circuit uses FETs. This circuit has been tested with the following two FETs on 6v to 12v with red and white LEDs. The 1M resistor must be reduced to 47k for the 2N7000. Note the different pin-outs for the two FETs.

BENCH POWER SUPPLY



This power supply can be built in less than an hour on a piece of copper-laminate. The board acts as a heat-sink and the other components can be mounted as shown in the photo, by cutting strips to suit their placement. The components are connected with enamelled wire and the transistor is bolted to the board to keep it cool.

The Bench Power Supply was designed to use old "C","D" and lantern batteries, that's why there are no diodes or electrolytics. Collect all your old batteries and cells and connect them together to get at least 12v -14v.

The output of this power supply is regulated by a 10v zener made up of the characteristic zener voltage of 8.2v between the base-emitter leads of a BC547 transistor (in reverse bias) and approx 1.7v across a red LED. The circuit will deliver 0v - 9v at 500mA (depending on the life left in the cells your are using). The 10k pot adjusts the output voltage and the LED indicates the circuit is ON. It's a very good circuit to get the last of the energy from old cells.

ADDING A VOLT-METER TO THE BENCH POWER SUPPLY

A voltmeter can be added to the Bench Power Supply by using a very low cost multimeter. For less than $10.00 you can get a mini multimeter with 14 ranges, including a 10v range. The multimeter can also be used to monitor current by removing the negative lead and making a new RED lead, fitting it to the "—" of the multimeter and selecting the 500mA range as shown in the photo below:

MAKING 0-1Amp meter for the BENCH POWER SUPPLY

The item in the photo is called a "Movement." A movement is a moving coil with a pointer and no resistors connected to the leads.

Any Movement can be converted to an ammeter without any mathematics.

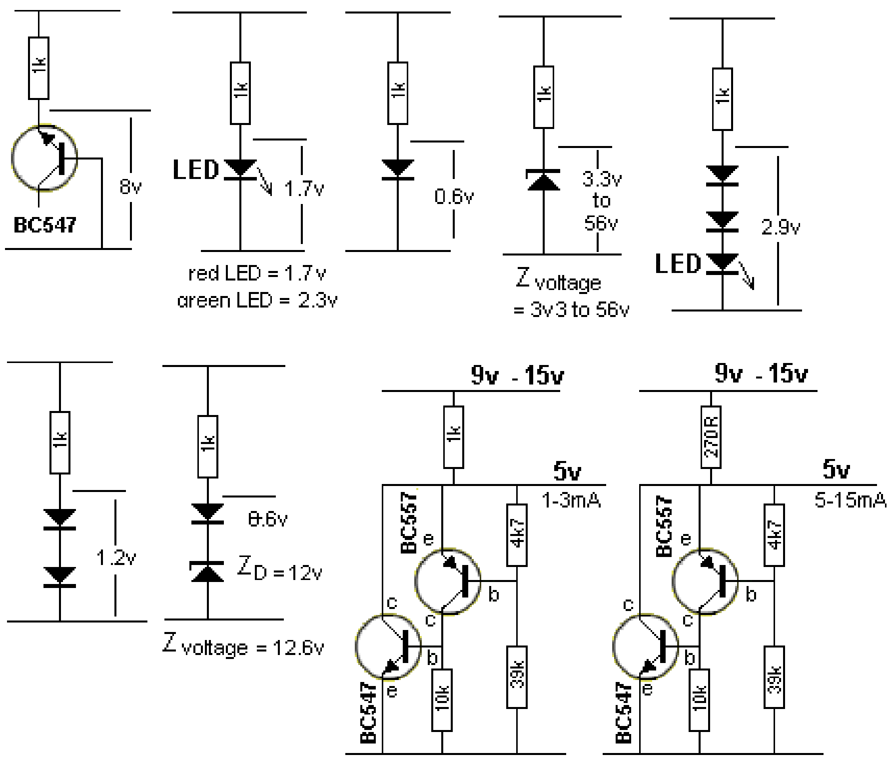
Simply solder two 1R resistors (in parallel) across the terminals of any movement and connect it in series with an ammeter on the output of the Bench Power Supply. The second ammeter provides a reference so you can calibrate the movement. Connect a globe and increase the voltage.

At 500mA, if the pointer is “up scale” (reading too high) add a trim-resistor. In our case it was 4R7.

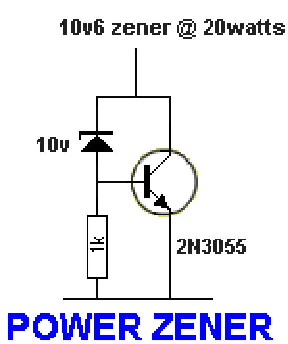
The three shunt resistors can be clearly seen in the photo. Two 1R and the trim resistor is 4R7.

You can get a movement from an old multimeter or they are available in electronics shops as a separate item. The sensitivity does not matter. It can be 20uA or 50uA FSD or any sensitivity.

MAKING A ZENER DIODE and POWER ZENER

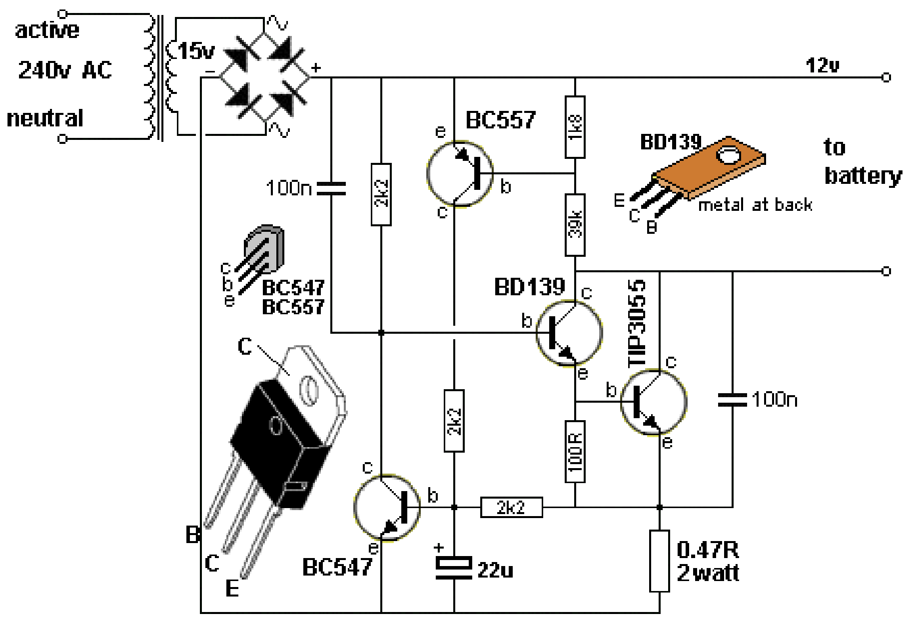


Sometimes a zener diode of the required voltage is not available. Here are a number of components that produce a characteristic voltage across them. Since they all have different voltages, they can be placed in series to produce the voltage you need. A reference voltage as low as 0.65v is available and you need at least 1 to 3mA through the device(s) to put them in a state of conduction (breakdown).



A POWER ZENER can be made from an ordinary zener and a transistor. The final power-zener voltage will be 0.6v higher than the zener and the wattage of the whole circuit will depend on the type of transistor used. Of course, constant use of this circuit will represent a waste of 20 watts and there are better ways to design a circuit, but it can be used to prevent a rail rising above a certain voltage and will only be used for short durations.

12v TRICKLE CHARGER



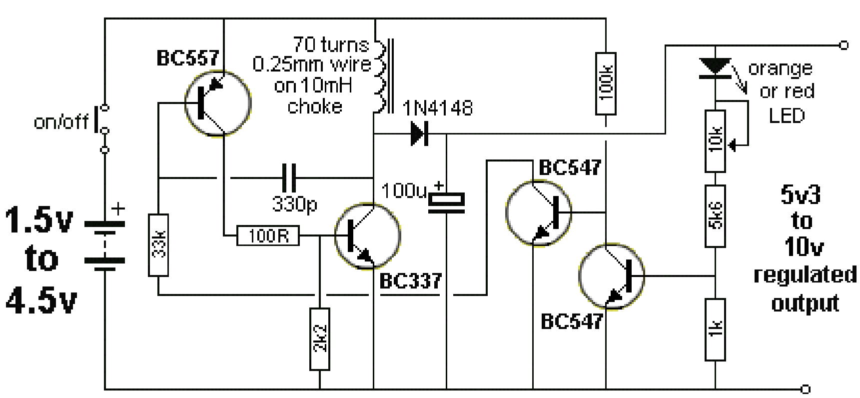
The 12v Trickle Charger circuit uses a TIP3055 power transistor to limit the current to the battery by turning off when the battery voltage reaches approx 14v or if the current rises above 2 amp. The signal to turn off this transistor comes from two other transistors - the BC557 and BC 547.

Firstly, the circuit turns on fully via the BD139 and TIP3055. The BC557 and BC 547 do not come into operation at the moment. The current through the 0.47R creates a voltage across it to charge the 22u and this puts a voltage between the base and emitter of the BC547. The transistors turn on slightly and remove some of the turn-on voltage to the BD139 and this turns off the TIP3055 slightly.

This is how the 2 amp max is created.

As the battery voltage rises, the voltage divider made up of the 1k8 and 39k creates a 0.65v between base and emitter of the BC557 and it starts to turn on at approx 14v. This turns on the BC 547 and it robs the BD136 of "turn-on" voltage and the TIP3055 is nearly fully turned off. All battery chargers in Australia must be earthed. The negative of the output is taken to the earth pin.

1.5v to 10v INVERTER



This very clever circuit will convert 1.5v to 10v to take the place of those expensive 9v batteries and also provide a 5v supply for a microcontroller project.

But the clever part is the voltage regulating section. It reduces the current to less than 8mA when no current is being drawn from the output. With a 470R load and 10v, the output current is 20mA and the voltage drop is less than 10mV. The pot will adjust the output voltage from 5.3v to 10v.

How the Circuit Works

The circuit starts by the 100k turning on the BC547 and the BC557 gets turned ON via the 33k resistor.

This turns ON the BC337 via the 100R resistor. You will notice the "current-limiting" resistors are getting small and smaller. This is because the transistor-current is getting larger and larger and we want the resistor to pass this higher current.

Current flowing through the collector-base of the BC337 causes current to flow through the inductor. This current creates expanding flux that cuts all the turns of the inductor and produces a voltage in the OPPOSITE DIRECTION. This voltage OPPOSES the incoming voltage and very little current flows.

Over a period of microseconds, this voltage drops a microscopic amount and thus a slightly higher current will flow.

The voltage on the collector drops and this change is passed through the 330p to turn on the BC557 MORE.

This continues until the BC337 is fully turned ON (by the action of the 330p).

The 330p now charges a little more and this reduces the base current in the BC557 and it starts to turn OFF.

This action starts to turn OFF the BC337 and very soon we have both transistors fully turned OFF.

The BC337 is effectively removed from the circuit and the current flowing through the inductor stops increasing. The magnetic flux stops increasing and the voltage it produces stops IMMEDIATELY.

The magnetic flux now does not have any voltage opposing it and it starts to collapse and cut all the turns of the inductor. It does this very quickly because there is no voltage opposing its collapse.

The result is a very high voltage in the opposite direction to the applied voltage. What this means is the lower terminal of the inductor produces a voltage that is ADDED to the supply voltage.

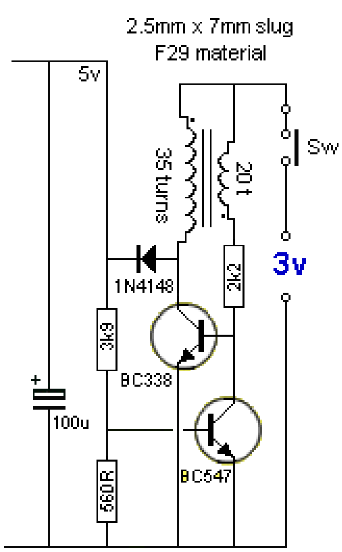
This voltage can be as high at 100v or more, and is passed through the diode. Even though this voltage is very high, it actually consists of a very high voltage with a very small current.

The combination of these two is called ENERGY and it flows into the 100u to charge it.

As the voltage on the 100u increases, its voltage is detected by the 4th transistor and when it reaches 10v, the 3rd transistor is turned OFF slightly so the first two transistors are not driven as hard.

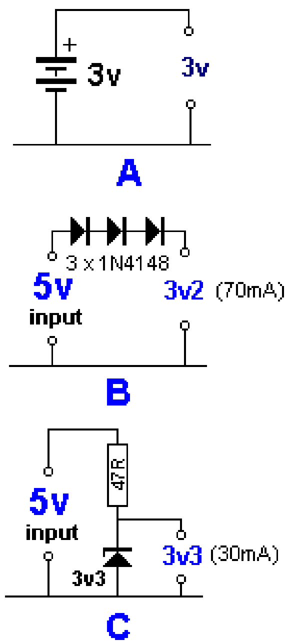
This is how a stable 10v is produced.

5v REGULATED SUPPLY FROM 3V



This circuit will produce a 5v regulated output from 2 cells (3v). The output current is limited to 50mA but will be ideal for many microcontroller circuits. The output voltage is set to 5v by the 3k9 and 560R resistors, making up a voltage divider network.

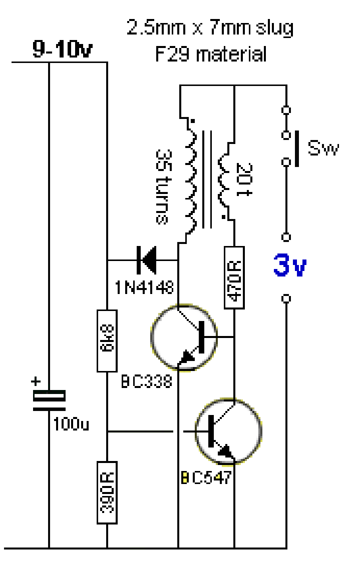
3.3v FROM 5V SUPPLY



Here are 3 ways to generate a 3.3v supply: Circuit “A” uses two 1.5v cells. This is the cheapest and best way to create a 3v supply.

Circuit “B” uses 3 x 1N448 signal diodes to drop 1.8v and produce 3.2v on the output. The 5v supply must be regulated. Circuit “C” produces 3.3v from a 3v3 zener. The 47R limits the output to about 30mA. The 5v can have a small ripple as the zener will create a stable 3v3 output.

9v SUPPLY FROM 3V



You can replace a 9v battery with this circuit. The output is about 10.4v on no load and 9.6v @30mA .

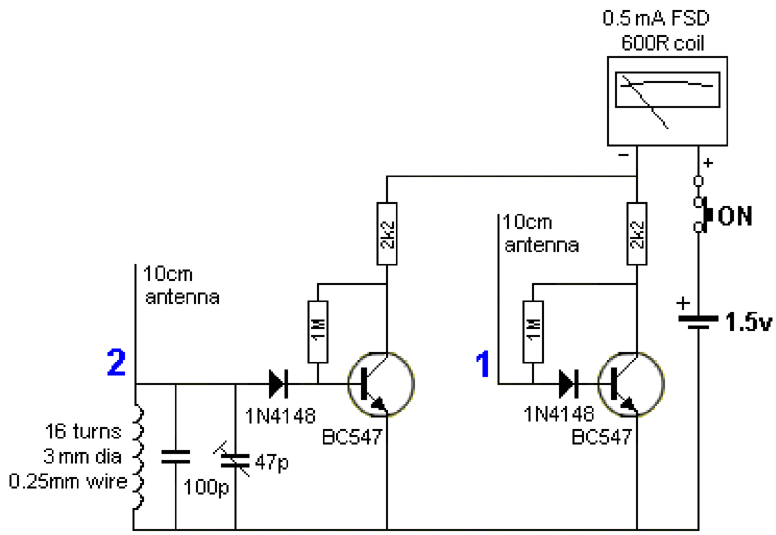
The advantage is the voltage stays over 9v for the life of the cells.

A normal 9v battery drops to 7v very quickly.

The output voltage is set to 9-10v by the 6k8 and 390R resistors. The 470R gives the circuit an idling current of about 20mA and the spikes are about 75mV.

By increasing the 470R, the quiescent current decreases but the voltage drops more when the current is 30mA.

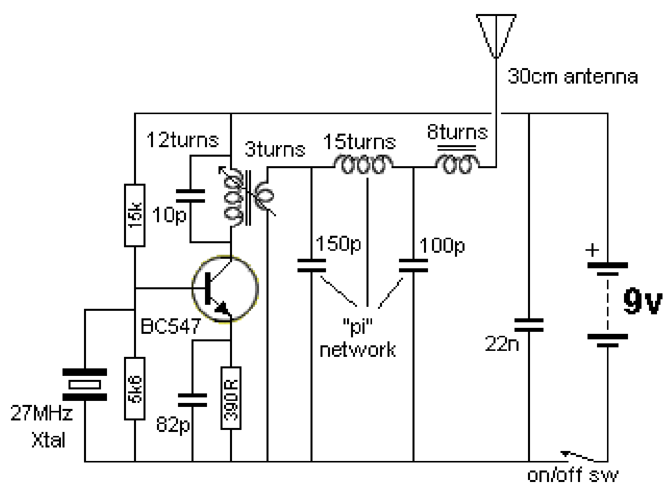
27MHz Field Strength Meter



This circuit will test 27MHz transmitters and show the transmitter is operating when the antenna is connected to point 1 and the actual frequency of transmission when the antenna is connected to point 2.

See the full project HERE.

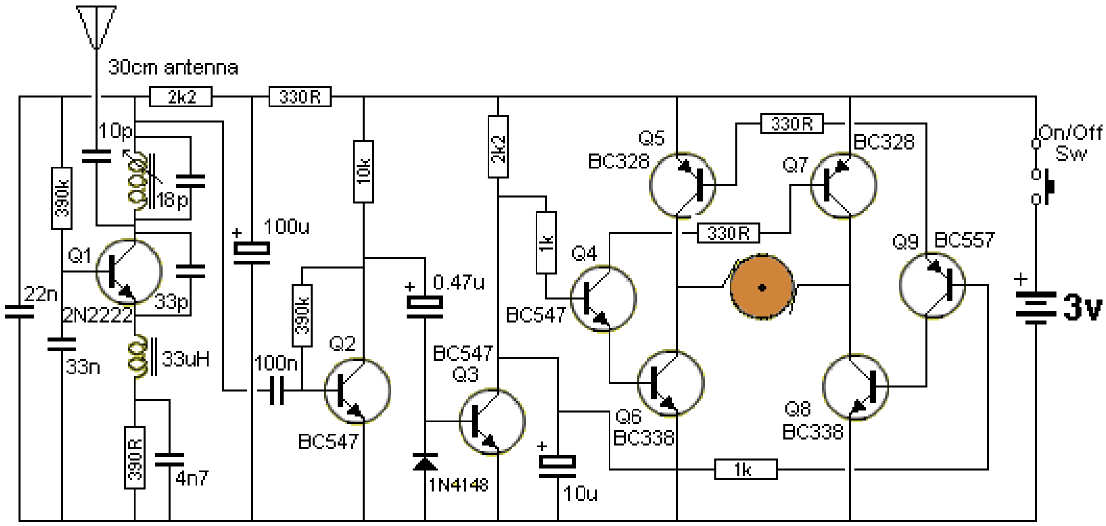
27MHz TRANSMITTER



The transmitter is a very simple crystal oscillator. The heart of the circuit is the tuned circuit consisting of the primary of the transformer and a 10p capacitor. The frequency is adjusted by a ferrite slug in the centre of the coil until it is exactly the same as the crystal. The transistor is configured as a common emitter amplifier. It has a 390R on the emitter for biasing purposes and prevents a high current passing through the transistor as the resistance of the transformer is very low.

The "pi" network matches the antenna to the output of the circuit. See full description in 27MHz Links article.

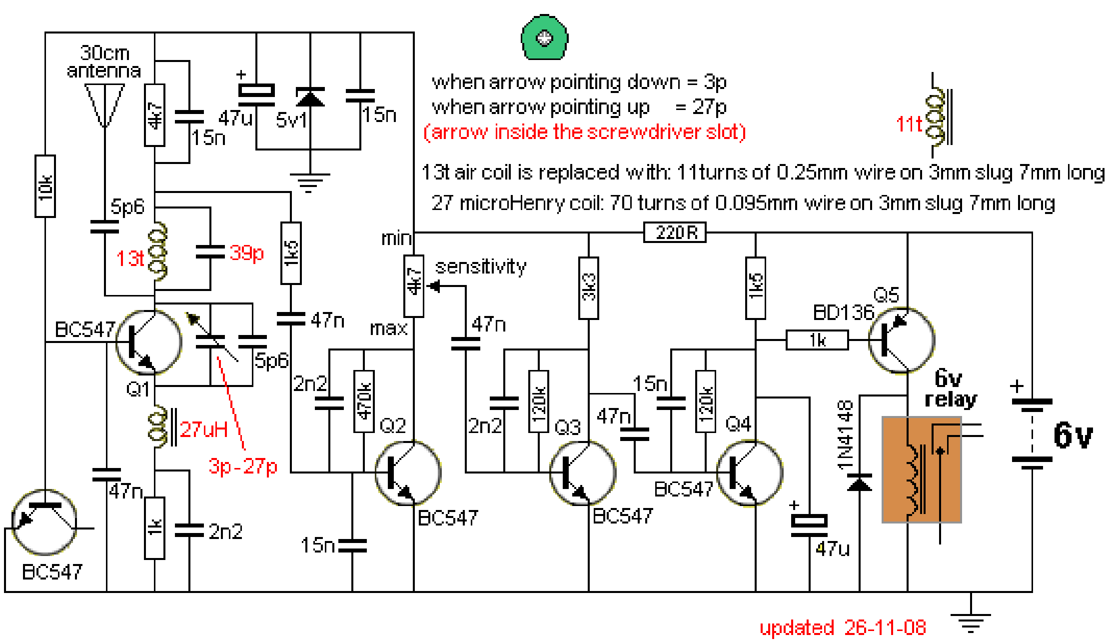
27MHz RECEIVER



The 27MHz receiver is really a transmitter. It's a very weak transmitter and delivers a low level signal to the surroundings via the antenna. When another signal (from the transmitter) comes in contact with the transmission from the receiver it creates an interference pattern that reflects down the antenna and into the first stage of the receiver.

The receiver is a super-regenerative design. It is self-oscillating (or already oscillating) and makes it very sensitive to nearby signals. See full description in 27MHz Links article.

27MHz RECEIVER-2

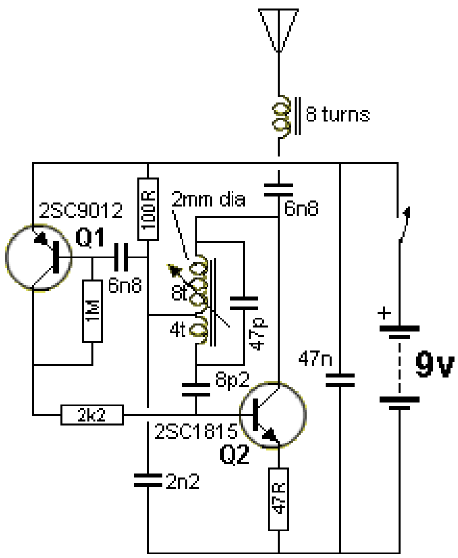


This circuit matches with the 27MHz Transmitter with Square-wave Oscillator. See full description on Talking Electronics website: 27MHz Links article. The receiver frequency is fixed. The transmitter is adjusted to suit the receiver. The 3-27p trimmer is adjusted for maximum gain (10p trimmer and 5p6 in our case) and this is a critical adjustment.

The base-emitter junction of the first BC547 sets 0.7v (as it is heavily turned on by the 10k) on the base of the oscillator Q1, and this is fixed. Q1 is very lightly turned on (due to the emitter resistor), and this makes it very sensitive when it is oscillating. Any 27MHz signal from the surroundings will upset the oscillator and any tone in the signal will be passed to the stages for amplification. The coil is 13 turns. It can be replaced with 11 turns of 0.25mm wire on 3mm dia slug 7mm long. Although the original Russian product worked very well, our prototype did not have very good sensitivity. The circuit was very difficult to set-up.

Note: When making the 27uH inductor and checking its value on an inductance meter; if the meter does not read low values accurately, put two inductors in series. Measure the first inductor, say 100uH. The two inductors in series will be 127uH as inductors combine just like resistors in series! The result is the addition of the individual values.

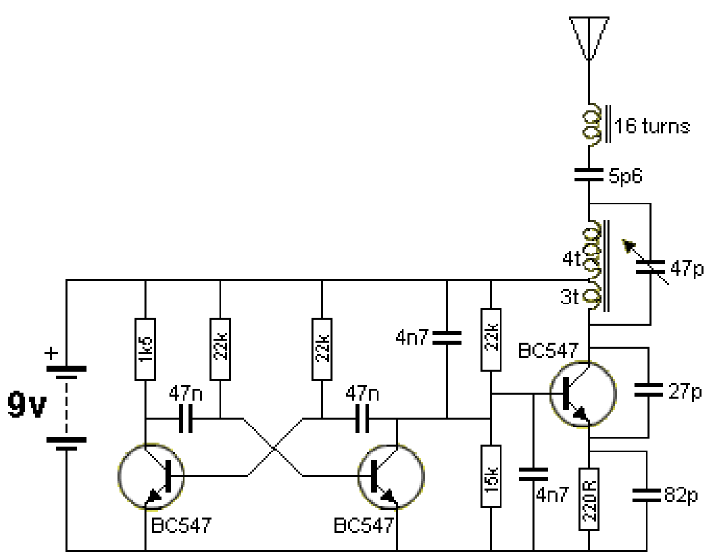
27MHz TRANSMITTER WITHOUT A CRYSTAL



A 27MHz transmitter without a crystal. When a circuit does not have a crystal, the oscillator is said to be "voltage dependent" or "voltage controlled" and when the supply voltage drops, the frequency changes.

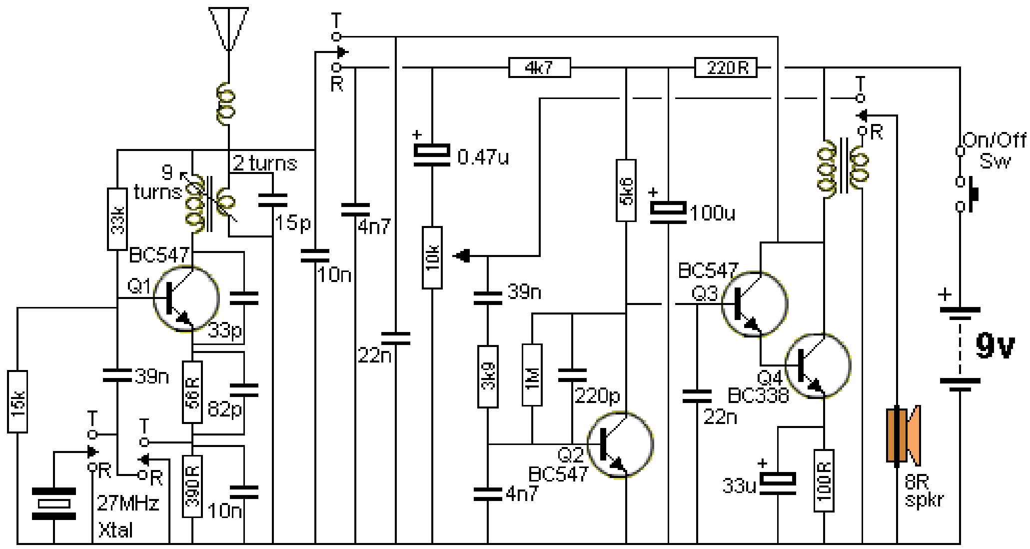
If the frequency drifts too much, the receiver will not pick up the signal. For this reason, a simple circuit as shown is not recommended. We have only included it as a concept to show how the 27MHz frequency is generated. It produces a tone and this is detected by a receiver. See full description in 27MHz Links article.

27MHz TRANSMITTER WITH SQUARE-WAVE OSCILLATOR



The circuit consists of two blocks. Block 1is a multivibrator and this has an equal mark/space ratio to turn the RF stage on and off. Block 2 is an RF oscillator. The feedback to keep the stage operating is provided by the 27p capacitor. The frequency-producing items are the coil (made up of the full 7 turns) and the 47p air trimmer. These two items are called a parallel tuned circuit. They are also called a TANK CIRCUIT as they store energy just like a TANK of water and pass it to the antenna. The frequency of the circuit is adjusted by the 47p air trimmer. See full description in 27MHz Links article.

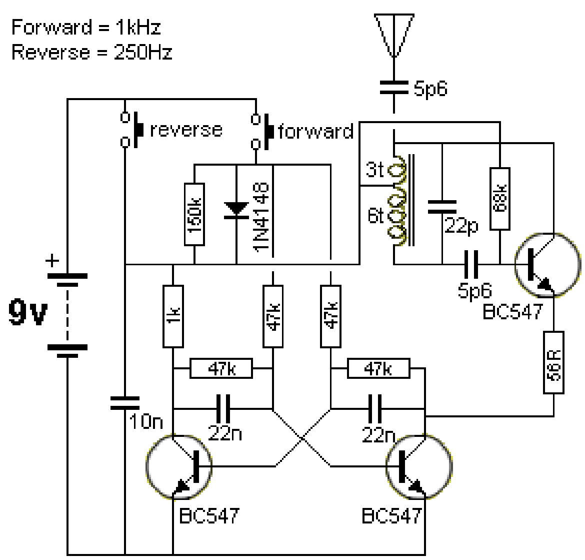
WALKIE TALKIE



Nearly all the components in the 4-transistor circuit are used for both transmitting and receiving. This makes it a very economical design. The frequency-generating stage only needs the crystal to be removed and it becomes a receiver. Next is a three transistor directly coupled audio amplifier with very high gain. The first transistor is a pre-amplifier and the next two are wired as a super-alpha pair, commonly called a Darlington pair to drive the speaker transformer.

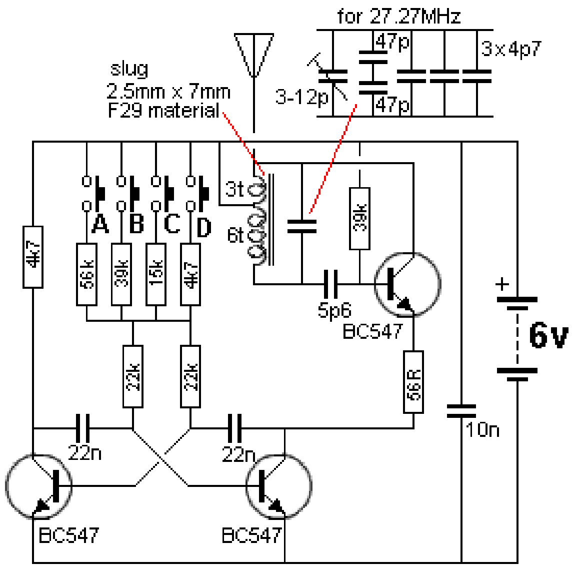
See full description in 27MHz Links article.

27MHz TRANSMITTER - 2 CHANNEL



This circuit does not use a crystal but has a clever feature of using the two push buttons to turn the circuit on when it is required to transmit. The frequency of the multivibrator is determined by the value of resistance on the base of each transistor. The multivibrator is driven directly from the supply with the forward button and via a 150k for the reverse frequency. The receiver requires a 1kHz tone for forward and 250Hz for reverse. See full description in 27MHz Links article.

27MHz TRANSMITTER - 4 CHANNEL



This circuit uses the same number of components as the 2-Channel circuit above but has 4 channels.

The frequency of the multivibrator is determined by the value of resistance on the base of each transistor.

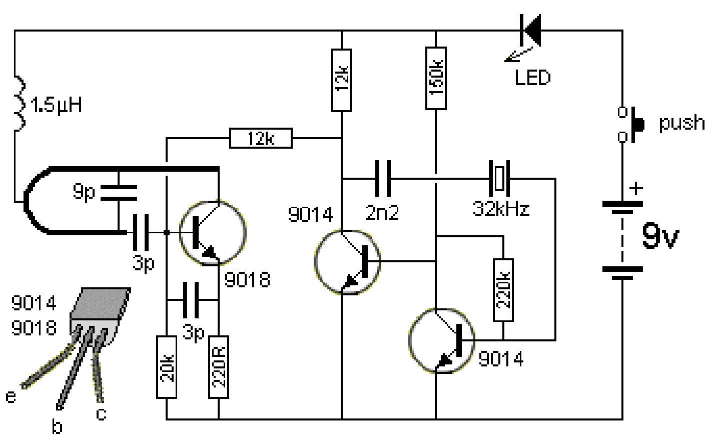
A 4 channel receiver has been designed by talking Electronics using a PIC12F628 micro to detect the different frequencies.

See P4 of: 2 Digit Up/Down Counter (see left index on Talking Electronics website).

2 Digit Up/Down Counter has the receiver section.

- A = 500Hz
- B = 550Hz
- C = 660Hz
- D = 1kHz

303MHz TRANSMITTER

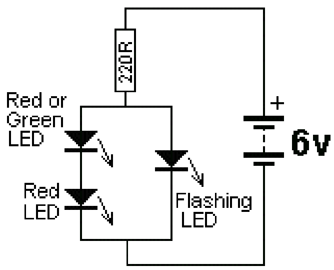


The transmitter circuit is made up of two building blocks - the 303MHz RF oscillator and the 32kHz crystal controlled oscillator to generate a tone so the receiver does not false-trigger.

The 303MHz oscillator consists of a self-oscillating circuit made up of the coil on the PC board and a 9p (9 puff) capacitor.

See full description in Wireless Doorbell article.

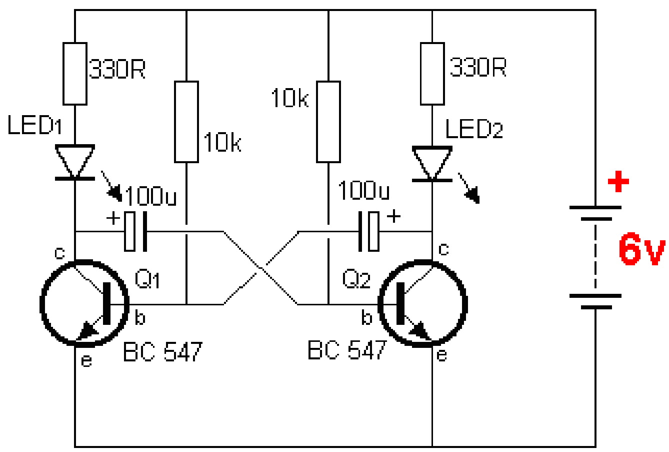
BOOM GATE LIGHTS



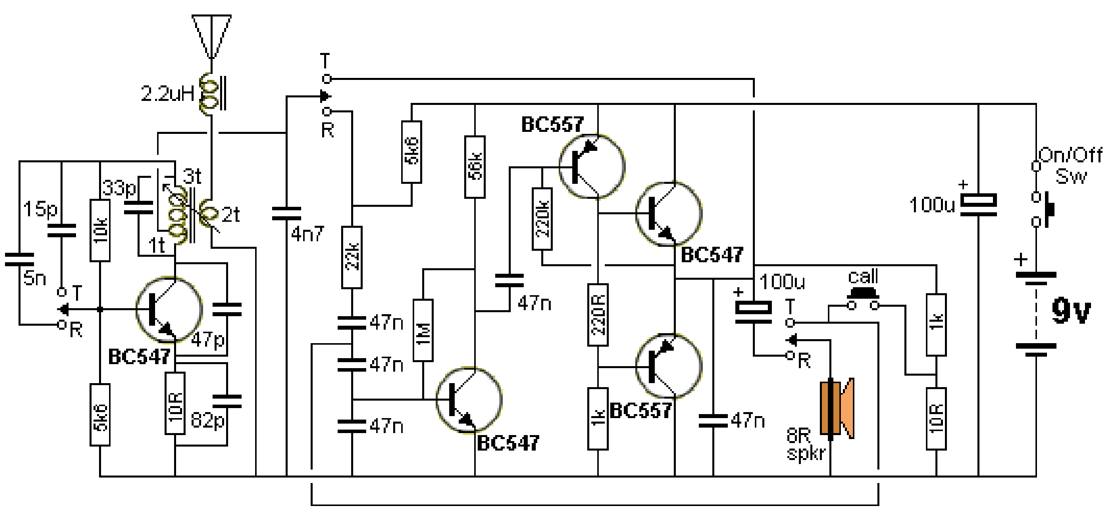
This simple circuit will produce flashing lights for your model railway crossing. It uses one flashing LED and one normal red LED, with a green LED hidden in the background. It can be used somewhere else on your layout but it is needed to produce a voltage drop so the two red LEDs will flash. You cannot get a simpler circuit.

The second circuit produces the same effect but the flash-rate is more even.

The 1/10th watt resistors used in this circuit, compared with 0.25watt resistors.

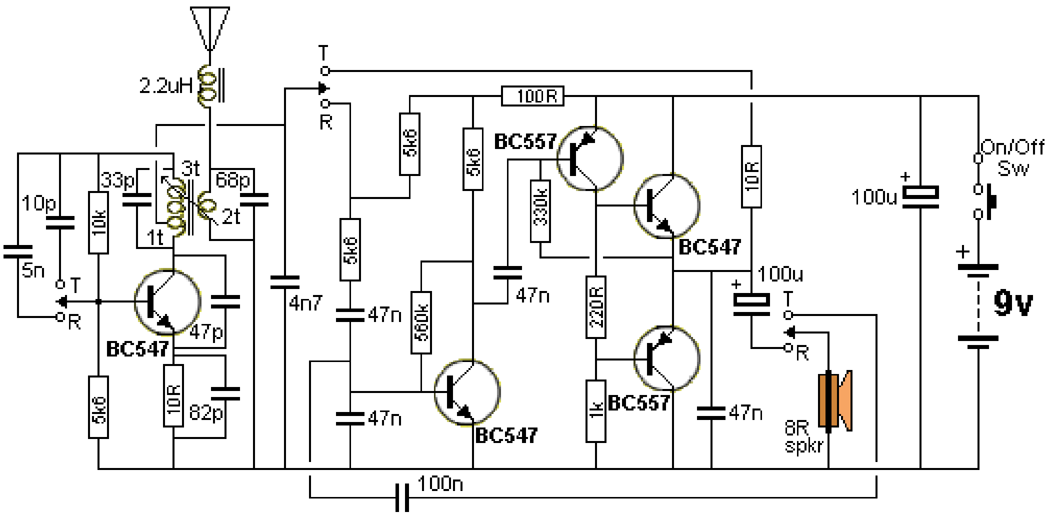


5 TRANSISTOR WALKIE TALKIE 1



This walkie talkie circuit does not have a crystal or speaker transformer, with the board measuring just 3cm x 4cm and using 1/10th watt resistors, it is one of the smallest units on the market, for just $9.50 to $12.00. The wires in the photo go to the battery, speaker, call-switch and antenna. The most difficult component in the circuit to duplicate is the oscillator coil. See the photo for the size and shape. The coil dia is 5mm and uses 0.25mm wire. The actual full-turn or half turn on the coil is also important. Almost all 5 transistor walkie talkies use this circuit or slight variations. See the article: 27MHz Transmitters for theory on how these transmitters work - it is fascinating.

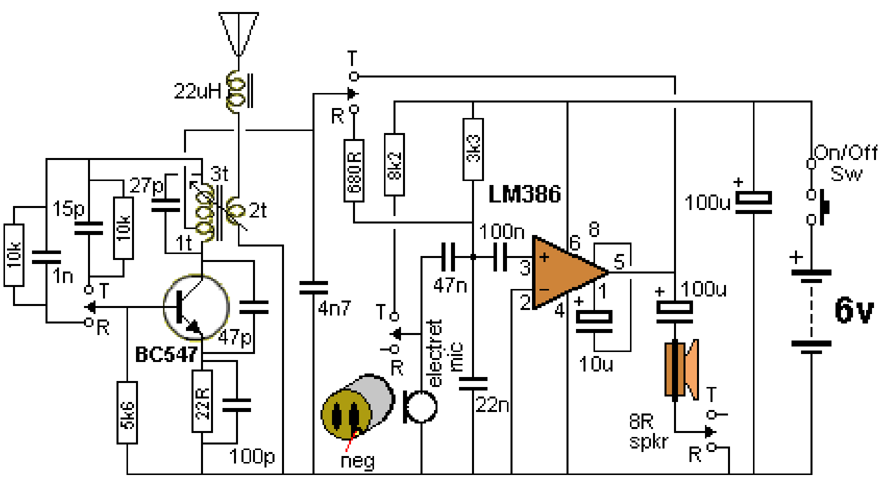
5 TRANSISTOR WALKIE TALKIE 2



Here is another walkie talkie circuit, using slightly different values for some of the components.

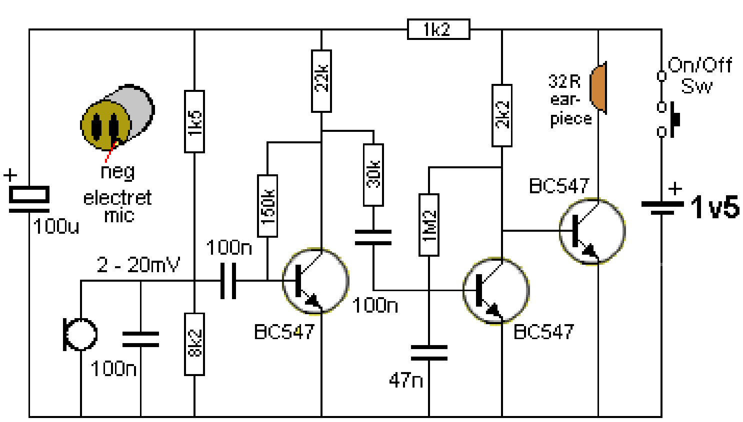
See the article: 27MHz Transmitters - for theory on how these transmitters work.

WALKIE TALKIE with LM386



Here is a more up-to-date version of the walkie talkie, using an LM 386 amplifier IC to take the place of 4 transistors.

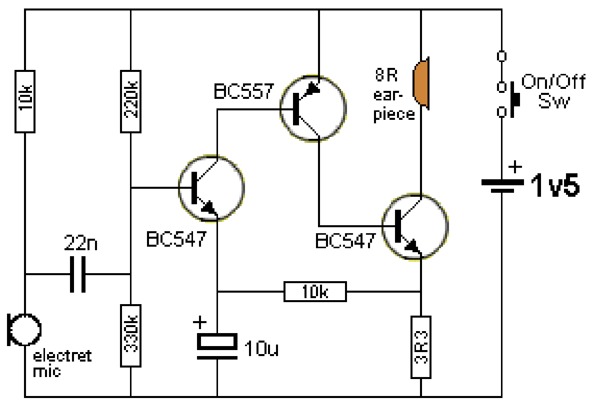
SPY AMPLIFIER



This simple circuit will detect very faint sounds and deliver them to a 32 ohm earpiece. The circuit is designed for 1.5v operation and is available from $2.00 shops for less than $5.00

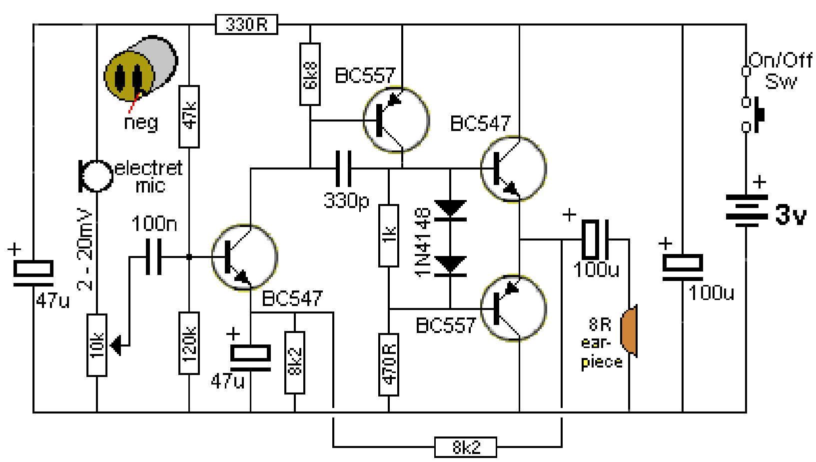
The photo shows the surface-mount components used in its construction.

HEARING AID 1.5v SUPPLY



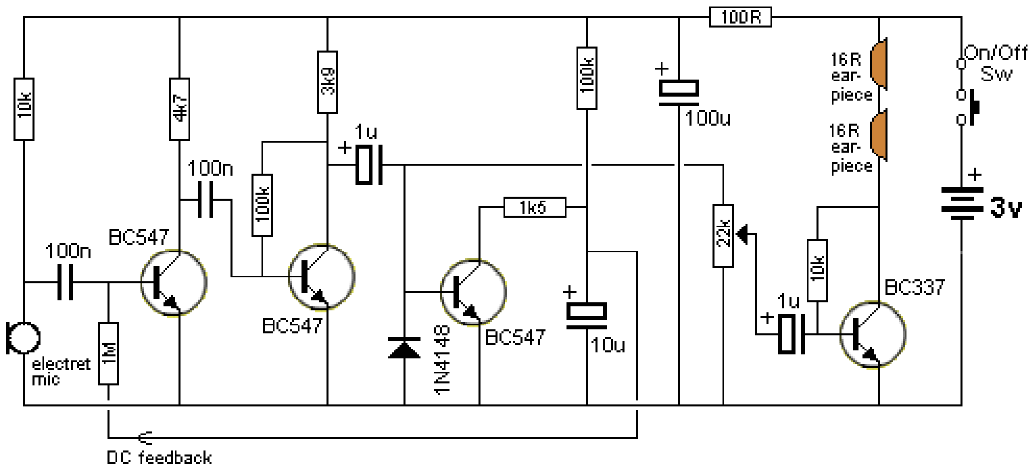
This simple circuit will detect very faint sounds and deliver them to an 8 ohm earpiece. The circuit is designed for 1.5v operation.

HEARING AID with PUSH PULL OUTPUT



This circuit will detect very faint sounds and deliver them to an 8 ohm earpiece. It is designed for 3v operation.

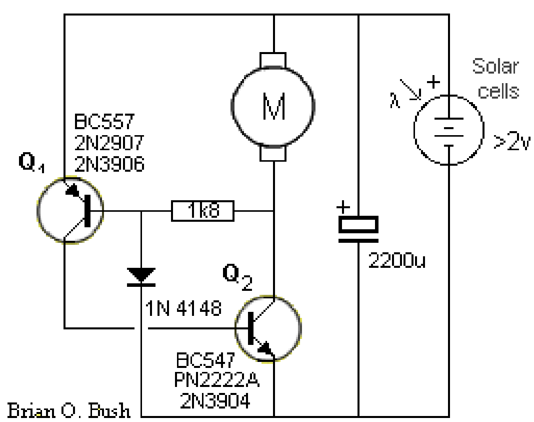
HEARING AID with CONSTANT VOLUME



This is a very handy circuit as it provides constant volume.

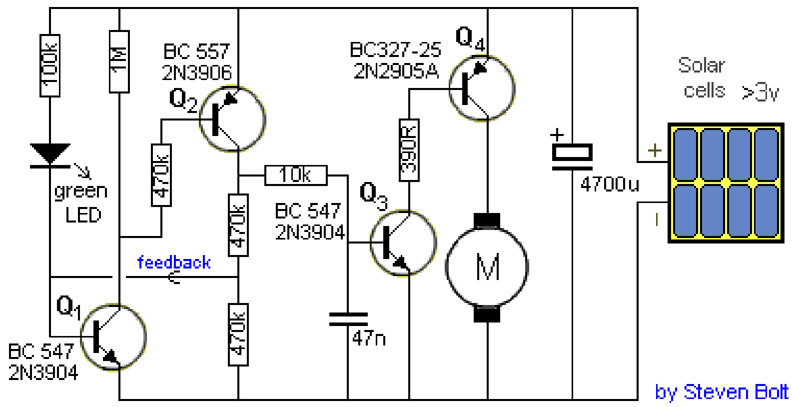
It is designed for 3v operation.

SOLAR ENGINE



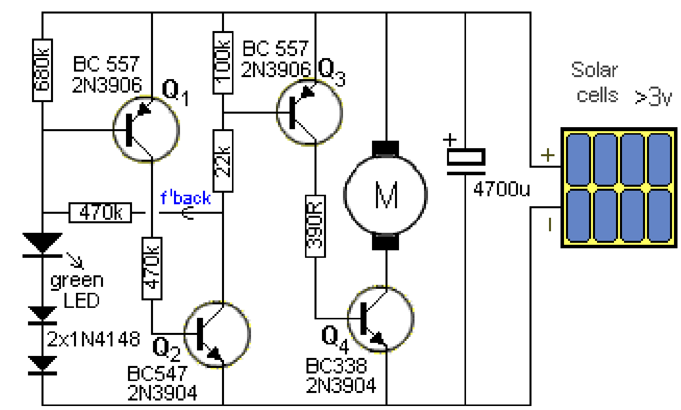
This circuit is called Type-1 SE. Low current from a solar cell is stored in a large capacitor and when a preset voltage-level is reached, the energy from the capacitor is released to a motor. For full details on how the circuit works and how to modify it, see: http://www.talkingelectronics.com/projects/Robots/Page2.html

SUN EATER-I



An improved design over Solar Engine circuit above. It has a clever 2-transistor self-latching arrangement to keep the circuit ON until the voltage drops to 1.5v. The circuit turns on at 2.8v. This gives the motor more energy from the electrolytic at each "pulse." For full details on how the circuit works and how to modify it, see: http://www.talkingelectronics.com/projects/Robots/Page2.html

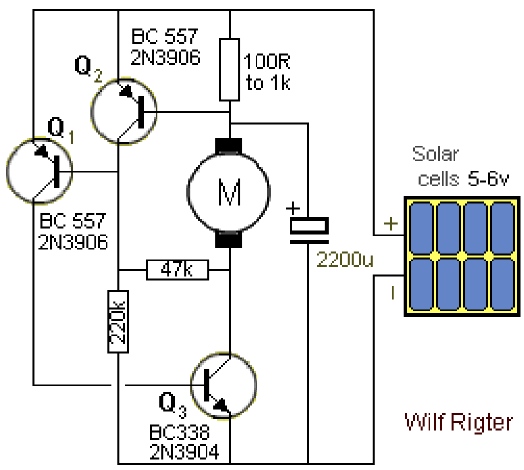
SUN EATER-1A



This circuit is an improvement on the Sun Eater I shown above. It works exactly the same except the slight re-arrangement of the components allows an NPN power transistor to be used. One less resistor is needed and one less capacitor but two extra diodes have been added to increase the upper turn-on voltage.

For full details on how the circuit works and how to modify it, see: http://www.talkingelectronics.com/projects/Robots/Page2.html

SOLAR ENGINE Type-3



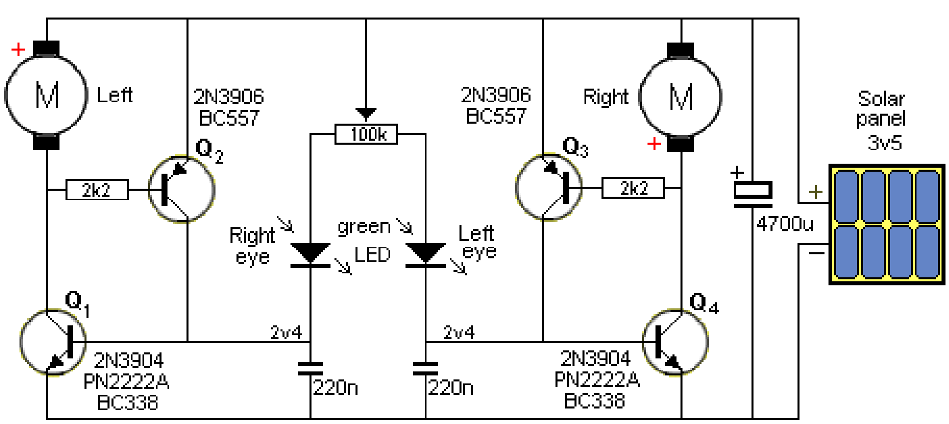
Type-3 circuits are current controlled or current-triggered. This is another very clever way of detecting when the electrolytic has reached its maximum charge.

At the beginning of the charge-cycle for an electrolytic, the charging current is a maximum. As the electrolytic becomes charged, the current drops. In the type-3 circuit, the charging current passes through a 100R resistor and creates a voltage drop. This voltage is detected by a transistor (Q2) and the transistor is turned ON.

This action robs transistor (Q1) from turn-on voltage and the rest of the circuit is not activated. As the charging current drops, Q2 is gradually turned off and Q1 becomes turned on via the 220k resistor on the base.

This turns on Q3 and the motor is activated. The voltage across the storage electrolytic drops and the current through the 100R rises and turns the circuit off. The electrolytic begins to charge again and the cycle repeats. For full details on how the circuit works and how to modify it, see: http://www.talkingelectronics.com/projects/Robots/Page2.html

SOLAR PHOTOVORE

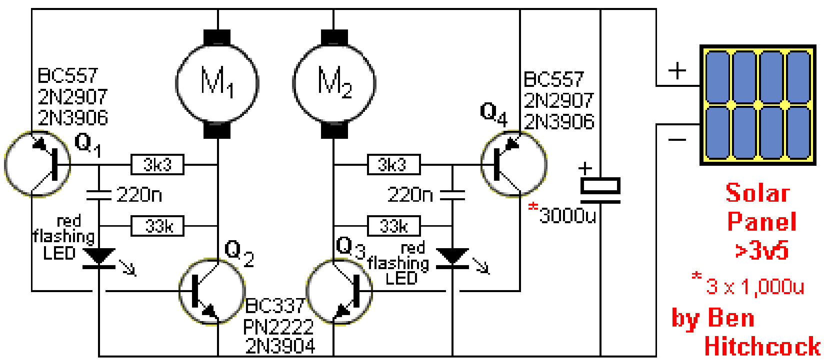


The green LEDs cause the Solar Engine on the opposite side to fire and the Solar Photovore turns toward the light source. The motors are two pager "vibe" motors with the weights removed.

The 100k pot on the "head" balances the two Solar Engines. If you cannot get the circuit to work with green LEDs, use photo-transistors.

For full details on how the circuit works and how to modify it, see: http://www.talkingelectronics.com/projects/Robots/Page4.html

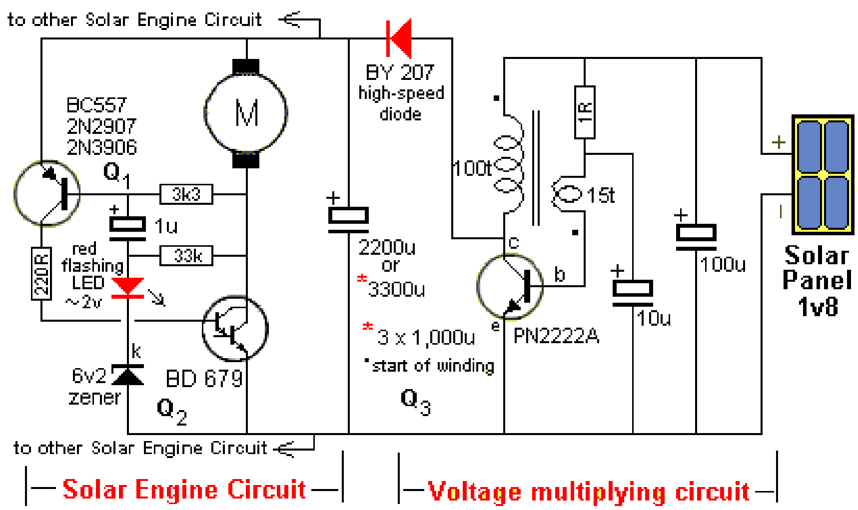
FRED Photopopper (Flashing LED)



It is a Photopopper using low-cost components. It uses two red or green flashing LEDs to turn the circuit on when the voltage across the electrolytic has reached about 2.7v. The flashing LEDs change characteristics according to the level of the surrounding light and this turns the circuit into phototropic.

For full details on how the circuit works and how to modify it, see: http://www.talkingelectronics.com/projects/Robots/Page6.html

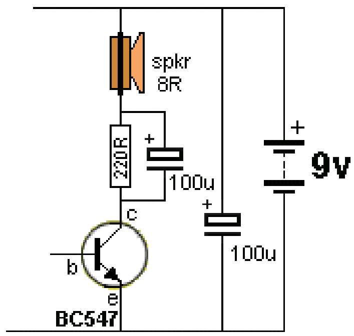
ROBO ROLLER



The circuit consists of two building blocks. The Photopopper circuit and a voltage multiplying (or voltage increasing) circuit from a Solar Charger project.

For full details on how the circuit works and how to modify it, see: http://www.talkingelectronics.com/projects/Robots/Page7.html

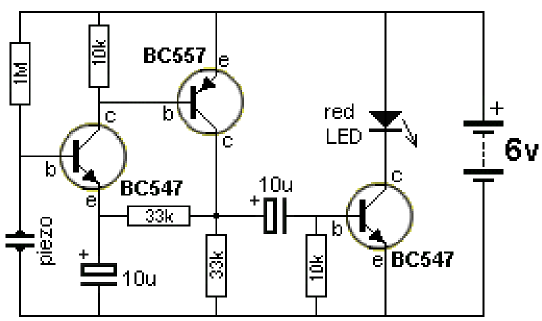
SIGNAL BY-PASS



This circuit allows a class-A amplifier to drive a low impedance speaker and has a low quiescent current. The 220R in series with the speaker limits the “wasted” current to about 20mA max as the transistor is generally biased at mid-voltage. However the transistor will be almost directly driving the speaker when a signal is being processed and the only limitation is the ability of the 220R to discharge the 100u during each cycle.

The circuit is called a signal by-pass as the signal by-passes the 220R and drives the speaker directly (via the 100u).

SOUND-TO-LIGHT

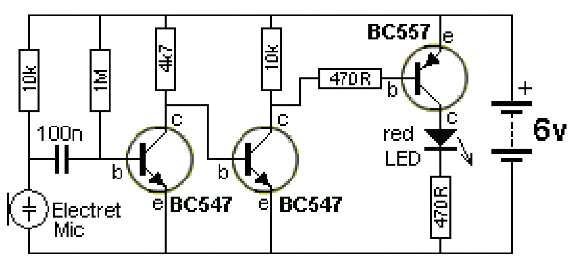


The LED illuminates when the piezo diaphragm detects sound.

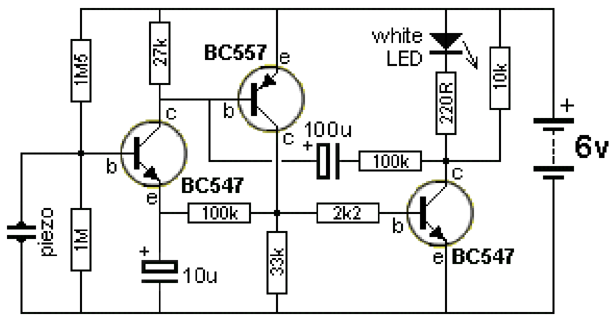
Some piezo diaphragms are very sensitive and produce 100mV when whistling at 50cm. Others produce 1mV. You must test them with a CRO.

The sensitivity of the diaphragm will determine the sensitivity of the circuit.

The following circuit uses an electret microphone:



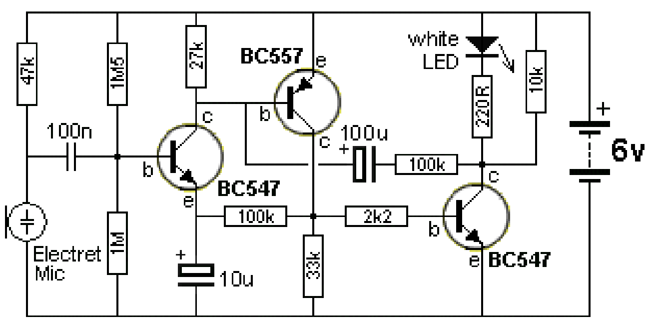
CLAP SWITCH



see also VOX.

SOUND-TO-LIGHT with Delay

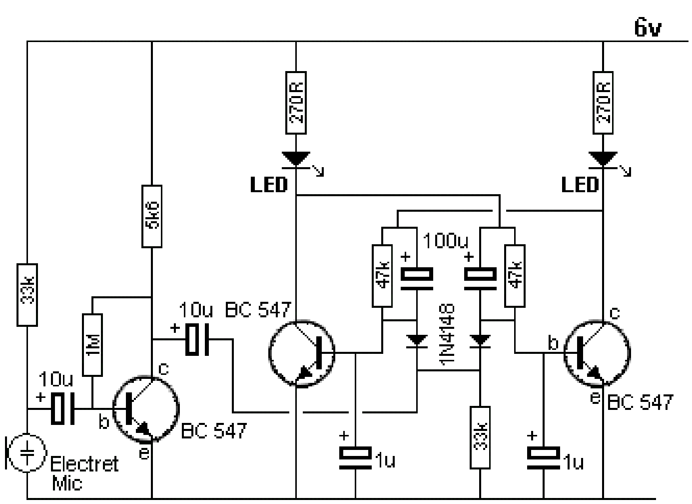
By re-arranging the components slightly from the previous circuit, we create a 15 second illumination of the LED. It will be illuminated with the clap of the hands.



The quiescent current is about 20uA, allowing 4 AA cells to last a long time.

The circuit takes about 20 seconds to reset after the LED goes out. The 100u discharges through the 27k, 100k and 10k resistors. The circuit can also be designed to accept an electret microphone:

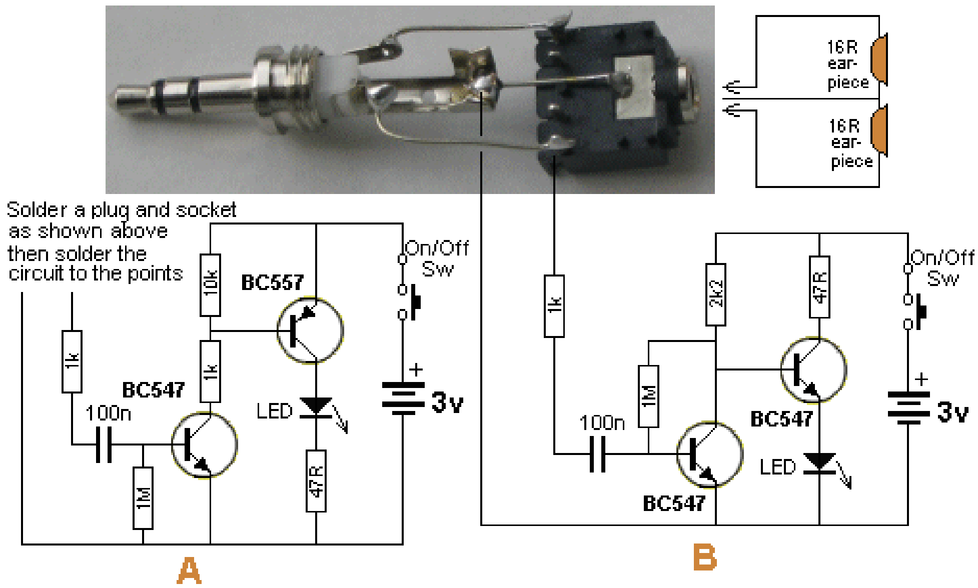
CLAP SWITCH "ON-OFF"



This circuit turns the LED ON with a clap or short whistle. And a further clap turns it OFF. It uses a speaker as a microphone and the fourth output of the 4017 is used to reset the chip. The 100u on pin 2 upsets the amplifier and prevents it clocking the chip, until the electro either charges or discharges. A buffer transistor can replace the LED to operate a relay. It only requires 2mV signal to activate the circuit.

Above: A 3.5mm switched stereo plug and socket wiring.

MUSIC-TO-COLOUR

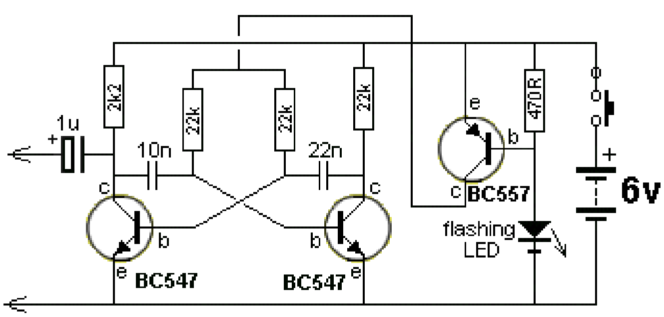


The LED illuminates when the circuit detects a high amplitude waveform. It can be connected to a "Walkman" or mini radio with earphones. A second channel can be connected to produce a stereo effect. Circuit A consumes less current as the LED is off when no audio is detected. Circuit B pulses the LED brighter when audio is detected.

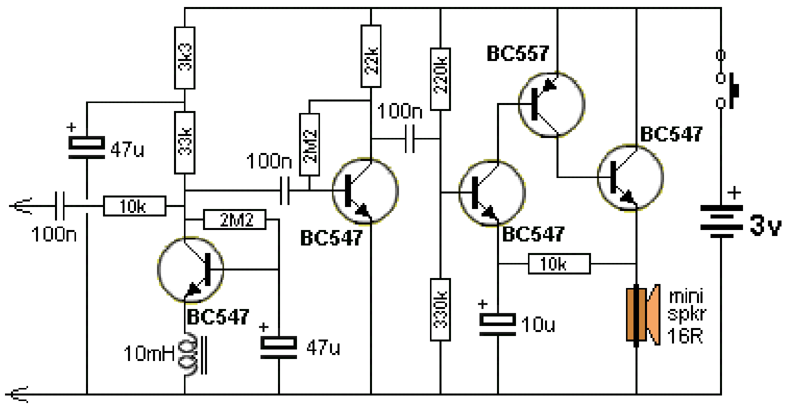
CABLE TRACER

Why pay $100 for a cable tracer when you can build one for less than $10.00! This type of tracer is used by telephone technicians, electricians and anyone laying, replacing or wiring anything, using long cables, such as intercoms, television or security.

Our cable tracer consists of two units. One unit has a multivibrator with an output of 4v p-p at approx 5kHz. This is called the transmitter.



The other unit is a very sensitive amplifier with capacitive input for detecting the tone from the transmitter and a magnetic pickup for detecting magnetic lines of force from power cables carrying 240v. This is called the receiver.



The circuit also has an inductive loop, made up of a length of wire, to pick up stray signals from power cables, so if one detector does not detect the signal, the other will. Our circuit is nothing like that in the professional unit shown here:

The transmitter is built on a small length of PC board, cut into lands with a file. The photos clearly show how all the components are mounted and how the board is fitted into a toothbrush holder. The flashing LED shows the unit is ON and serves to control the beep-beep-beep of the circuit. The flashing LED is not an ordinary LED.

You cannot use an ordinary LED. It must be a FLASHING LED as this type of LED has a built-in resistor and a chip to make the LED flash.

The circuit does not make the LED flash, the LED makes the circuit beep-beep-beep due to the on-off from the chip inside the LED.

One constructor used an ordinary LED - and BANG! That's why we are the first in the world to create a symbol for a flashing LED. The extra bar represents the chip inside the LED.

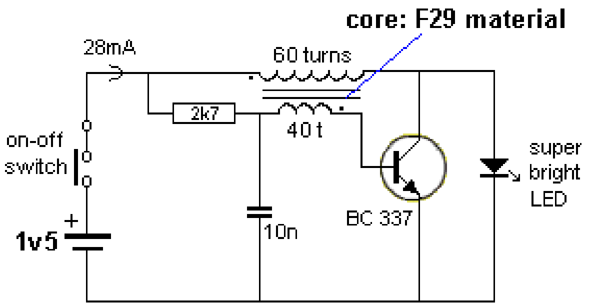
The receiver circuit is a high-gain amplifier and produces constant background noise so the slightest magnetic field can be detected. The 10mH choke can be any value but the largest number of turns on the core is best.

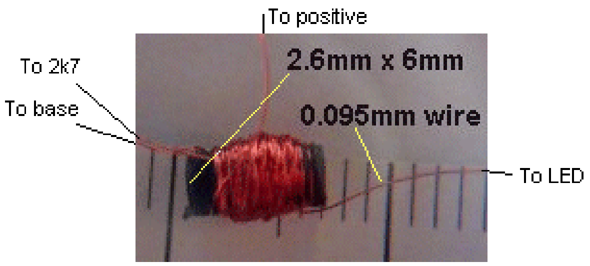
The mini speaker can be a 16R earpiece but these are not as loud as a mini speaker.

Quiescent current is 50mA so the on-off switch can be a push-button.

LED TORCH with 1.5v SUPPLY

Also see BLOCKING OSCILLATOR also called FLYBACK OSCILLATOR - the same circuit.





Transformer Details

This simple circuit will illuminate a super-bright white LED to full brightness with 28mA from a 1.5v cell. The LED is 20,000mcd (20cd @ 15° viewing angle) and has an output of approx 1lumen.

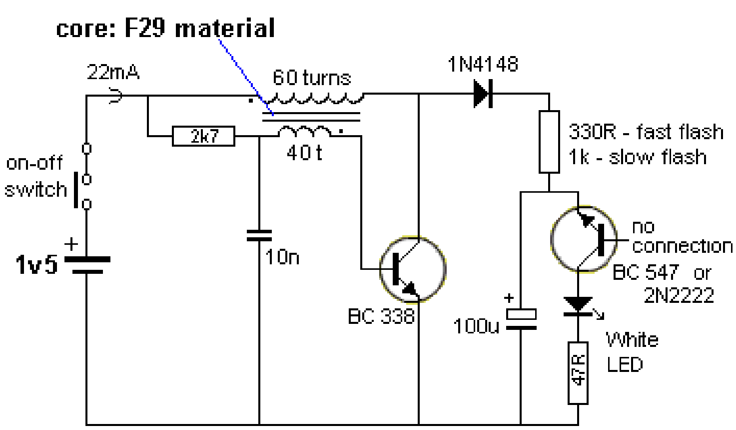
The transformer is wound on a small ferrite slug 2.6mm dia and 6mm long. It is made from F29 ferrite material as the circuit operates at a high frequency (100kHz to 500kHz).

The efficiency of the circuit revolves around the fact that a LED will produce a very high output when delivered pulses, but the overall current will be less than a steady DC current.

BC 337 has a collector-emitter voltage of 45v. (BC338 has 25v collector-emitter voltage rating.) The voltage across the transistor is no more than 4v as the LED absorbs the spikes. Do not remove the LED as the spikes from the transformer will damage the transistor.

The circuit will drive 1 or 2 while LEDs in series.

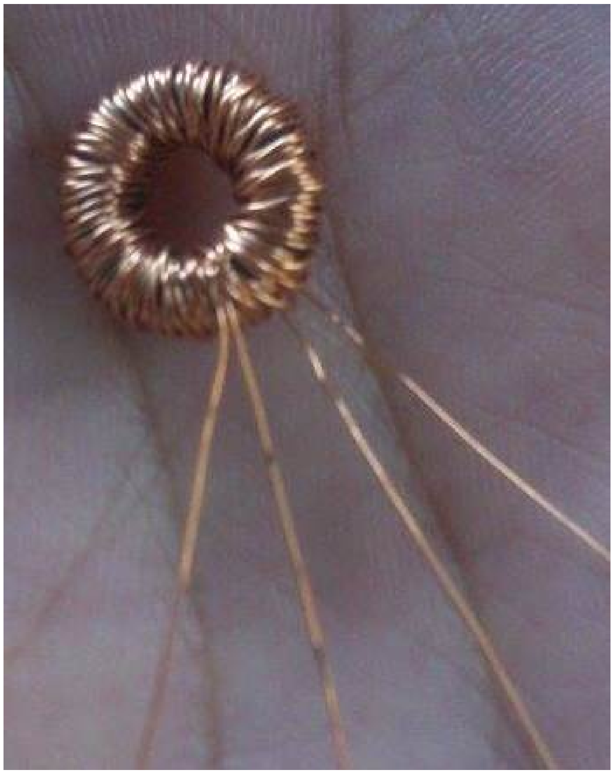
WHITE LED FLASHER



This circuit will flash a super-bright white LED from a 1.5v cell. The transformer is wound on a small ferrite slug 2.6mm dia and 6mm long as shown in a project above.

The circuit uses the zener characteristic of the reverse-base-emitter junction of a BC 547 to pass current and flash the LED.

USING A TOROID INDUCTOR



Most of our circuits use a ferrite rod and NOT a TOROID.

A toroid is a circular core (sometimes called a doughnut or torus or ring or annulus) and is actually the most efficient type of ferrite core because none of the flux is lost to the outside surroundings.

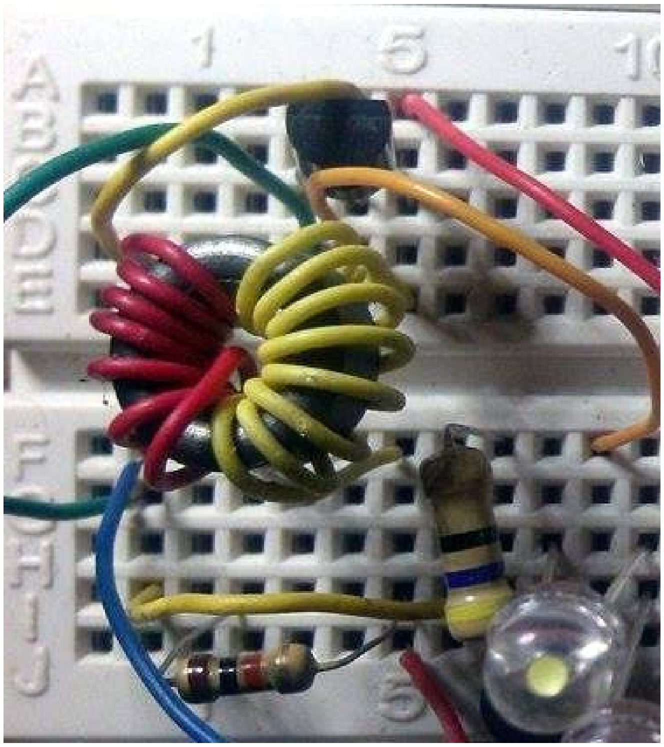
BUT if you use a toroid, you MUST work out the amount of flux you will be generating when the transistor is turned ON and this will give you the flux density in the toroid.

But this is a very difficult thing to do.

If you deliver more flux than the toroid can accept, the expanding flux will not increase at this point in time and the current taken (supplied or delivered) by the transistor will increase ENORMOUSLY and the transistor will be DESTROYED.

If you use a ferrite rod, the flux will be lost to the outside air (out the end of the rod) and the abrupt saturation-point will NOT be generated.

This means a ferrite rod is a much-more “sloppy” or “loose” or “accommodating” component and is much easier to incorporate into a circuit that has not been mathematically designed. If you want to use a toroid, the only way to “design a circuit” that does not “self-destroy” is to add a lot more turns and gradually remove a few of the turns while feeling the output transistor for temperature-rise or measure the current taken by the circuit.



Sometimes the number of turns will be reduced to 7 turns plus 7 turns for some of the circuits driving LEDs in the boost converters shown below.

Why only 7 turns for a toroid?

As the transistor turns ON, the 7 turns produces much less flux than 30 turns and the transistor can turn on for a much longer period of time.

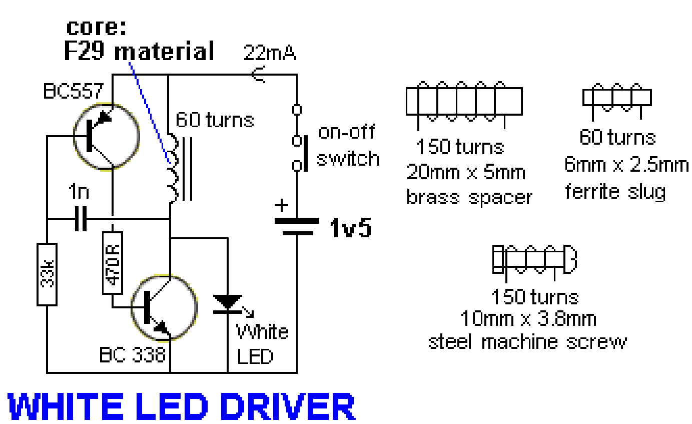
When it is fully turned ON, the core is just at the point of being fully saturated. At this instant, the flux no-longer expands (increases) and thus the voltage produced in the feedback winding ceases. This is when the "increasing" part of the cycle stops, and the "turn-off" part of the cycle starts.

This means the current through the transistor is only a maximum for a very short period of time.

That's why you have to experiment yourself and it's only when you get the circuit to work perfectly, that you will LEARN ELECTRONICS.

The workings of an inductor are much more complex than you think.

1v5 WHITE LED DRIVER



This circuit will drive a super-bright white LED from a 1.5v cell.

The 60 turn inductor is wound on a small ferrite slug 2.6mm dia and 6mm long with 0.25mm wire.

The main difference between this circuit and the two circuits above is the use of a single winding and the feedback to produce oscillation comes from a 1n capacitor driving a high gain amplifier made up of two transistors.

The feedback is actually positive feedback via the 1n and this turns on the two transistors more and more until finally they are fully turned on and no more feedback signal is passed though the 1n. At this point they start to turn off and the signal through the 1n turns them off more and more until they are fully turned off.

The 33k turns on the BC557 to start the cycle again.

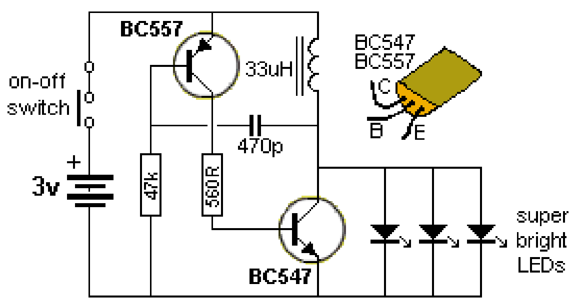
If you do not have a ferrite slug, the inductor can be made from a machine screw 10mm long and about 3-4mm dia. Wind 150 turns of 0.25mm wire; or you can use a brass ferrule 20mm long x 5mm. Wind 150 turns.

RESULTS for the same brightness:

- **Slug: 21mA**
- **Brass Spacer: 18mA**
- **Machine screw: 14mA**

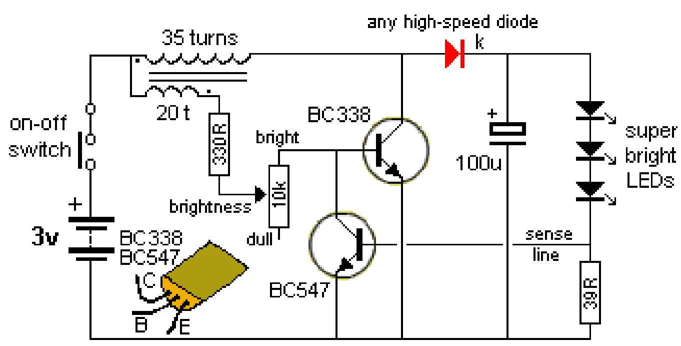
Isn't this a SURPRISE!

LED TORCH - 3v Supply



This circuit will drive up to 3 high-bright white LEDs from a 3v supply. (It will also work from 1.5v) The inductor consists of 50 turns on a 1.6mm dia ferrite slug using 0.1mm enamelled wire. This circuit can use a ready-made 33uH choke, making it suitable for mass production

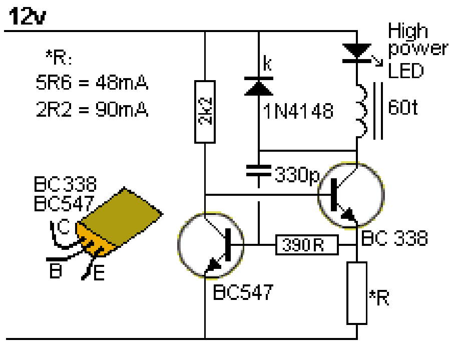
LED TORCH with ADJUSTABLE BRIGHTNESS



This circuit will drive up to 3 high-bright white LEDs from a 3v supply. The circuit has a pot to adjust the brightness to provide optimum brightness for the current you wish to draw from the battery.

The transformer is wound on a ferrite slug 2.6mm dia and 6mm long as shown in the LED Torch with 1.5v Supply project. This circuit is a "Boost Converter" meaning the supply is less than the voltage of the LEDs. If the supply is greater than the voltage across the LEDs, they will be damaged.

BUCK CONVERTER for HIGH-POWER LED 48mA to 90mA

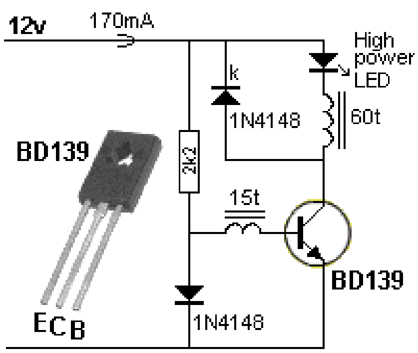


This circuit is a "Buck Converter" meaning the supply is greater than the voltage of the LED. It will drive 1 high-power white LED from a 12v supply and is capable of delivering 48mA when R = 5R6 or 90mA when R = 2R2. The LED is much brighter when using this circuit, compared with a series resistor delivering the same current. But changing R from 5R6 to 2R2 does not double the brightness. It only increases it a small amount. The inductor consists of 60 turns of 0.25mm wire, on a 15mm length of ferrite rod, 10mm diameter. Frequency of operation: approx 1MHz.

The circuit is not designed to drive one 20mA LED.

This circuit draws the maximum for a BC 338.

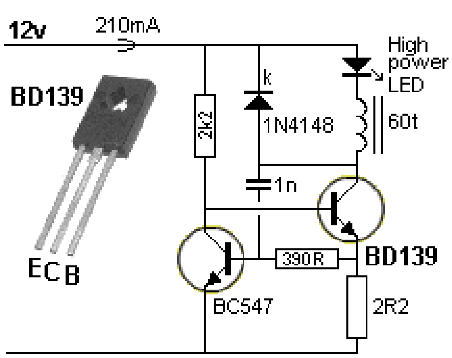
BUCK CONVERTER for HIGH-POWER LED 170mA



This circuit is slightly simpler than above but it does not have the feature of being able to adjust the drive-current.

The inductor is the same as the photo above but has a feedback winding of 15 turns. Connect the circuit via a 220R resistor and if the LED does not illuminate, reverse the feedback winding. The driver transistor will need a small heatsink.

BUCK CONVERTER for HIGH-POWER LED 210mA

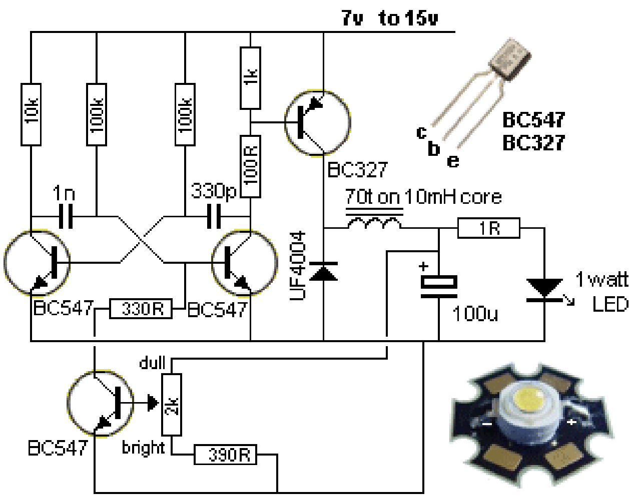


This circuit will drive 1 high-power white LED from a 12v supply and is capable of delivering 210mA.

The driver transistor is BD 139 and the details of the inductor are shown above.

The voltage across the LED is approx 3.3v - 3.5v The driver transistor will need a small heatsink. The 2R2 can be increased if a lower drive-current is required.

BUCK CONVERTER for HIGH-POWER LED 250mA - 1watt LED



This circuit will drive 1watt white LED from a 12v supply and is capable of delivering 300mA.

The driver transistor is BC 327 and the inductor is 70 turns of 0.25mm wire wound on the core of a 10mH inductor.

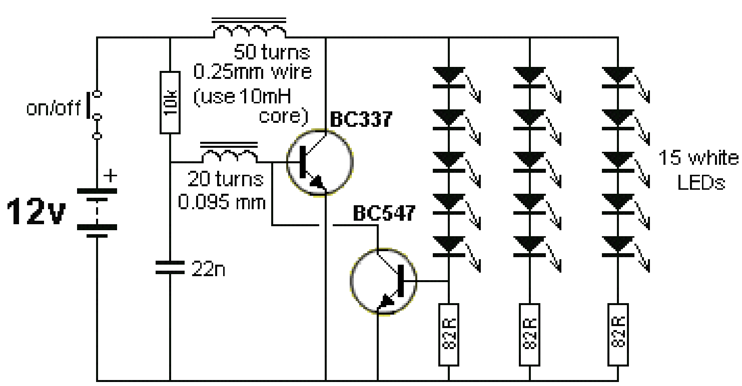
See Inductor to learn how the inductor works. The voltage across the LED is approx 3.3v - 3.5v The 1R is used to measure the mV across it.

300mV equals 300mA LED current.

The diode MUST be high speed. A non-high-speed diode increases current 50mA!

This circuit is the best design as it does not put peaks of current though the LED. Reduce 390R slightly to increase maximun current.

MAKE YOUR OWN 1-WATT LED



15 LEDs on Matrix board The transformer consists of 50 turns 0.25mm wire connected to the pins.

The feedback winding is 20 turns 0.095mm wire with “fly-leads.”

This circuit drives 15 LEDs to produce the same brightness as a 1-watt LED. The circuit consumes 750mW but the LEDs are driven with high-frequency, high-voltage spikes, and become more-efficient and produce a brighter output that if driven by pure-DC.

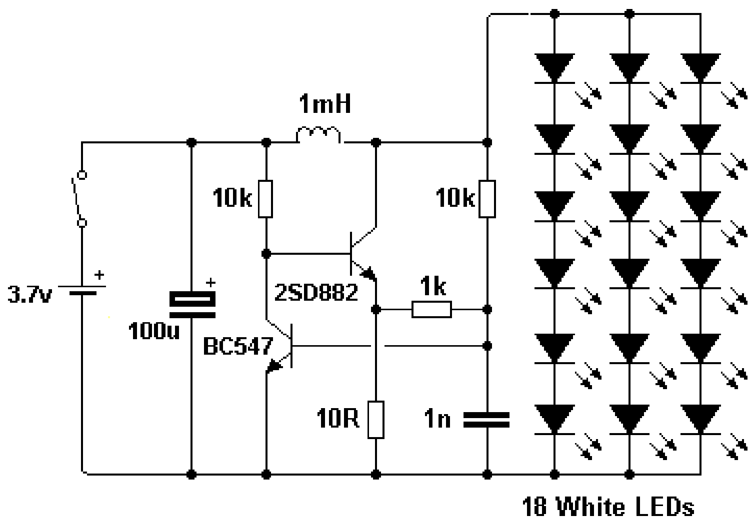
The LEDs are connected in 3 strings of 5 LEDs. Each LED has a characteristic voltage of 3.2v to 3.6v making each chain between 16v and 18v. By selecting the LEDs we have produced 3 chains of 17.5v

Five LEDs (in a string) has been done to allow the circuit to be powered by a 12v battery and allow the battery to be charged while the LEDs are illuminating. If only 4 LEDs are in series, the characteristic voltage may be as low as 12.8v and they may be over-driven when the battery is charging. (Even-up the characteristic voltage across each chain by checking the total voltage across them with an 19v supply and 470R dropper resistor.) The transformer is shown above. It is wound on a 10mH choke with the original winding removed. This circuit is called a "boost circuit." It is not designed to drive a single 1-watt LED (a buck circuit is needed).

The LEDs in the circuit are 20,000mcd with a viewing angle of 30 degrees (many of the LED specifications use "half angle." You have to test a LED to make sure of the angle).

This equates to approximately 4 lumens per LED. The 4-watt CREE LED claims 160 lumens (or 40 lumens per watt). Our design is between 50 - 60 lumens per watt and it is a much-cheaper design.

18 LEDs using a 3.7v Li-Ion CELL



This circuit drives 18 white LEDs from a 3.7v Li-Ion cell. It has been designed by Samuel Budiyanto budiyantosamuel90@gmail.com using components from an old Compact Fluorescent Lamp. No data is available on the 1mH inductor and the circuit has been provided for experimentation purposes ONLY.

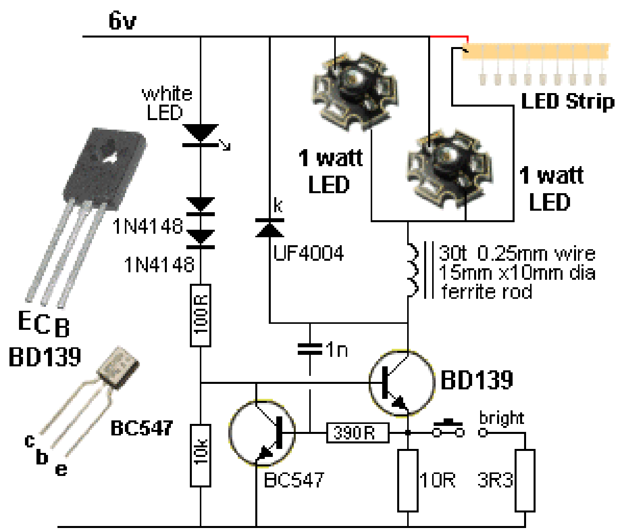
It is an interesting circuit because the two transistors provide a constant brightness and the BC547 provides feedback to keep the circuit oscillating.

The 10k base resistor seems very high but the circuit has been tested for 12 hours on a 1200mA-Hr cell and the brightness remained constant. The brightness is determined by how hard you drive the 2SD882 transistor. It is turned on by the 10k resistor and this will deliver very little current, but since the transistor has a gain of 100 to 300, the collector current will be up to about 100mA.

Basically the circuit will over-drive the LEDs and the BC547 will limit the current to the required brightness level.

The BC547 transistor has the effect of turning OFF the 2SD at a particular instant in each cycle to reduce the time when it is turned ON. The BC547 gets its "timing" from the 10k and 1k resistors, by the fact that these resistors form a voltage divider to produce a voltage on the base. When the 2SD turns ON, a voltage is developed across the 10R that adds to this voltage but it is delayed slightly by the 1n capacitor. The 1n determines the frequency at which the circuit will oscillate. By experimenting with these 4 components you get the required brightness and this remains constant for the life of the cell. All the LEDs are in series on each string and the brightness will depend on matching each string. By swapping some of the LEDs you will be able to adjust the brightness to make them all emit equally.

1-WATT LED - a very good design



Circuit takes 70mA on LOW brightness and 120mA on HIGH Brightness see MOD below

Circuit takes 70mA on LOW brightness and 120mA on HIGH Brightness see MOD below. This circuit has been specially designed for a 6v rechargeable battery or 5 x 1.2v NiCad cells. **Do not use any other voltage.**

It has many features:

- The pulse-operation to the two 1-watt LEDs delivers a high current for a short period of time and this improves the brightness.
- The circuit can drive two 1-watt LEDs with extremely good brightness and this makes it more efficient than any other design.

The circuit is a two-transistor high-frequency oscillator and it works like this:

- The BD139 is turned ON via the base, through the white LED and two signal diodes and it amplifies this current to appear though the collector-emitter circuit.
- This current flows though the 1-watt LED to turn it ON and also through the 30-turn winding of the inductor.
- At the same time the current through the 10R creates a voltage-drop and when this voltage rises to 0.65v, the BC547 transistor starts to turn ON. This robs the base of the BD139 of "turn-on voltage" and the current through the inductor ceases to be expanding flux, but stationary flux.
- The 1n capacitor was initially pushing against the voltage-rise on the base of the BC547 but it now has a reverse-effect of allowing the BC547 to turn ON.
- This turns off the BD139 a little more and the current through the inductor reduces.
- This creates a collapsing flux that produces a voltage across the coil in the opposite direction. This voltage passes via the 1n to turn the BC547 ON and the BD139 is fully turned OFF.
- The inductor effectively becomes a miniature battery with negative on the lower LED and positive at the anode of the Ultra Fast diode. The voltage produced by the inductor flows through the UF diode and both 1-watt LEDs to give them a spike of high current. The circuit operates at approx 500kHz and this will depend on the inductance of the inductor.

The circuit has about 85% efficiency due to the absence of a current-limiting resistor, and shuts off at 4v, thus preventing deep-discharge of the rechargeable cells or 6v battery.

The clever part of the circuit is the white LED and two diodes. These form a zener reference to turn the circuit off at 4v. The 10k resistor helps too.

The circuit takes 70mA on low brightness and 120mA on HIGH brightness via the brightness-switch.

The LEDs actually get 200mA pulses of current and this produces the high brightness.

The Inductor

The coil or inductor is not critical. You can use a broken antenna rod from an AM radio (or a flat antenna slab) or an inductor from a computer power supply. Look for an inductor with a few turns of thick wire (at least 30) and you won't have to re-wind it.

Here are two inductors from surplus outlets:

- http://www.goldmine-elec-products.com/prodinfo.asp?number=G16521B - 50 cents
- http://www.allelectronics.com/make-a-store/item/CR-345/345-UH-TOROIDAL-INDUCTOR/1.html - 40cents

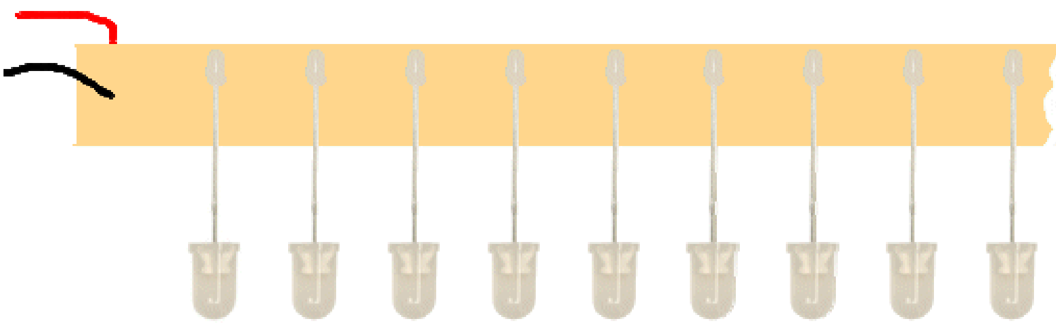
Here are the surplus inductors:

The cost of surplus is from 10 cents to 50 cents, but you are sure to find something from a computer power supply.

Pick an inductor that is about 6mm to 10mm diameter and 10mm to 15mm high. Larger inductor will not do any damage. They simply have more ferrite material to store the energy and will not be saturated. It is the circuit that delivers the energy to the inductor and then the inductor releases it to the LEDs via the high speed diode.

IMPROVEMENT

By using the following idea, the current reduces to 90mA and 70mA and the illumination over a workbench is much better than a single high-power LED. It is much brighter and much nicer to work under. Connect fifteen 5mm LEDs in parallel (I used 20,000mcd LEDs) by soldering them to a double-sided strip of PC board, 10mm wide and 300mm long. Space them at about 20mm. I know you shouldn't connect LEDs in parallel, but the concept works very well in this case. If some of the LEDs have a characteristic high voltage and do not illuminate very brightly, simply replace them and use them later for another strip. You can replace one or both the 1-watt LEDs with a LED Strip, as shown below:



No current-limit resistor... Why isn't the LED damaged?

Here's why the LED isn't damaged: When the BD139 transistor turns ON, current flows through the LEDs and the inductor. This current gradually increases due to the gradual turning-on of the transistor and it is also increasing through the inductor. The inductor also has an effect of slowing-down the "in-rush" of current due to the expanding flux cutting the turns of the coil, so there is a "double-effect" on avoiding a high initial current. That's why there is little chance of damaging the LEDs. When it reaches 65mA, it produces a voltage of .065 x 10 = 650mV across the 10R resistor, but the 1n is pushing against this increase and it may have to rise to 150mA to turn on the BC547. LEDs can withstand 4 times the normal current for very short periods of time and that's what happens in this case. The BD139 is then turned off by the voltage produced by the inductor due to the collapsing magnetic flux and a spike of high current is passed to the LEDs via the high speed diode. During each cycle, the LEDs receive two pulses of high current and this produces a very high brightness with the least amount of energy from the supply. All the components run "cold" and even the 1-watt LEDs are hardly warm.

Charging and Discharging

This project is designed to use all your old NiCad cells and mobile phone batteries. It doesn't matter if you mix up sizes and type as the circuit takes a low current and shuts off when the voltage is approx 4v for a 6v pack. If you mix up

600mA-Hr cells with 1650mA-Hr, 2,000mA-Hr and 2,400mA-Hr, the lowest capacity cell will determine the operating time. The capacity of a cells is called "C." Normally, a cell is charged at the 14 hour-rate. The charging current is 10% of the capacity. For a 600mA-Hr cell, this is 60mA. In 10 hours it will be fully charged, but charging is not 100% efficient and so we allow another 2 to 4 hours. For a 2,400mA-Hr cell, it is 240mA. If you charge them faster than 14-hr rate, they will get HOT and if they get very hot, they may leak or even explode. But this project is designed to be charged via a solar panel using 100mA to 200mA cells, so nothing will be damaged. Ideally a battery is discharged at C/10 rate. This means the battery will last 10 hours and for a 600mA-Hr cell, this is 60mA. If you discharge it at the "C-rate," it will theoretically last 1 hour and the current will be 600mA. But at 600mA, the cells may only last 45 minutes. If you discharge is at C/5 rate, it will last 5 hours. Our project takes 120mA so no cell will be too-stressed. A 600mA-Hr cell will last about 4-5 hours, while the other cells will last up to 24 hours. Try to keep the capacity of each cell in a "battery-pack" equal.

MODIFICATIONS FROM A READER budiyantosamuel90@gmail.com

- The 390R changed to 1k.
- The 1n changed to 470p.
- Replaced the UF4004 with 4 x 1 N4148 in parallel.

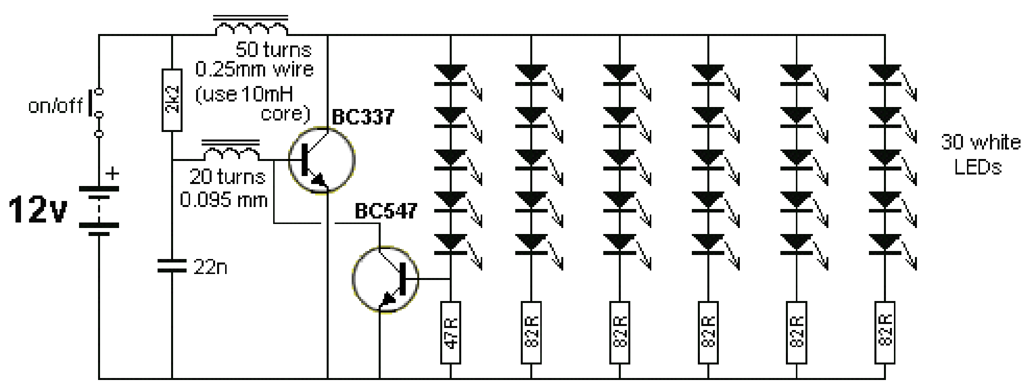
> The result is amazing, much brighter! I can't believe it. I put 20 white LEDs in a LED strip... and it works nicely. Much brighter than two 1 Watt LEDs.

If the length of a ferrite rod is too short, the magnetic material will saturate and it will not accept any more current and it will start to produce losses by heating-up. A toroid may work better because it will accept a higher flux density because the magnetic path does not have an air gap. (a ferrite rod is said to have an air-gap at the ends of the rod).

That's why a toroid will be smaller than a rod.

1.5 WATT LED

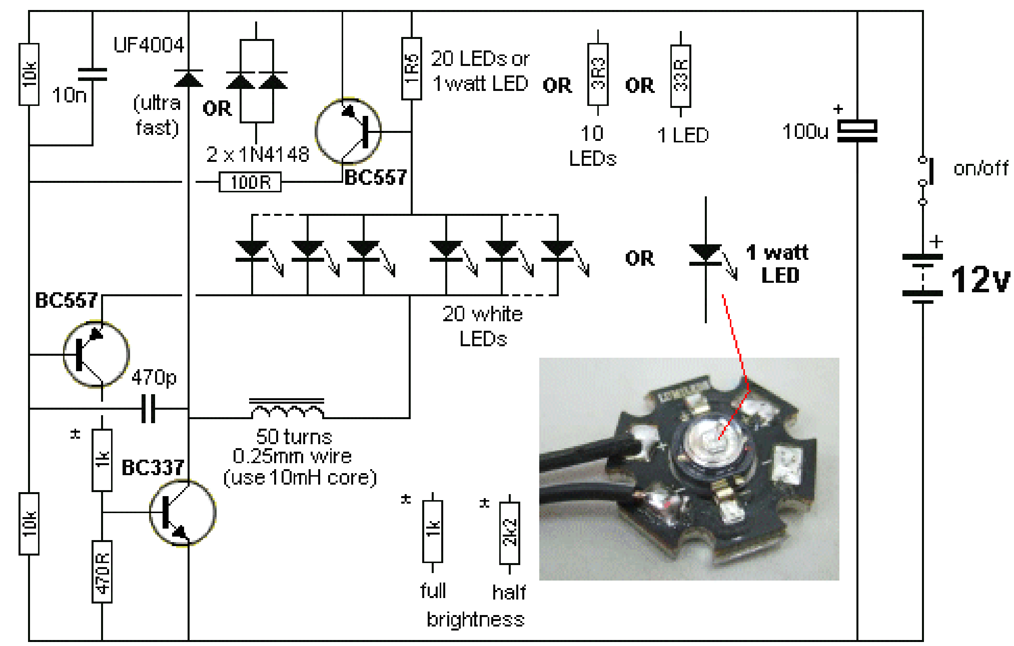
The circuit below can be modified to drive up to 30 white LEDs.



The effectiveness of a LED array increases when they are spread out slightly and this makes them more efficient than a single 1 watt or 2 watt LED.

The two modifications to the circuit make the BC337 work harder and this is the limit of the inductor. The current consumption is about 95mA. The winding details for the transformer are shown above.

DRIVE 20 LEDs FROM 12v - approx 1watt circuit



This is another circuit that drives a number of LEDs or a single 1 watt LED. It is a “Buck Circuit” and drives the LEDs in parallel. They should be graded so that the characteristic voltage-drop across each of them is within 0.2v of all the other LEDs. The circuit will drive any number from 1 to 20 by changing the “sensor” resistor as shown on the circuit. The current consumption is about 95mA @ 12v and lower at 18v. The circuit can be put into dim mode by increasing the drive resistor to 2k2.

The UF4004 is an ultra fast 1N4004 - similar to a high-speed diode.

You can use 2 x 1N4148 signal diodes.

The circuit will not drive two LEDs in series - it runs out of voltage (and current) when the voltage across the load is 7v. It oscillates at approx 200kHz. Build both the 20 LED and 1 watt LED version and compare the brightness and effectiveness.

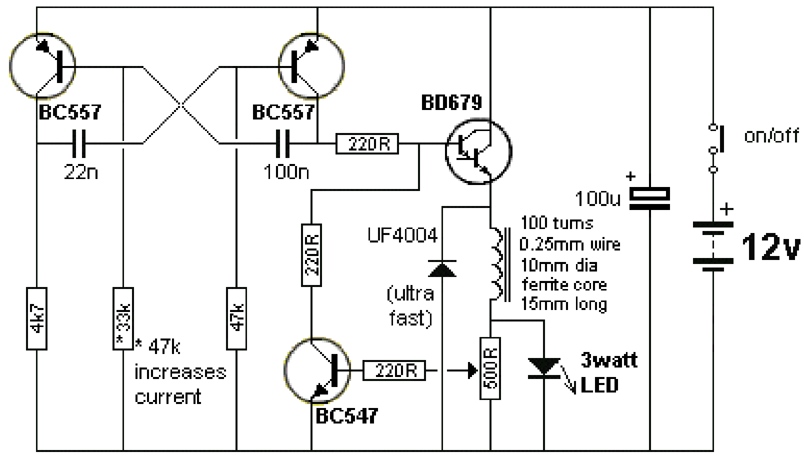
The photo of the 1 watt LED on the left must be heatsinked to prevent the LED overheating. The photo on the circuit diagram shows the LED mounted on a heatsink and the connecting wires.

A 1-watt demo board showing the complex step-up circuitry. This is a Boost circuit to illuminate the LED and is completely different to our design.

It has been included to show the size of a 1 watt LED.

The reason for a Boost or Buck circuit to drive one or more LEDs is simple. The voltage across a LED is called a “characteristic voltage” and comes as a natural feature of the LED. We cannot alter it. To power the LED with exactly the correct amount of voltage (and current) you need a supply that is EXACTLY the same as the characteristic voltage. This is very difficult to do and so a resistor is normally added in series. But this resistor wastes a lot of energy. So, to keep the loses to a minimum, we pulse the LED with bursts of energy at a higher voltage and the LED absorbs them and produces light. With a Buck circuit, the transistor is turned on for a short period of time and illuminated the LEDs. At the same time, some of the energy is passed to the inductor so that the LEDs are not damaged. When the transistor is turned off, the energy from the inductor also gives a pulse of energy to the LEDs. When this has been delivered, the cycle starts again.

BUCK CONVERTER for 3watt LED



This circuit drives a 3watt LED. You have to be careful not to damage the LED when setting up the circuit. Add a 10R to the supply rail and hold it in your fingers. Make sure it does not get too hot and monitor the voltage across the resistor. Each 1v represents 100mA. The circuit will work and nothing will be damaged. If the resistor "burns your fingers" you have a short circuit.

The BC557 multivibrator has a "mark-to-space ratio" determined by the 22n and 33k, compared to the 100n and 47k, producing about 3:1. The BD679 is turned ON for about 30% of the time. This produces a very bright output, and takes about 170mA for 30% of the time. You cannot measure this current with a meter as it reads the peak value and the reading will be totally false. The only way to view the waveform is on a CRO, and calculate the current.

The 100-turn inductor allows the BD679 turn turn ON fully and "separates" the voltage on the emitter of the BC679 from the voltage on the top of the 3watt LED.

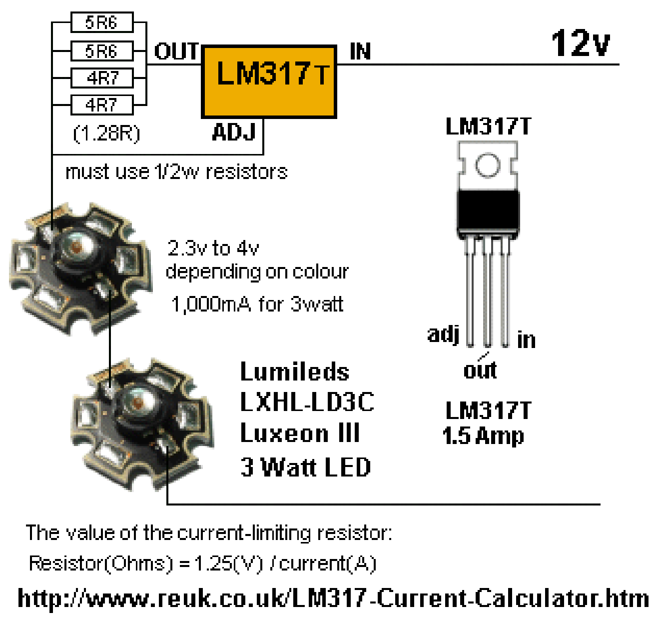
When the BD679 turns ON, the emitter rises to about 10v. But the top of the LED **NEVER** rises above 3.6v. The inductor "buffers" or "separates" these two voltages by producing a voltage across the winding equal to 6.4v and that's why the LED is not damaged.

When the transistor turns off (for 60% of the time), the magnetic flux produced by the current in the inductor collapses and produces a voltage in the opposite direction. This means the inductor now becomes a miniature battery and for a very short period of time it produces energy to illuminate the LED. The top of the inductor becomes negative and the bottom is positive. The current flows through the LED and through the Ultra High-Speed 1N4004 diode to complete the circuit. Thus the circuit takes advantage of the energy in the inductor.

A 500R pot is placed across the LED and a voltage is picked off the pot to turn on a BC547 transistor. This transistor "robs" some of the "turn-on" for the BD679 transistor to reduce the brightness of the LED.

Because the circuit is driving the LED with pulses, very high brightness is obtained with a low current. Our eyes detect peak brightness and you can compare the performance of this circuit with a DC driven LED.

CONSTANT CURRENT DRIVES TWO 3WATT LEDs

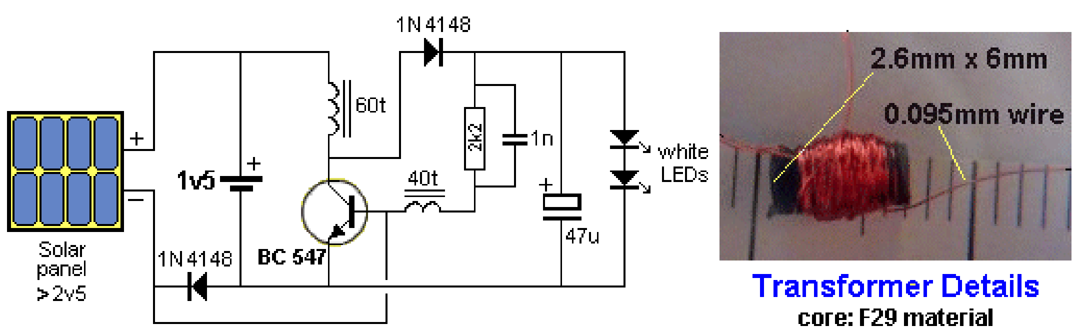


This constant current circuit is designed to drive two 3-watt Luxeon LEDs. The LEDs require 1,000mA (1Amp) and have a characteristic voltage-drop across them of about 3.8v. Approximately 4v is dropped across the LM317T regulator and 1.25v across the current-limiting resistors, so the input voltage (supply) has to be 12.85v. A 12v battery generally delivers 12.6v.

The LM 317T 3-terminal regulator will need to be heatsinked.

This circuit is designed for the LM series of regulator as they have a voltage differential of 1.25v between "adj" and "out" terminals.

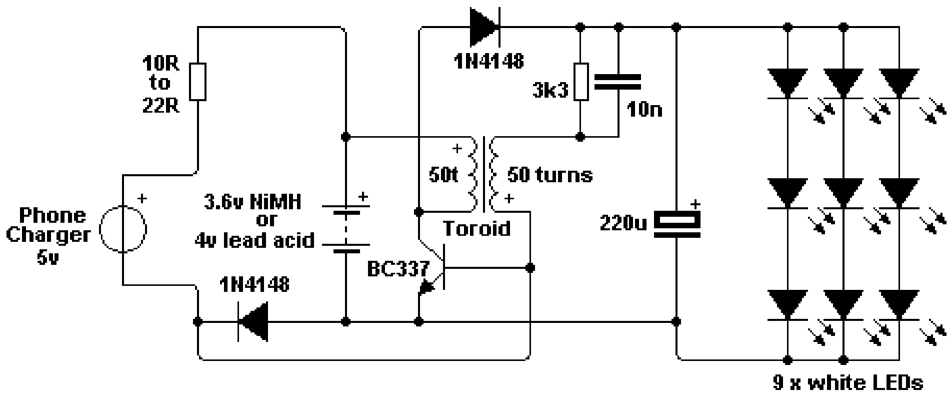
AUTOMATIC GARDEN LIGHT



This circuit automatically turns on and illuminates the LEDs when the solar panel does not detect any light. It switches off when the solar panel produces more than 1v and charges the battery when the panel produces more than 1.5v + 0.6v = 2.1v

AUTOMATIC BATHROOM LIGHT or PASSAGE LIGHT

by Samuel Budiyanto budiyantosamuel90@gmail.com.

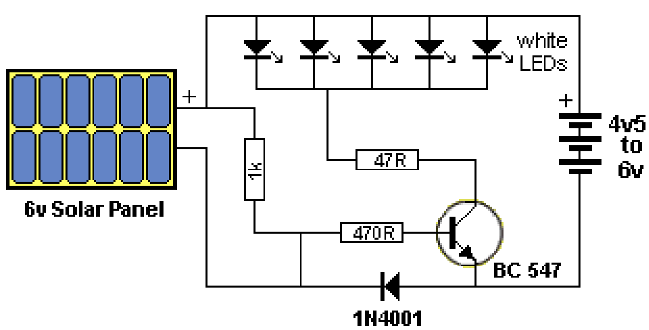


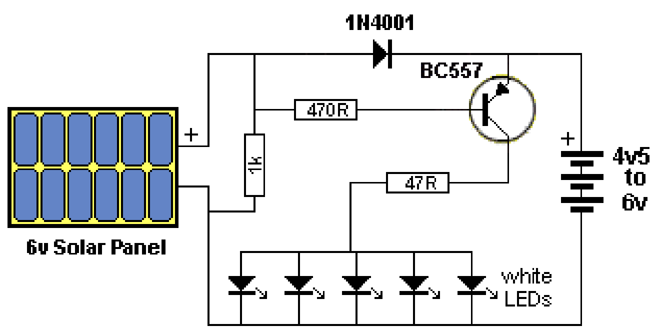
This circuit is for all those who experience black-outs and "power-outs".

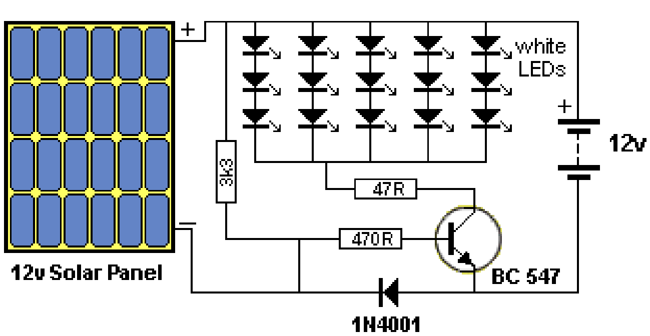
It uses a 5v charger from an old mobile phone to trickle charge a 3.6v cell or 2 x lead acid cells.

Use a small toroid about 40mm diameter or a 10mm ferrite rod 40mm long and 0.25mm wire. Keep the charge to 10mA to 20mA and the LEDs will come on every time the power fails. My circuit has been working for the past 7 months. If the LEDs don't illuminate with equal brightness, change them around and they will equalise.

AUTOMATIC SOLAR LIGHT







This circuit automatically turns on and illuminates the LEDs when the solar panel does not detect any light. It switches off when the solar panel produces more than 0.5v above the battery voltage.

You can use any number of white LEDs. LEDS should not be connected in parallel, however they work if you selects LEDs that produce the same brightness. Any dull LEDs can be used in another circuit.

When the solar panel receives sunlight, the voltage on the base of the transistor keeps it turned OFF. When the panel receives no illumination, the 470R and 1k resistors turn the transistor ON.

You can use a 6v 0.5watt or 1 watt solar panel and the first circuit uses an NPN transistor while the second circuit uses a PNP transistor.

The output of the solar panel automatically adjusts to the voltage of the battery and as more light is detected by the panel, the current increases.

A 0.5watt panel contains 100mA cells and a 1watt panel contains 200mA cells.

The battery can have any capacity from 600mAHr to 1800mAHr.

We are assuming the battery is used all night and is flat in the morning.

A 600mAHr battery will take 6-8 hours to fully charge with a 0.5watt panel and a 1800mAHr battery will take 2 days to charge with a 1 watt panel.

Each white LED requires about 20mA for good brightness and the 47R resistor will have to be adjusted to suit the battery voltage and the number of LEDs.

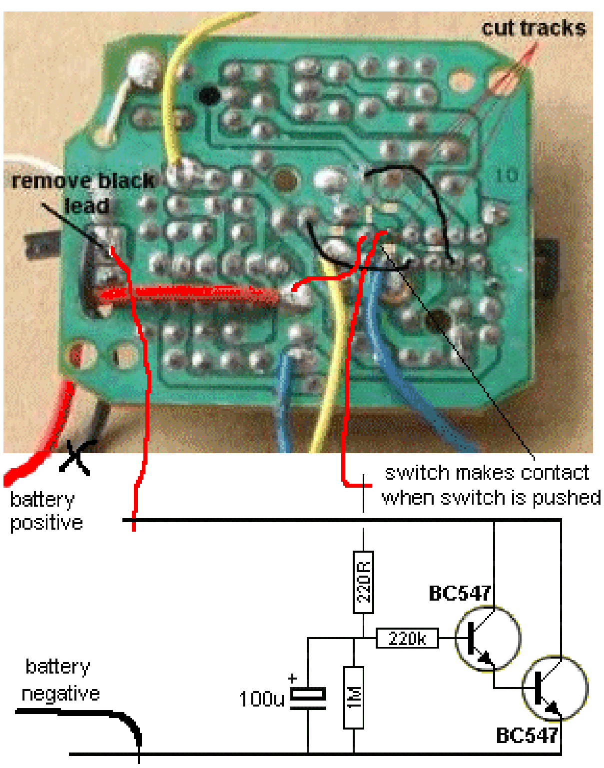
The third circuit uses a 12v 0.5watt or 1 watt solar panel and the circuit is much more efficient as 3 white LEDs can be connected in series for each 20mA of current.

27MHz DOOR PHONE

This circuit turns a walkie talkie into a handy wireless door phone. It saves wiring and the receiver can be taken with you upstairs or outside, without loosing a call from a visitor.

A 5-Transistor walkie talkie can be used (see 5 TRANSISTOR WALKIE TALKIE 1 above) and the modifications made to the transmitter and receiver are shown below:

THE TRANSMITTER

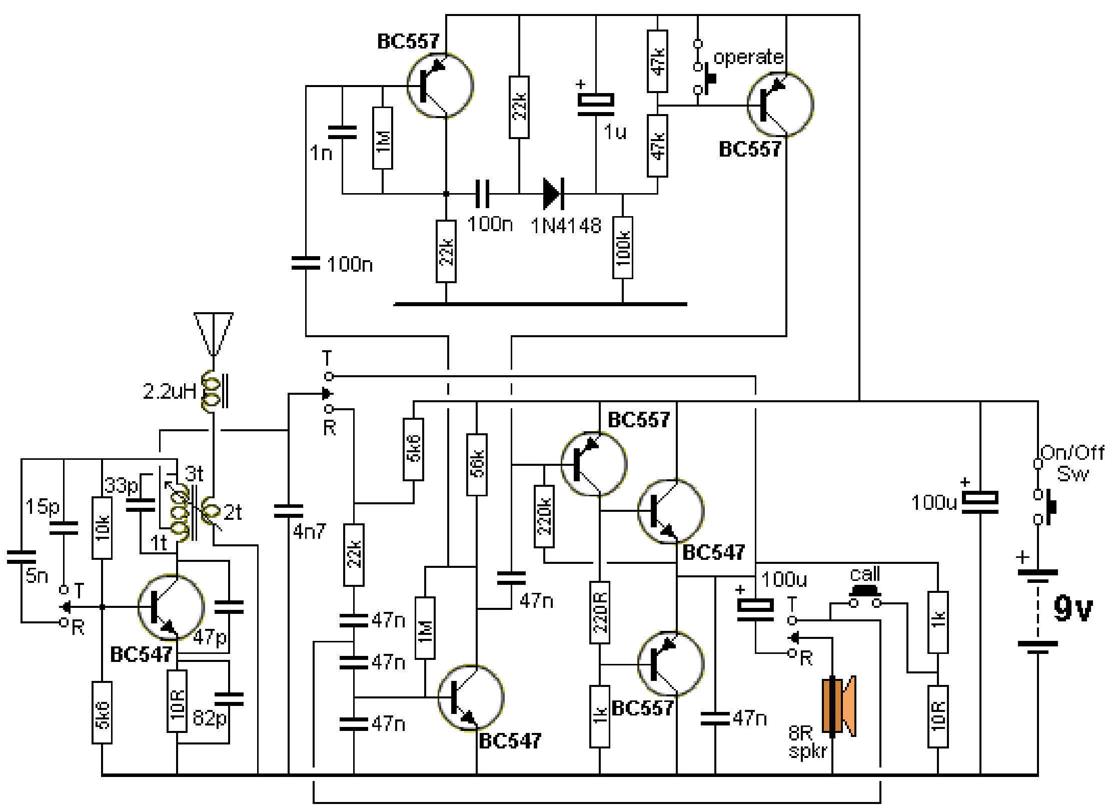


Only three sections of the transmit/ receive switch are used in the walkie talkie circuit and our modification uses the fourth section. Cut the tracks to the lands of the unused section so it can be used for our circuit. There are a number of different printed circuit boards on the market, all using the same circuit and some will be physically different to that shown in the photo. But one of the sections of the switch will be unused. Build the 2-transistor delay circuit and connect it to the walkie talkie board as shown. When the “push-to-talk” switch is pressed, the PC board will be activated as the delay circuit effectively connects the negative lead of the battery to the negative rail of the board for about 30 seconds. The 100u gradually discharges via the 1M after the “press-to-talk” switch is released and the two transistors turn off and the current drops to less than 1 micro-amp - that’s why the power switch can be left on. .

The transmitter walkie talkie is placed at the front door and the power switch is turned on. To call, push the “push-to-talk” switch and the “CALL” button at the same time for about 5 seconds. The circuit will activate and when the “push-to-talk” switch is released, the circuit will produce background noise for about 30 seconds and you will hear when call is answered.

The “push-to-talk” switch is then used to talk to the other end and this will activate the circuit for a further 30 seconds. If the walkie talkie does not have a “CALL” switch, 3 components can be added to provide feedback, as shown in the circuit below, to produce a tone.

THE RECEIVER

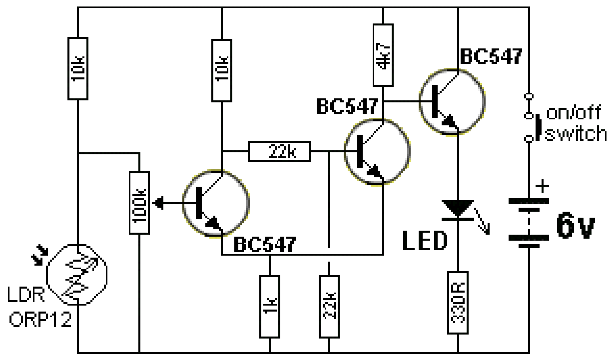


The receiver circuit needs modification and a 2-transistor circuit is added. This circuit detects the tone and activates the 3-transistor direct-coupled amplifier so that the speaker produces a tone.

The receiver circuit is switched on and the 2-transistor circuit we connect to the PC board effectively turns on the 3-transistor amplifier so that the quiescent current drops from 10mA to about 2-3mA. It also mutes the speaker as the amplifier is not activated. The circuit remains on all the time so it will be able to detect a “CALL.” When a tone is picked up by the first two transistors in the walkie talkie, it is passed to the first transistor in our “add-on” section and this transistor produces a signal with sufficient amplitude to remove the charge on the 1u electrolytic. This switches off the second transistor and this allows the 3-transistor amplifier to pass the tone to the speaker. The operator then slides a switch called “OPERATE” to ON (down) and this turns on the 3-transistor amplifier. Pressing the “push-to-talk” switch (labelled T/R) allows a conversation with the person at the door. Slide the “OPERATE” switch up when finished.

The receiver walkie talkie with the 2-transistor “add-on”

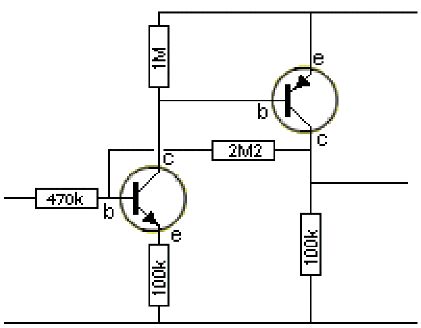
SCHMITT TRIGGER



A Schmitt Trigger is any circuit that has a fast change-over from one state to the other. In our case we have used 2 transistors to produce this effect and the third is an emitter-follower buffer.

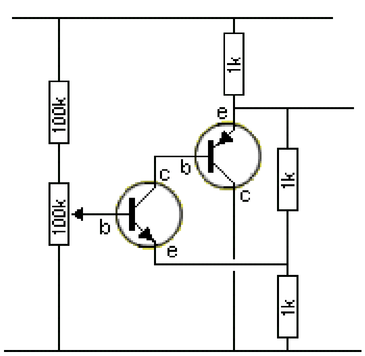
The circuit will drive a LED or relay and the purpose is to turn the LED ON quickly at a particular level of illumination and OFF at a higher level. The gap between ON and OFF is called the HYSTERESIS GAP.

SCHMITT TRIGGER 2



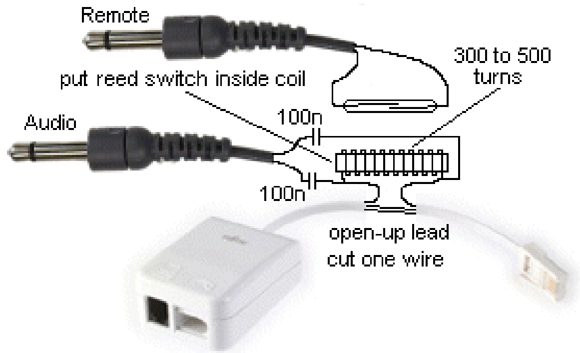
The following circuit is a Schmitt Trigger made with NPN and PNP transistors:

SCHMITT TRIGGER 3



The following circuit is another Schmitt Trigger made with NPN and PNP transistors. The 100k "stop resistor" on the 100k prevents the circuit turning ON when the pot is near the supply rail.

PHONE TAPE 1

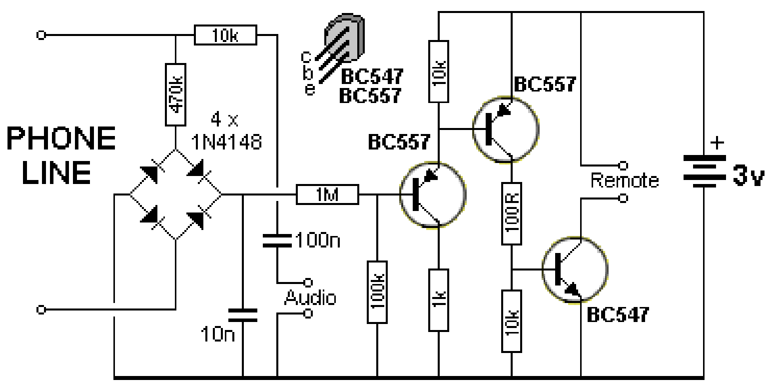


This simple circuit will allow you to tape-record a conversation from a phone line.

It must be placed between the plug on the wall and the phone. The easiest way is to cut an extension lead. Wind 300-500 turns of 0.095mm wire on a plastic straw and place the reed switch inside. Start with 300 turns and see if the reed switch activates, Keep adding turns until the switch is reliable.

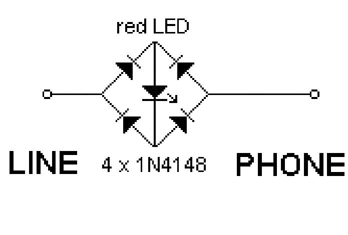
Fit two 100n capacitors to the ends of the winding for the audio. Plug the Audio into “Mic” on tape recorder. Plug the remote into “remote” on the tape recorder and push “record.” The tape recorder will turn on when the phone is lifted and record the conversation.

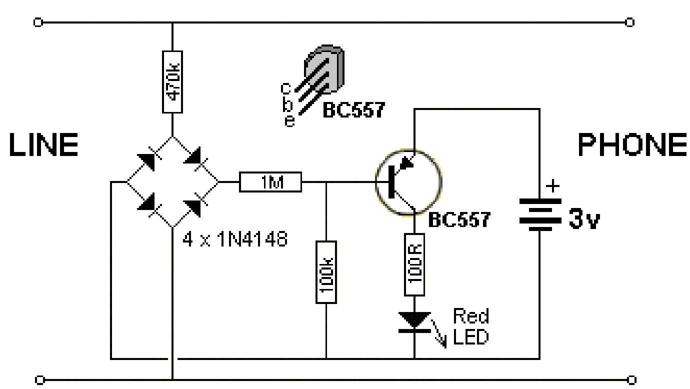
PHONE TAPE 2



The circuit is turned off when the phone line is 45v as the voltage divider made up of the 470k, 1M and 100k puts 3.5v on the base of the first BC557 transistor. If you are not able to cut the lead to the phone, the circuit above will record a conversation from an extension lead. The remote plug must be wired around the correct way for the motor to operate.

PHONE ALERT

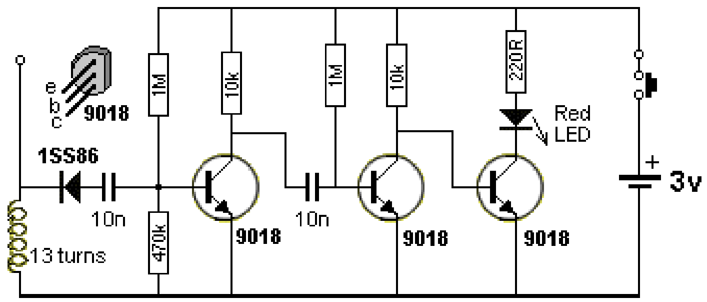




Two circuits are available to show when a phone is being used. The first circuit must be placed between the socket on the wall and the phone - such as cutting into the lead and insert the bridge and diode.

But if you cannot cut the lead to the phone, you will have to add an extension cord and place the second circuit at the end of the line. You can also connect a phone at the end if needed.

PHONE ALERT-2 (for mobile phone)

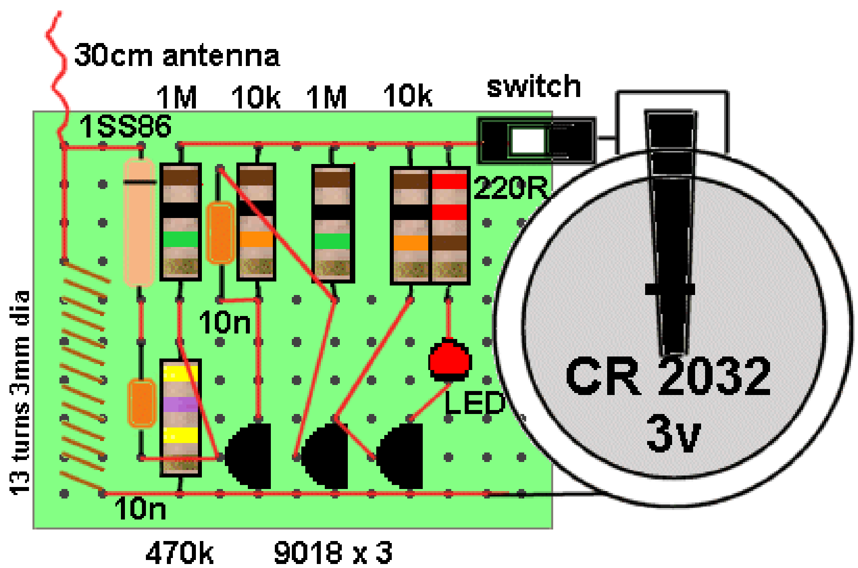


This circuit detects the RF when the phone is communicating with the tower during the hand-shaking prior to it ringing.

The 1SS86 is a Silicon Schottky Barrier Diode for UHF circuits and is 100 times more sensitive than a 1N4148 signal diode. Many of the "clone" 1SS86 diodes (fake or really another type of diode) sold on eBay NOT NOT WORK. The characteristics of the 1SSS86 are really amazing.

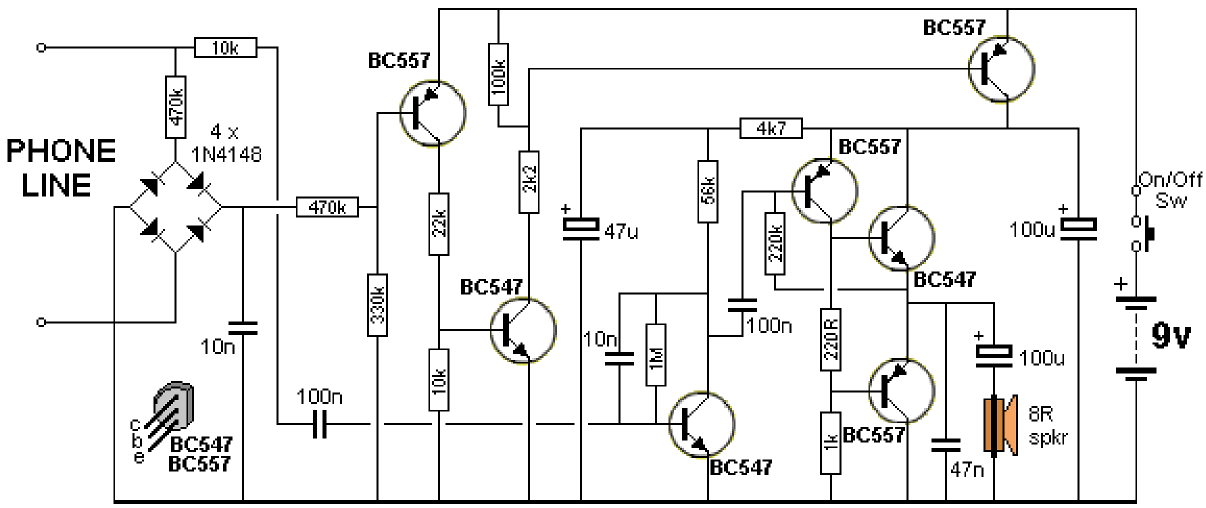
This is an ideal circuit to test different diodes. The first transistor is biased ON and the signal (waveform) developed across the coil takes the cathode end of the diode NEGATIVE for part of the cycle and this puts a slightly lower voltage on the left lead of the 10n capacitor. The right-lead follows and a slightly lower voltage is applied to the base of the transistor. The transistor turns OFF slightly and this effect is passed to the other two transistors to flash the LED.

With 1N4148, the phone must be 10cm from the project. With a 1SS86 it can be one metre away. The circuit takes about 1mA.



A kit is available from Talking Electronics for $3.00 plus $4.50 postage. The project is built on Matrix Board as shown in the drawing above.

THE LISTENER

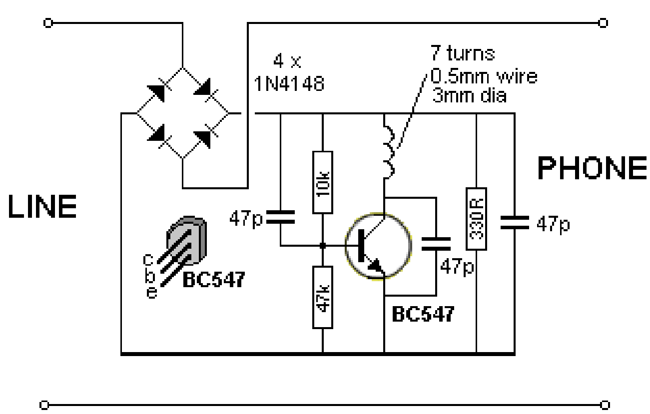


This circuit consists of a 4-transistor amplifier and a 3-transistor "switch" that detects when the phone line is in use, and turns on the amplifier. The voltage divider at the front end produces about 11v on the base of the first BC557 and this keeps the transistor off.

Switch the unit off when removed from the phone line.

PHONE TRANSMITTER 1

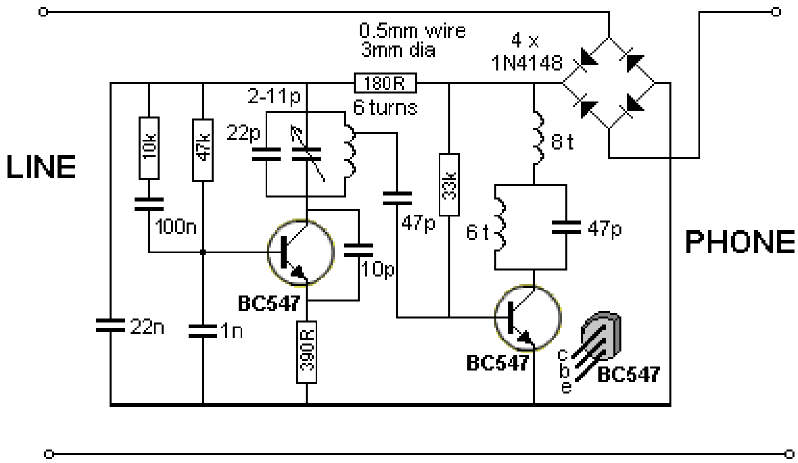
see also PHONE BUG circuit.



The circuit will transmit a phone conversation to an FM radio on the 88-108MHz band. It uses energy from the phone line to transmit about 100metres. It uses the phone wire as the antenna and is activated when the phone is picked up. The components are mounted on a small PC board and the lower photo clearly shows the track-work.

PHONE TRANSMITTER 2

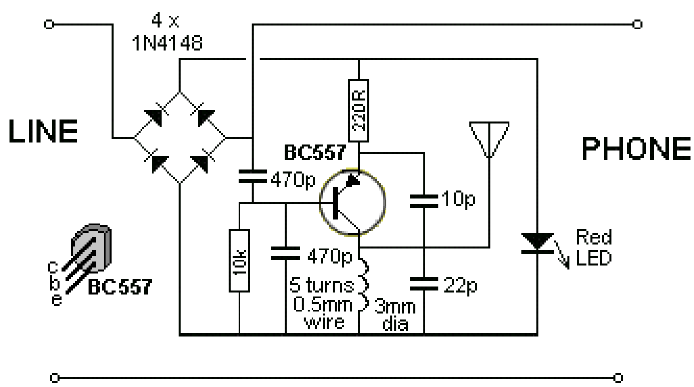
see also PHONE BUG circuit.



The circuit will transmit a phone conversation to an FM radio on the 88-108MHz band. It uses energy from the phone line to transmit about 200metres. It uses the phone wire as the antenna and is activated when the phone is picked up.

PHONE TRANSMITTER 3

see also PHONE BUG circuit.



This circuit has poor features but you can try it and see how it performs. It uses a PNP transistor and requires a separate antenna. It also has a supply of less than 1.9v, via the red LED. It would be better to put 2 LEDs in series to get a higher voltage. It is activated when the phone is picked up.

PHONE TRANSMITTER 4

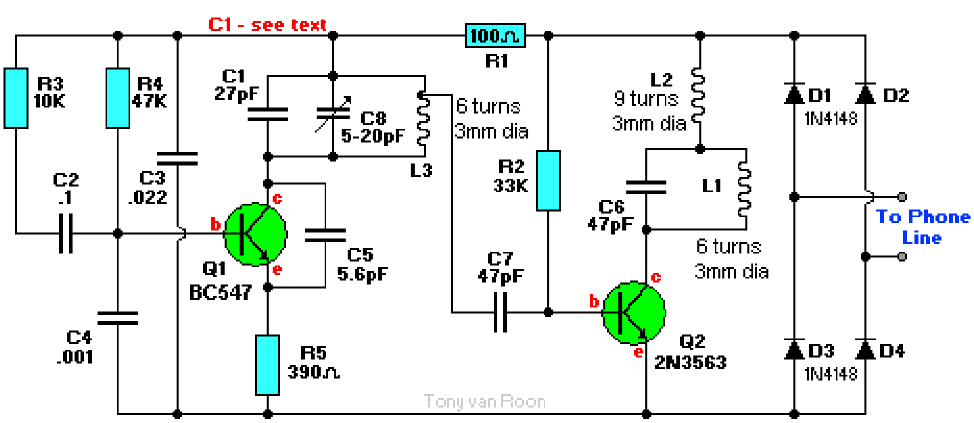
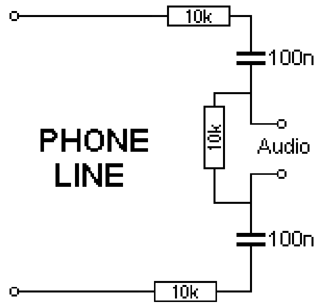


Fig.1 - Here's the FM Telephone Transmitter schematic diagram. The circuit connects in series with a phone line, "steals" power from it, and transmit both sides of the conversation to an FM radio tuned between 80 - 108MHz

see also Phone Bug (101-200 circuits)

The circuit was originally designed by me and presented in Poptronics magazine. It will transmit a phone conversation to an FM radio on the 88-108MHz band. It uses energy from the phone line to transmit about 200metres and uses the phone wire as the antenna. It is activated when the phone is picked up. The 22p air trimmer is shown as well as the 3 coils. Q2 is a buffer transistor between the oscillator and phone line and will provide a higher output than the previous circuits.

MUSIC ON HOLD

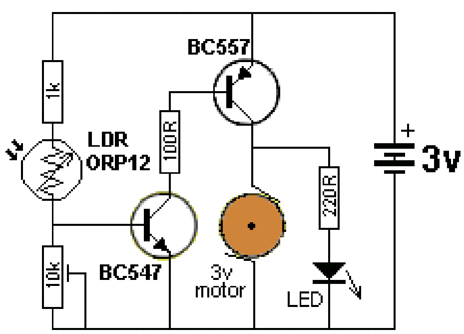


This simple circuit delivers audio to the phone line from the “audio-out” of a tape recorder or radio.

Adjust the volume control of the radio to produce a suitable level of audio.

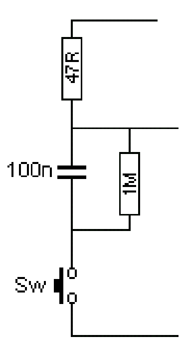
Use 400v capacitors to be on the safe-side.

ROBOT-1



A simple robot can be made with 2 motors and two light-detecting circuits, (identical to the circuit above). The robot is attracted to light and when the light dependent resistor sees light, its resistance decreases. This turns on the BC547 and also the BC557. The shaft of the motor has a rubber foot that contacts the ground and moves the robot. The two pots adjust the sensitivity of the LDRs. This kit is available from Velleman as kit number MK127.

SWITCH DEBOUNCER and PULSE PRODUCER

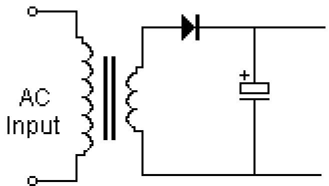


Thus is one of the simplest and cleverest circuits ever produced (by Ron: http://www.zen22142.zen.co.uk/ronj/tg1.html). Ron says:

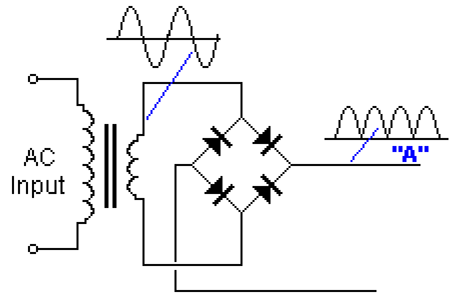
> It produces a complete pulse every time the button is pressed. When the button is pressed, the output goes low for 3uS and produces a pulse to activate the clock-line of a chip. Our circuit produced 100% reliability and the cap takes 0.1sec to discharge.
>
> The circuit does not have any filtering to prevent switch noise as it relying on the fact that a single pulse is produced in 3uS and the circuit assumes no switch noise can be produced in that time-interval.

TRANSISTOR CIRCUITS, Part II

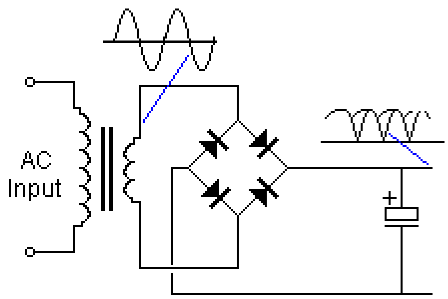
RECTIFYING a VOLTAGE



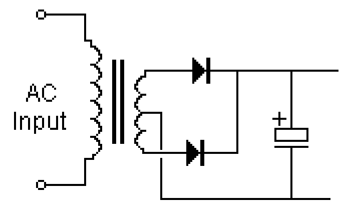
Half-wave rectifier



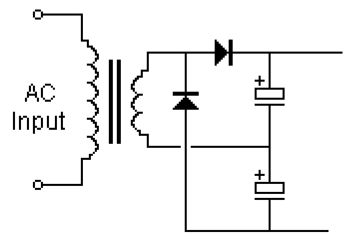
Full-wave rectifier



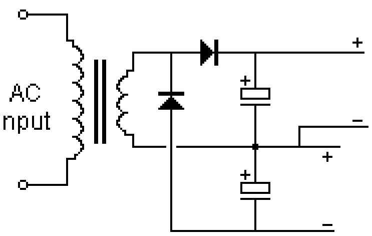
Full-wave rectifier



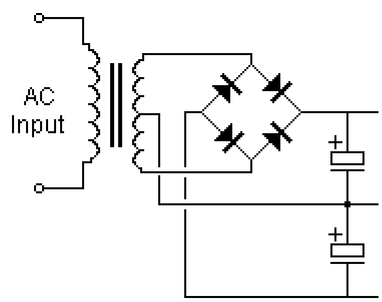
Centre-tapped secondary



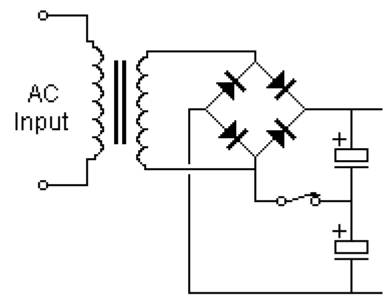
Full-wave voltage doubler
Each section is half-wave supplied. The circuit uses both positive and negative parts of the waveform



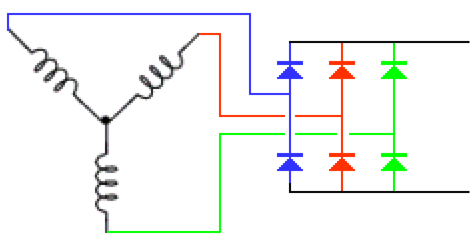
Dual Power Supply
using a single secondary



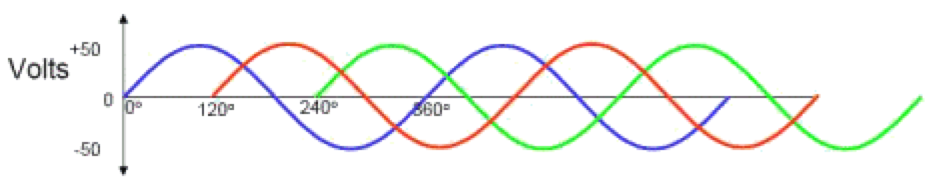
Dual Power Supply
using a
Centre-tapped secondary



This clever circuit is a voltage doubler when the switch is closed



3-phase alternator such as car alternator or windmill

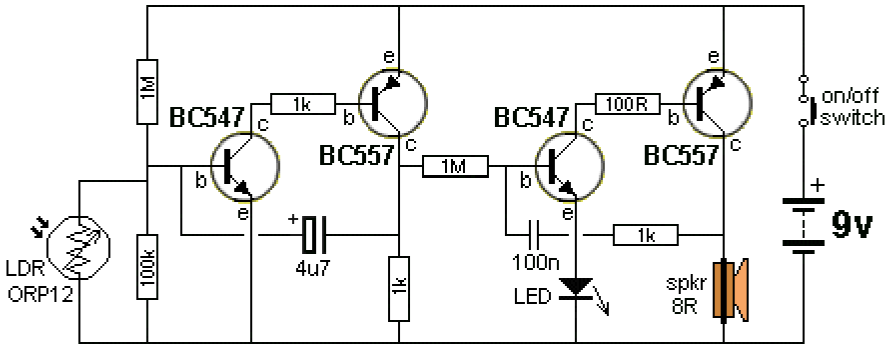


These circuits show how to change an oscillating voltage (commonly called AC) to DC. The term AC means Alternating Current but it really means Alternating Voltage as the rising and falling voltage produces an increasing and decreasing current.

The term DC means Direct Current but it actually means Direct or unchanging Voltage.

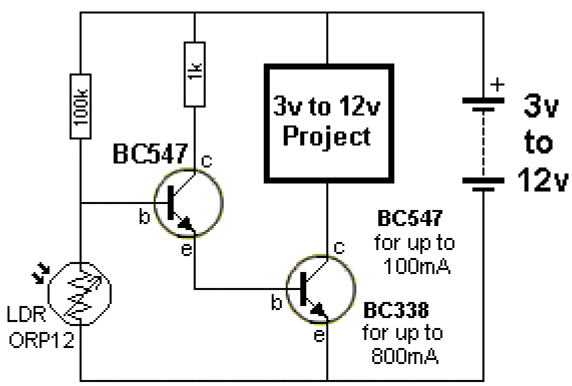
The output of the following circuits will not be pure DC (like that from a battery) but will contain ripple. Ripple is reduced by adding a capacitor (electrolytic) to the output.

DARK DETECTOR with Beep-Beep-Beep Alarm



This circuit detects darkness and produces a beep-beep-beep alarm. The first two transistors form a high-gain amplifier with feedback via the 4u7 to produce a low-frequency oscillator. This provides voltage for the second oscillator (across the 1k resistor) to drive a speaker.

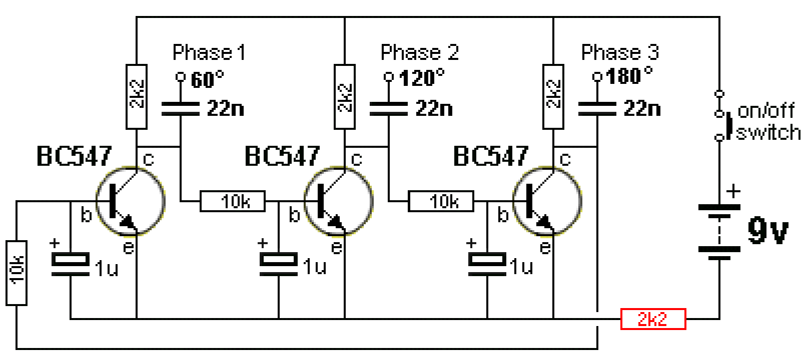
Project can turn ON when DARK



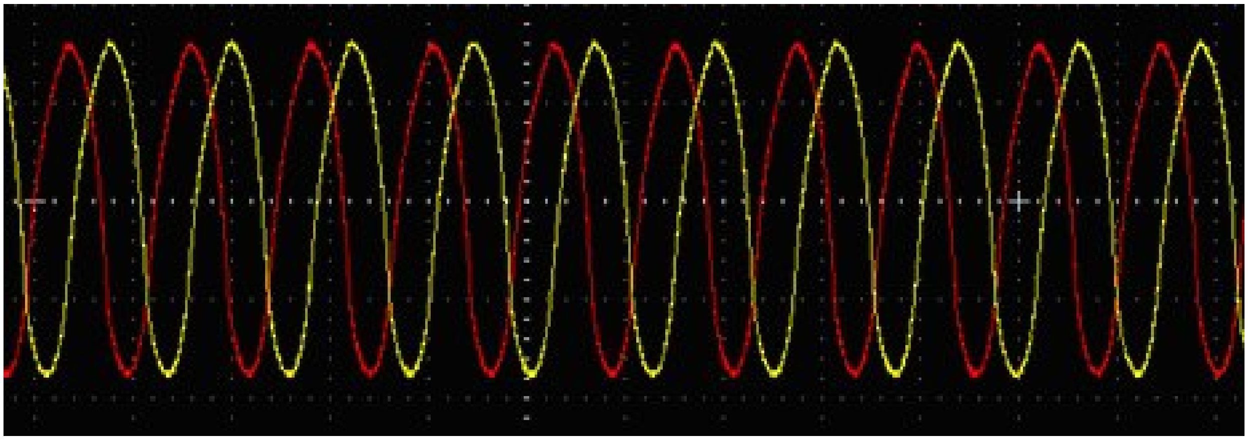
This circuit detects darkness and allows the project to turn on. The project can be any circuit that operates from 3v to 12v.

The components have been chosen for a 6v project that requires 500mA.

3-PHASE SINEWAVE GENERATOR

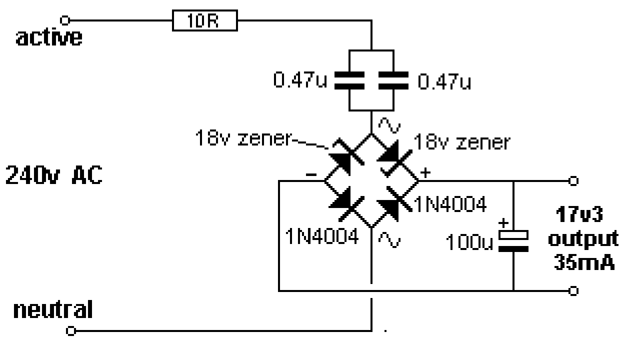


This circuit produces a sinewave and each phase can be tapped at the point shown. The secret to producing a good waveform is the addition of the 2k2 resistor in the 0v rail This circuit and waveform is provided by Jack Hoffnung.



Two of the three waveforms - we only have dual trace CRO's !!!!

TRANSFORMERLESS POWER SUPPLY



This clever design uses 4 diodes in a bridge to produce a fixed voltage power supply capable of supplying 35mA.

All diodes (every type of diode) are zener diodes. They all break down at a particular voltage. The fact is, a power diode breaks down at 100v or 400v and its zener characteristic is not useful.

But if we put 2 zener diodes in a bridge with two ordinary power diodes, the bridge will break-down at the voltage of the zener. This is what we have done. If we use 18v zeners, the output will be 17v4.

When the incoming voltage is positive at the top, the left zener provides 18v limit (and the other zener produces a drop of 0.6v) This allows the right zener to pass current just like a normal diode. The output is 17v4. The same with the other half-cycle.

The current is limited by the value of the X2 capacitors and this is 7mA for each 100n when in full-wave (as per this circuit). We have 1u capacitance. Theoretically the circuit will supply 70mA but we found it will only deliver 35mA before the output drops. The capacitors should comply with X1 or X2 class. The 10R is a safety-fuse resistor.

The problem with this power supply is the "live" nature of the negative rail. When the power supply is connected as shown, the negative rail is 0.7v above neutral. If the mains is reversed, the negative rail is 340v (peak) above neutral and this will kill you as the current will flow through the diode and be lethal. You need to touch the negative rail (or the positive rail) and any earthed device such as a toaster to get killed. The only solution is the project being powered must be totally enclosed in a box with no outputs.

A **TRANSFORMERLESS POWER SUPPLY** is also called a **CAPACITOR FED POWER SUPPLY**. It is very dangerous.

Here's why:

A **Capacitor Power Supply** uses a capacitor to interface between a "high voltage supply" and a low voltage – called THE POWER SUPPLY.

In other words a capacitor is placed between a "high voltage supply" we call THE MAINS (between 110v and 240v) and a low voltage that may be 9v to 12v. Even though a capacitor consists of two plates that do not touch each other, a **Capacitor Power Supply** is a very dangerous project, for two reasons.

You may not think electricity can pass though a capacitor because it consists of plates that do not touch each other.

But a capacitor works in a slightly different way. A capacitor connected to the mains works like this: Consider a magnet on one side of a door. On the other side we have a sheet of metal. As you slide the magnet up the door, the sheet of metal rises too.

The same with a capacitor. As the voltage on one side of the capacitor rises, the voltage on the other side is "pulled out of the ground" - and it rises too.

If you stand on the ground and hold one lead of the capacitor and connect the other to the active side of the "mains," the capacitor will "pull" 120v or 240v "out of the ground" and you will get a shock.

Don't ask "how" or "why." This is just the simplest way to describe how you get a shock via a capacitor that consists of two plates.

If the capacitor "shorts" between the two plates, the 120v or 240v will be delivered to your power supply and create damage.

Secondly, if any of the components in your power supply become open-circuit, the voltage on the power supply will increase. But the most dangerous feature of this type of power supply is reversal of the mains leads.

The circuit is designed so that the neutral lead goes to the earth of your power supply.

This means the active is connected to the capacitor.

Now, the way the active works is this: The active lead rises 120x 1.4 = 180v in the positive direction and then drops to 180v in the opposite direction. In other words it is 180v higher than the neutral line then 180v lower than the neutral.

For 240v mains, this is 325v higher then 325v lower. The neutral is connected to the chassis of your project and if you touch it, nothing will happen. It does not rise or fall.

But suppose you connect the power leads around the wrong way.

The active is now connected to the chassis and if you touch the chassis and a water pipe, you will get a 180v or 345v shock.

That's why a CAPACITOR-FED power supply must be totally isolated. Now we come to the question: How does a capacitor produce a 12v power supply? When a capacitor is connected to the mains, one lead is rising and falling. Depending on the size of the capacitor, it will allow current to flow into and out of the other lead.

If the capacitor is a large value, a high current will flow into and out of the lead. In addition, a high voltage will allow a higher current to flow.

This current is "taken out of the ground" and "flows back into the ground." It does not come from the mains. The mains only: "influences" the flow of current.

Thus we have a flow of current into and out of the capacitor.

If you put a resistor between the capacitor and "ground," the amount of current that will flow, depends on 3 things, the amplitude of the voltage, the size of the capacitor and the speed of the rise and fall.

When current flows through a resistor, a voltage develops across the resistor and if we select the correct value of resistance, we will get a 12v power supply.

THE OUTPUT VOLTAGE

The OUTPUT VOLTAGE of all transformerless power supplies will be about 50% HIGHER than the mains voltage if a LOAD is not connected. That's RIGHT: The output of a 120v CAPACITOR POWER SUPPLY (transformerless power supply) will be about 180v and a 240v mains transformerless power supply will be about 345v. How do you get a 12v or 24v supply????

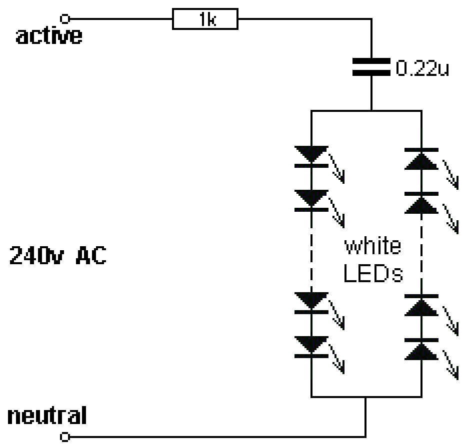
It works like this: The transformerless power supply is a CURRENT-DELIVERED power supply. In other words we have to talk about CURRENT-VALUES and not voltages.

For a bridge circuit (called a full-wave design) it will deliver 7mA for each 100n. Suppose we have 220n. We have 15mA available.

We take the 15mA and say: How many volts will develop across a 100R load? The answer = 0.015 x 100 = 15v. I f we use 82R the voltage will be about 12v. If we use 220R the voltage will be 33v. That's how the output voltage is developed.

If you add another 220n across the 220n, the voltages will be DOUBLE. It's as simple as that.

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.

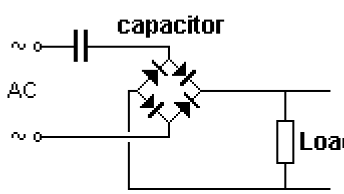
Insulation must be provided and the lights (LEDs) must be away from prying fingers.

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.

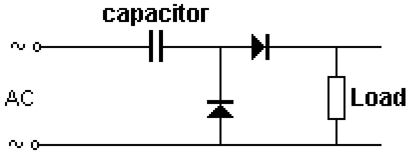
For 50 LEDs in each string, the total characteristic voltage will be 180v so that the peak voltage will be 330v - 180v = 150v. Each LED will see less than 7mA peak during the half-cycle they are illuminated. The 1k resistor will drop 7v - since the RMS current is 7mA (7mA x 1,000 ohms = 7v). No rectifier 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.

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).



Full-wave capacitor Supply



Half-wave capacitor Supply

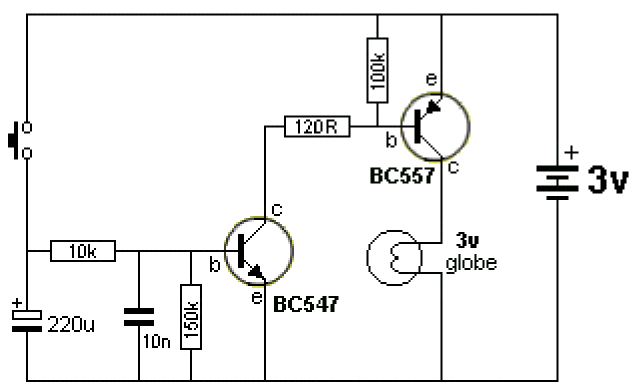
The current-capability of a capacitor needs more explanation. In the diagram on the left we see a capacitor feeding a full-wave power supply. This is exactly the same as the LEDs on 240v circuit above. Imagine the LOAD resistor is removed.

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.

BOOK LIGHT

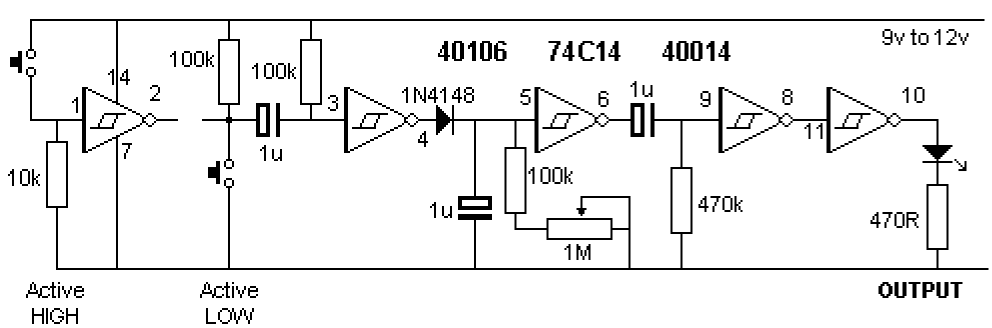


This circuit keeps the globe illuminated for a few seconds after the switch is pressed.

There is one minor fault in the circuit. The 10k should be increased to 100k to increase the "ON" time.

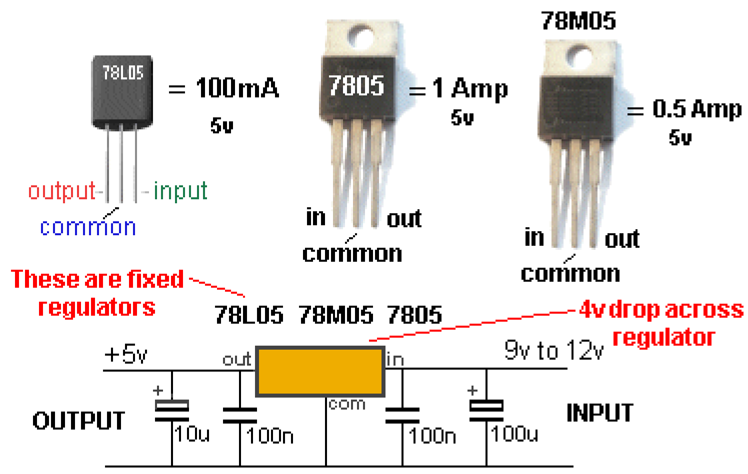
CAMERA ACTIVATOR

This circuit was designed for a customer who wanted to trigger a camera after a short delay.



The output goes HIGH about 2 seconds after the switch is pressed. The LED turns on for about 0.25 seconds. The circuit will accept either active HIGH or LOW input and the switch can remain pressed and it will not upset the operation of the circuit. The timing can be changed by adjusting the 1M trim pot and/or altering the value of the 470k.

POWER SUPPLIES - FIXED

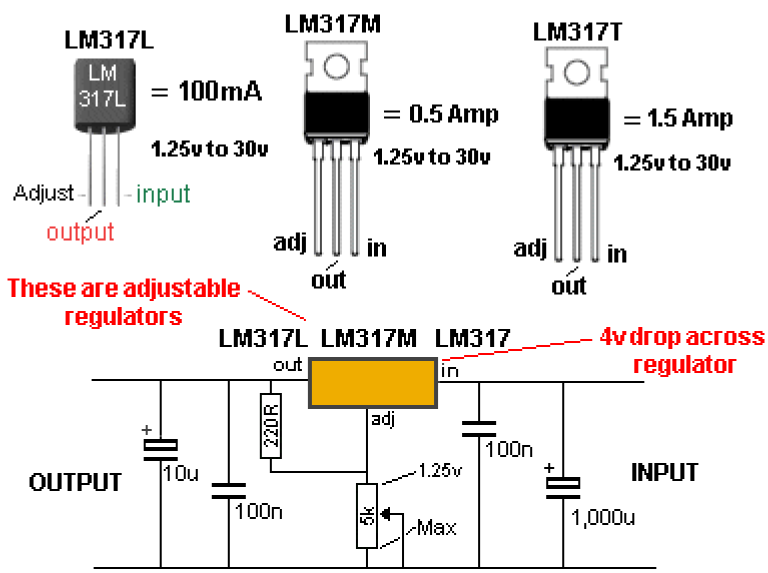


A simple power supply can be made with a component called a “3-pin regulator or 3-terminal regulator” It will provide a very low ripple output (about 4mV to 10mV provided electrolytics are on the input and output.

The diagram above shows how to connect a regulator to create a power supply. The 7805 regulators can handle 100mA, 500mA and 1 amp, and produce an output of 5v, as shown.

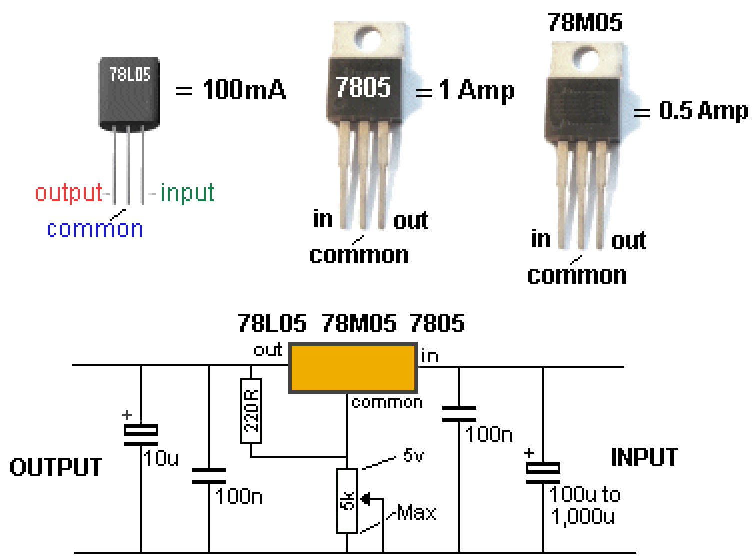
These regulators are called linear regulators and drop about 4v across them - minimum. If the current flow is 1 amp, 4watts of heat must be dissipated via a large heatsink. If the output is 5v and input 12v, 7volts will be dropped across the regulator and 7watts must be dissipated.

POWER SUPPLIES - ADJUSTABLE



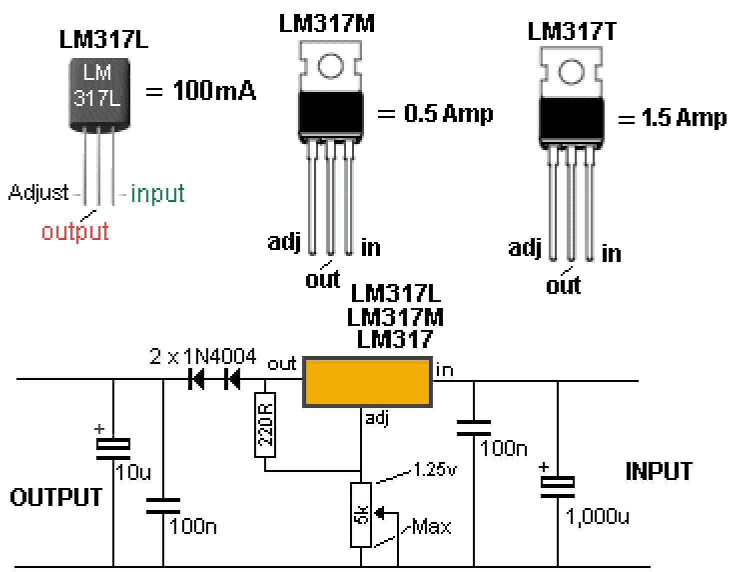
The LM317 regulators are adjustable and produce an output from 1.25 to about 35v. The LM317T regulator will deliver up to 1.5amp.

POWER SUPPLIES - ADJUSTABLE using 7805



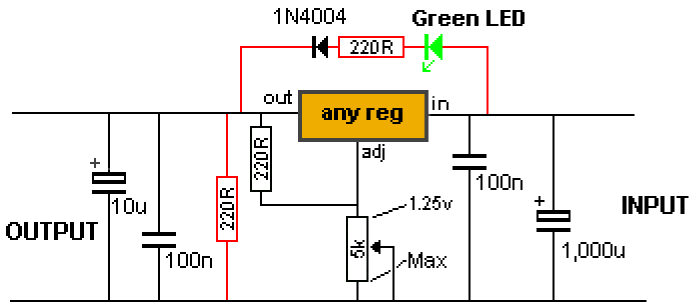
The 7805 range of regulators are called "fixed regulators" but they can be turned into adjustable regulators by "jacking-up" their output voltage. For a 5v regulator, the output can be 5v to 30v.

POWER SUPPLIES - ADJUSTABLE from 0v



The LM317 regulator is adjustable from 1.25 to about 35v. To make the output 0v to 35v, two power diodes are placed as shown in the circuit. Approx 0.6v is dropped across each diode and this is where the 1.25v is "lost."

LOW INPUT VOLTAGE



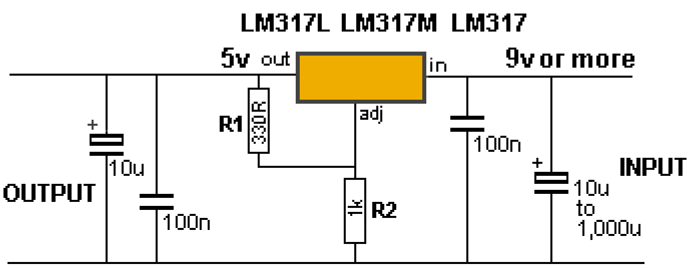
This clever circuit lets you know if the voltage across the regulator drops below 2v.

This is very important when you are increasing the output voltage and the regulator SUDDENLY drops out of regulation because the voltage across it is insufficient.

This can be due to the ripple causing the problem and you will see the green LED flickering.

You can add extra diodes in series with the LED to get a safety margin of 2.6v or 3.2v The 220R on the output is only needed when the output is not loaded and the current taken by the LED needs to be brought from the 0v rail as the output does not like to dragged higher than 5v (or its present output voltage).

5v POWER SUPPLY



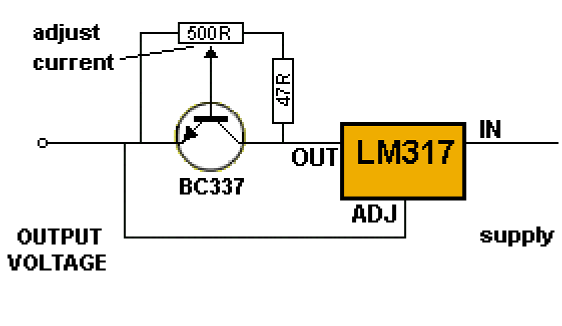
on-line calculator for LM317:
http://diyaudioprojects.com/Technical/Voltage-Regulator/

$$V_{out} = 1.25v\left(1 + \frac{R2}{R1}\right) + I_{adj}(R2)$$

	5.04v	9.6v	11.83v
R1	330R	330R	390R
R2	1k	2k2	3k3

Using the the LM317 regulator to produce 5v supply (5.04v):

CONSTANT CURRENT



This constant current circuit can be adjusted to any value from a few milliamp to about 500mA - this is the limit of the BC337 transistor.

The circuit can also be called a current-limiting circuit and is ideal in a bench power supply to prevent the circuit you are testing from being damaged.

Approximately 4v is dropped across the regulator and 1.25v across the current-limiting section, so the input voltage (supply) has to be 5.25v above the required output voltage. Suppose you want to charge 4 Ni-Cad cells. Connect them to the output and adjust the 500R pot until the required charge-current is obtained.

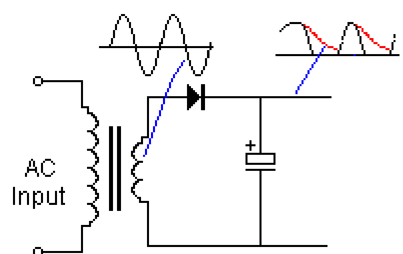
The charger will now charge 1, 2, 3 or 4 cells at the same current. But you must remember to turn off the charger before the cells are fully charged as the circuit will not detect this and over-charge the cells.

The LM 317 3-terminal regulator will need to be heatsinked.

This circuit is designed for the LM series of regulator as they have a voltage differential of 1.25v between “adj” and “out” terminals.

7805 regulators can be used but the losses in the BC337 will be 4 times greater as the voltage across it will be 5v.

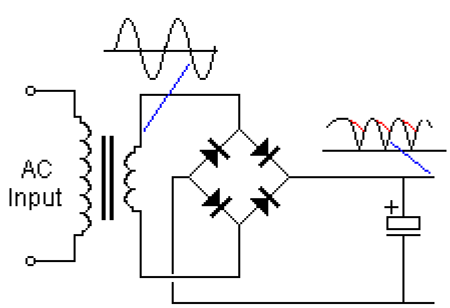
THE POWER SUPPLY



Half-wave rectifier

The simplest power supply is a transformer, diode and electrolytic: But the ripple will be very high because only every alternate portion of the ac signal is being passed through the diode and the electrolytic (called the filter capacitor) cannot smooth the ripple very well. The result will be a loud hum if powering an amplifier.

An improvement is to use a bridge rectifier. This will reduce the ripple and reduce the hum because the waveform to the electrolytic consists of pulses that are closer together and the electrolytic does not have to supply as much energy because the pulses are closer together.



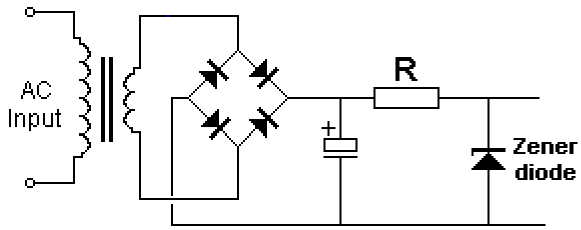
Full-wave rectifier

ZENER REGULATION

The next improvement is to reduce the ripple with a zener diode.

The zener diode is placed across the voltage you want to smooth and as the voltage increases, the zener diode turns ON more and additional current flows through it to the 0v rail. This reduces the voltage but the result is a smoother voltage.

This is called a SHUNT REGULATOR or ZENER SHUNT REGULATOR or ZENER DIODE STABILIZER.



Shunt Zener Regulator

In place of a zener, we can use a transistor.

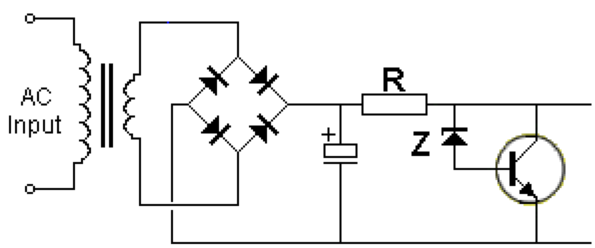
THE SHUNT TRANSISTOR

A transistor placed across the voltage to be regulated (or stabilized) is called a SHUNT TRANSISTOR, because it shunts or sends the unwanted extra waveform to the 0v rail, and thereby smoothes the voltage.

It uses a zener to sense the voltage as in the zener regulator circuit above, but the current through the zener is less because the transistor turns ON and reduces the voltage. A lower-wattage zener diode can be used and since less current flows through it, the voltage across it will be more stable.

This arrangement is better than a zener diode regulator due the improved stability of the diode with less current flowing through it and the circuit will deliver about 100 times more current due to the inclusion of the transistor.

However, this circuit is very wasteful because the maximum current is flowing all the time and being sent to the 0v rail. When you add a load (such as an amplifier), the current is diverted from the shunt transistor and into the amplifier. The amplifier can only take current up to the maximum the transistor was passing to the 0v rail.

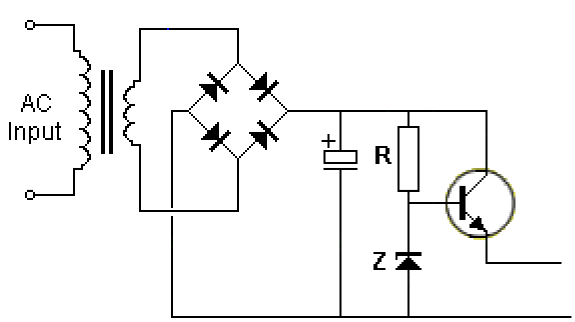


Transistor Shunt Regulator

THE PASS TRANSISTOR

A PASS TRANSISTOR is less wasteful than a SHUNT TRANSISTOR. The circuit takes almost no current (when the amplifier is not connected).

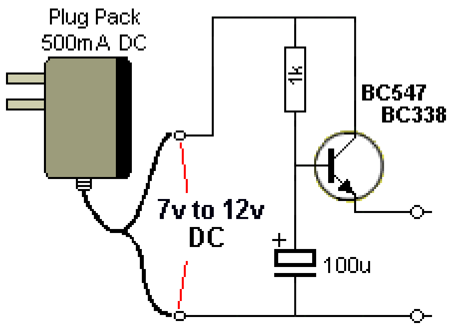
The ripple on the output is determined by the effectiveness of the zener (due to the low current is is required to pass) and the transistor (passes this voltage and) amplifies the current about 100 times.



Pass Transistor Regulator

No values have been provided for these circuits are they are intended to explain Shunt Transistor and Pass Transistor. The type of transistor and value of resistor in the power line will depend on the current.

THE ELECTRONIC FILTER



Here is a simple circuit to reduce the ripple from a power supply by a factor of about 100. This means a 20mV ripple will be 0.2mV and will not be noticed. This is important when you are powering an FM bug from a plug pack. The background hum is annoying and very difficult to remove with electrolytics. This circuit is the answer. The 1k and 100u form a filter that makes the 100u one hundred times more effective than if placed directly on the supply-line. The transistor detects the voltage on the base and also detects the very small ripple.

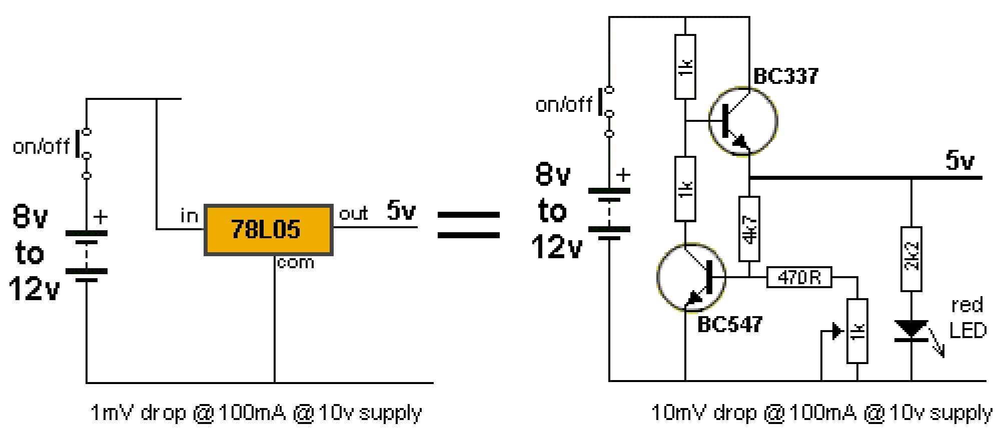
As current is taken by the load, about 100th of this current is required by the base and if the load current is 100mA, the current into the base will be 1mA and one volt will be dropped across the 1k resistor.

The circuit is suitable for up to 100mA. A power transistor can be used, but the 1k will have to be reduced to 220R for 500mA output. The output of the circuit is about 2v less than the output of the plug pack. By adding a zener across the electro, the output voltage will remain much more constant (fixed).

If a zener is not added, the output voltage will drop as the current increases due to a factor called REGULATION. This is the inability of the small transformer to provide a constant voltage. The addition of the 3 components only reduces the RIPPLE portion of the voltage - and does not change the fact that the voltage will droop when current is increased. It requires a zener to fix this problem.

This circuit can also be called: RIPPLE SUPPRESSOR, RIPPLE REDUCER or CAPACITANCE MULTIPLIER. The 100u can be increased to 470u or 1,000u.

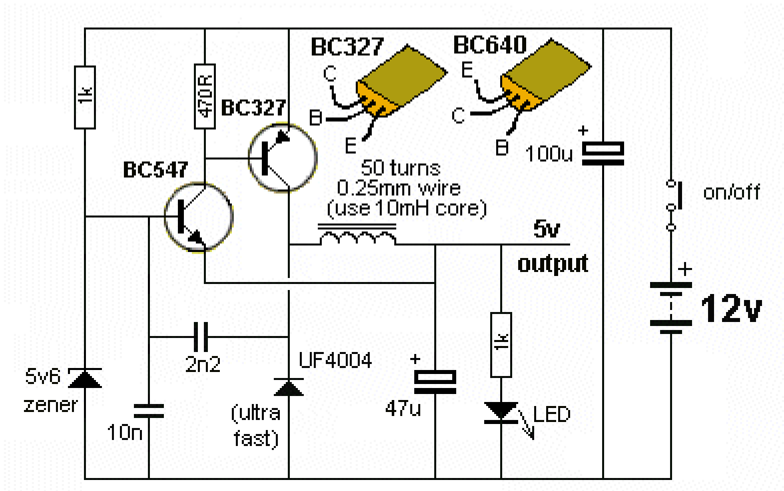
5v FROM OLD CELLS - Circuit 1



This circuit takes the place of a 78L05 3-terminal regulator. It produces a constant 5v @ 100mA. You can use any old cells and get the last of their energy. Use an 8-cell holder. The voltage from 8 old cells will be about 10v and the circuit will operate down to about 7.5v. The regulation is very good at 10v, only dropping about 10mV for 100mA current flow (the 78L05 has 1mV drop). As the voltage drops, the output drops from 5v on no-load to 4.8v and 4.6v on 100mA current-flow. The pot can be adjusted to compensate for the voltage-drop. This type of circuit is called a LINEAR REGULATOR and is not very efficient (about 50% in this case). See Circuit 2 below for BUCK REGULATOR circuit (about 85% efficient).

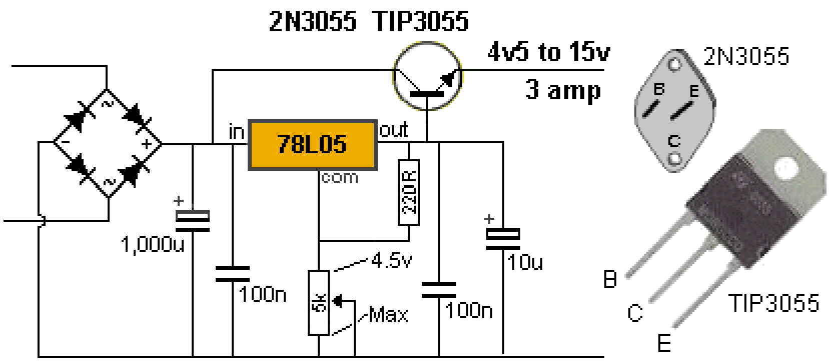
The battery snap plugs into the pins on the 5v regulator board with the red lead going to the negative output of the board as the battery snap is now DELIVERING voltage to the circuit you are powering.

5v FROM OLD CELLS - Circuit 2



This circuit is a BUCK REGULATOR. It can take the place of a 78L05 3-terminal regulator, but it is more efficient. It produces a constant 5v @ up to 200mA. You can use any old cells and get the last of their energy. Use an 8-cell holder. The voltage from 8 old cells will be about 10v and the circuit will operate down to about 7.5v. The regulation is very good at 10v, only dropping 10mV for up to 200mA output.

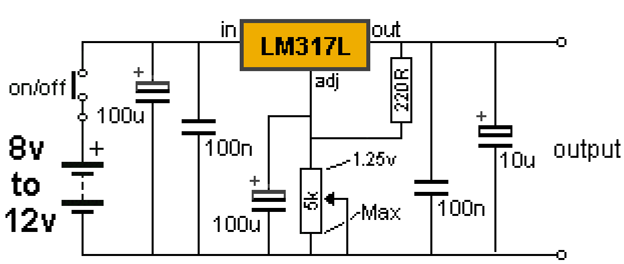
INCREASING THE OUTPUT CURRENT



The output current of all 3-terminal regulators can be increased by including a pass transistor. This transistor simply allows the current to flow through the collector-emitter leads. The output voltage is maintained by the 3-terminal regulator but the current flows through the "pass transistor." This transistor is a power transistor and must be adequately heatsinked.

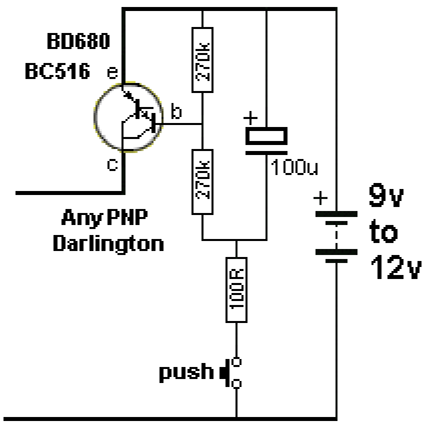
Normally a 2N3055 or TIP3055 is used for this application as it will handle up to 10 amps and creates a 10 amp power supply. The regulator can be 78L05 as all the current is delivered by the pass transistor.

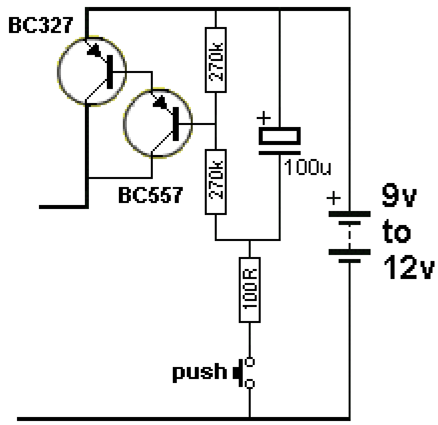
SOFT START

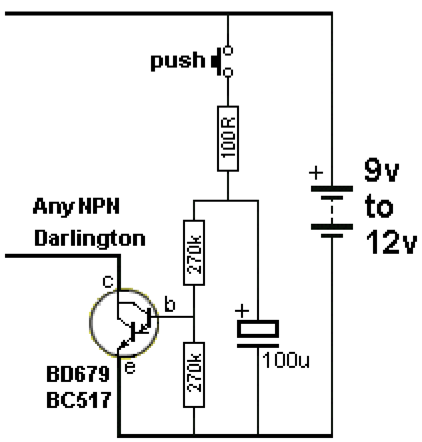


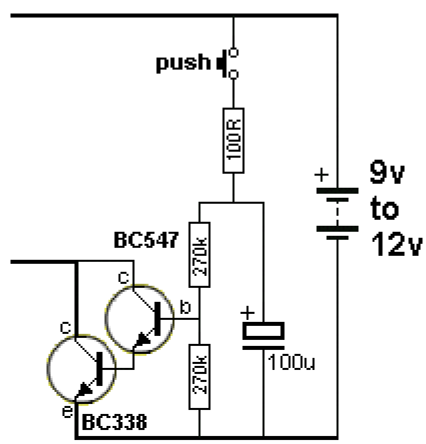
The output voltage of a 3-terminal regulator can be designed to rise slowly. This has very limited application as many circuits do not like this.

TURN-OFF DELAY



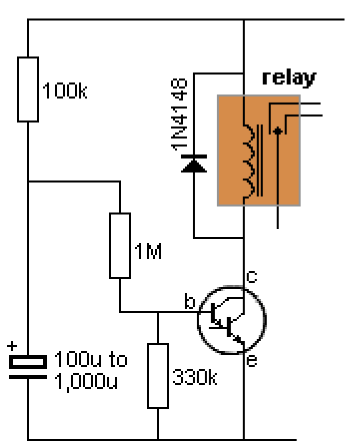


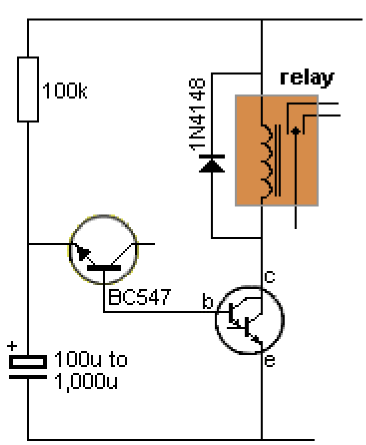




These 4 circuits are all the same. They supply power to a project for a short period of time. You can select either PNP or NPN transistors or Darlington transistors. The output voltage gradually dies and this will will produce weird effects with some projects. See circuit 4 in Time Delay Circuits (below) for a relay that remains active for a few seconds after the push button has been released.

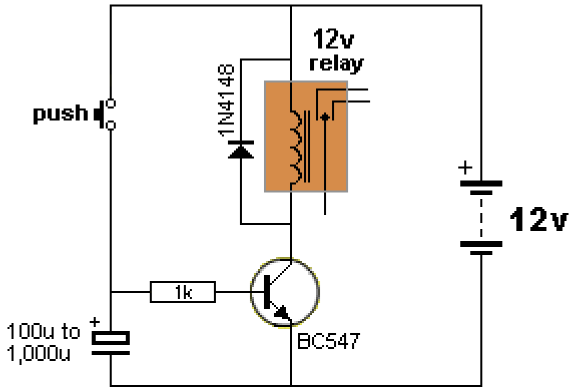
TIME DELAY CIRCUITS





These 3 circuits are all the same. They turn on a relay after a period of time.

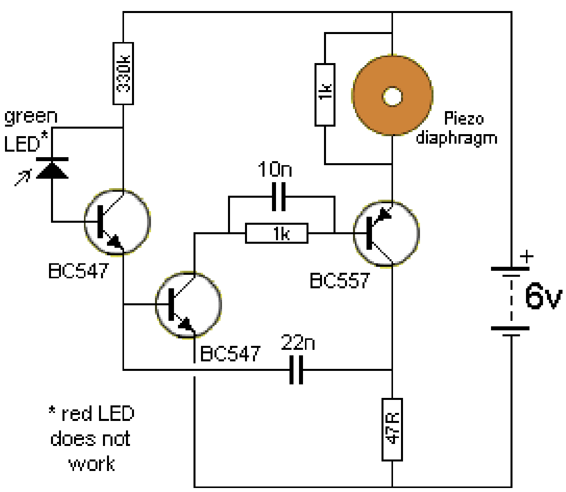
The aim of the circuit is to charge the electrolytic to a reasonably high voltage before the circuit turns ON. In fig 1 the voltage will be above 5v6. In fig 2 the voltage will be above 3v6. In fig 3 the voltage will be above 7v.



The relay in this circuit will remain active for a few seconds after the push button has been released.

The value of the 1k resistor and electrolytic can be adjusted to suit individual requirements.

LED DETECTS LIGHT 2

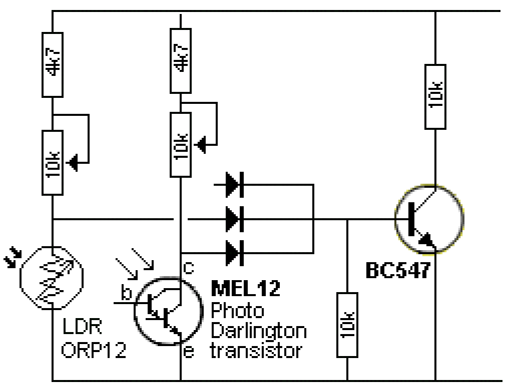


The LED in this circuit will detect light to turn on the oscillator. Ordinary red LEDs do not work. But green LEDs, yellow LEDs and high-bright white LEDs and high-bright red LEDs work very well.

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.”

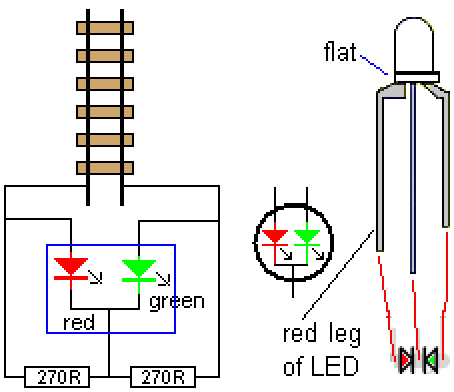
The piezo diaphragm does not contain any active components and relies on the circuit to drive it to produce the tone. A different LED DETECTS LIGHT circuit in the first part of this eBook.

TRAIN DETECTORS



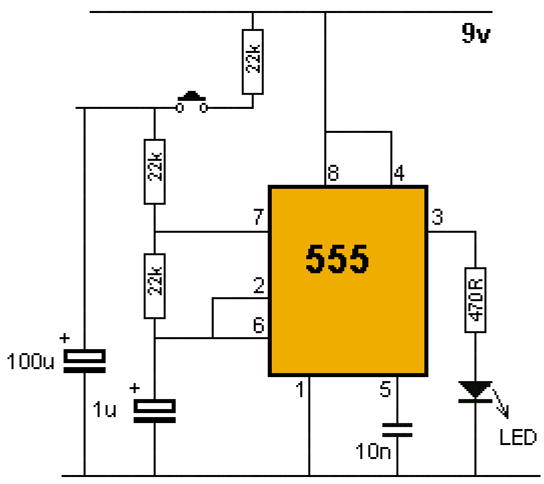
In response to a reader who wanted to parallel TRAIN DETECTORS, here is a diode OR-circuit. The resistor values on each detector will need to be adjusted (changed) according to the voltage of the supply and the types of detector being used. Any number of detectors can be added. See Talking Electronics website for train circuits and kits including Air Horn, Capacitor Discharge Unit for operating point motors without overheating the windings, Signals, Pedestrian Crossing Lights and many more.

TRACK POLARITY



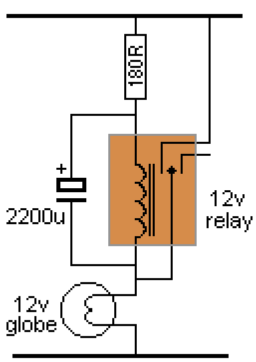
This circuit shows the polarity of a track via a 3-legged LED. The LED is called dual colour (or tri-colour) as it shows red in one direction and green in the other (orange when both LEDs are illuminated).

DECAYING FLASHER



In response to a reader who wanted a flashing LED circuit that slowed down when a button was released, the above circuit increases the flash rate to a maximum and when the button is released, the flash rate decreases to a minimum and halts.

SIMPLE FLASHER

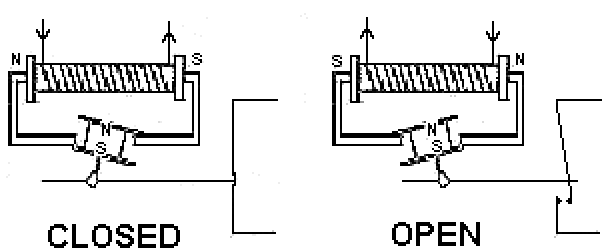


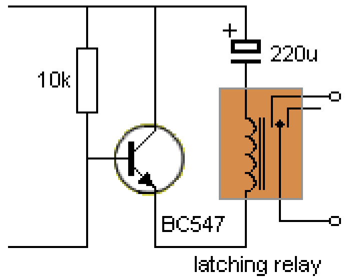
This simple circuit flashes a globe at a rate according to the value of the 180R and 2200u electrolytic.

LATCHING RELAY

To reduce the current in battery operated equipment a relay called LATCHING RELAY can be used. This is a relay that latches itself ON when it receives a pulse in one direction and unlatches itself when it receives a pulse in the other direction.

The following diagram shows how the coil makes the magnet click in the two directions.

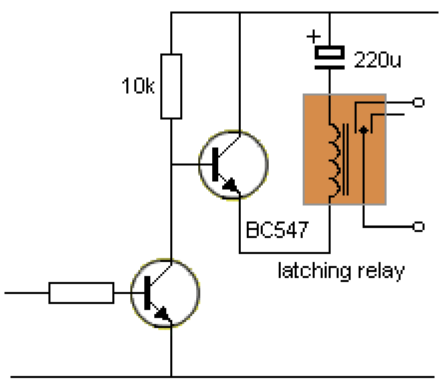




PULSE LATCHING RELAY ON/OFF

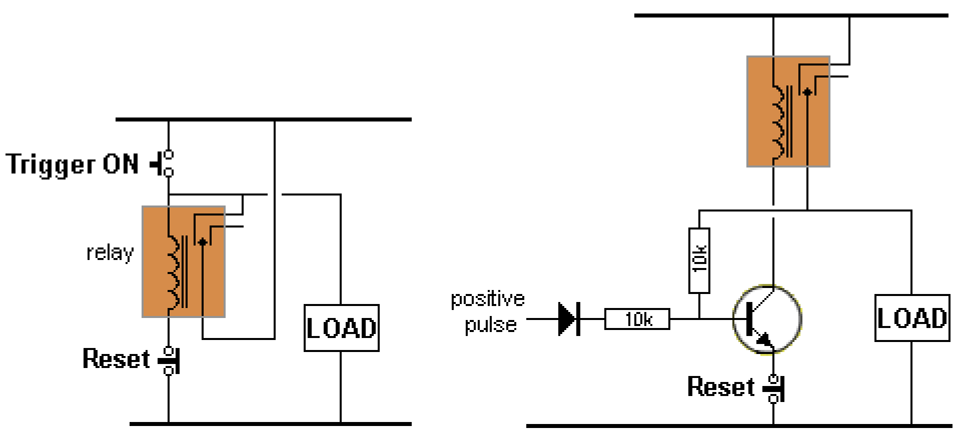
To operate this type of relay, the voltage must be reversed to unlatch it. The circuit above produces a strong pulse to latch the relay ON and the input voltage must remain HIGH. The 220u gradually charges and the current falls to a very low level. When the input voltage is removed, the circuit produces a pulse in the opposite direction to unlatch the relay.

The pulse-latching circuit above can be connected to a microcontroller via the circuit down here. The electrolytic can be increased to 1,000u to cater for relays with a low resistance.



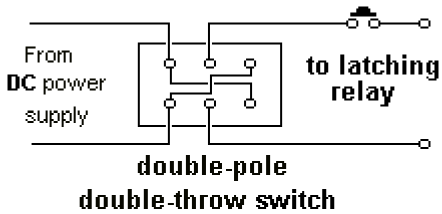
PULSE LATCHING RELAY ON/OFF via a MICROCONTROLLER

If you want to latch an ordinary relay so it remains ON after a pulse, the next circuits can be used. Power is needed all the time to keep the relay ON.

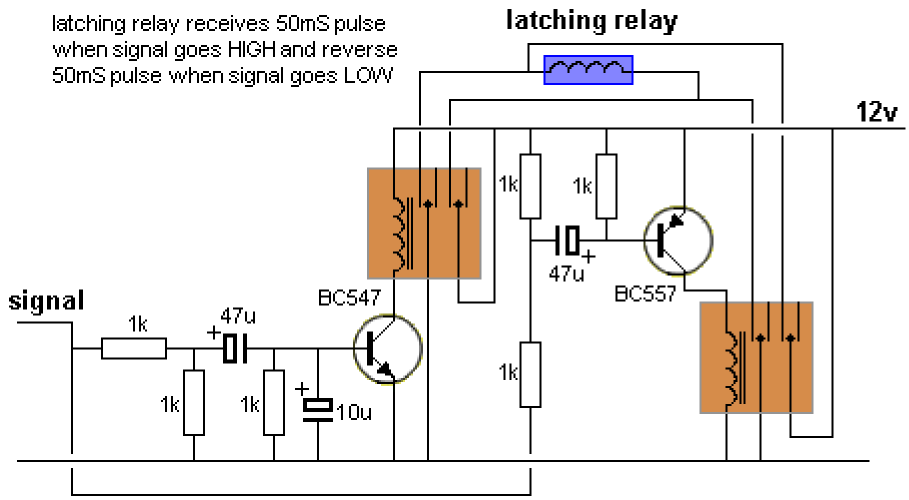


Latching an ordinary relay

If your latching relay latches when it receives a 50mS pulse and unlatches when it receives a 50mS pulse in the opposite direction, you just need a reversing switch and a push button. You just need to flick the switch to the latch or unlatch position and push the button very quickly.



To operate a latching relay from a signal, you need the following circuit:



To use this circuit you have to understand some of the technical requirements.

When the signal is HIGH it has driving power and is classified a low impedance and it will only turn ON the BC547. If you make sure the signal is HIGH when the circuit is turned ON, you will have no problem.

But if the signal is LOW when the 12v power is applied, the signal-line will be effectively "floating" and the four 1k resistors in series will turn on both transistors.

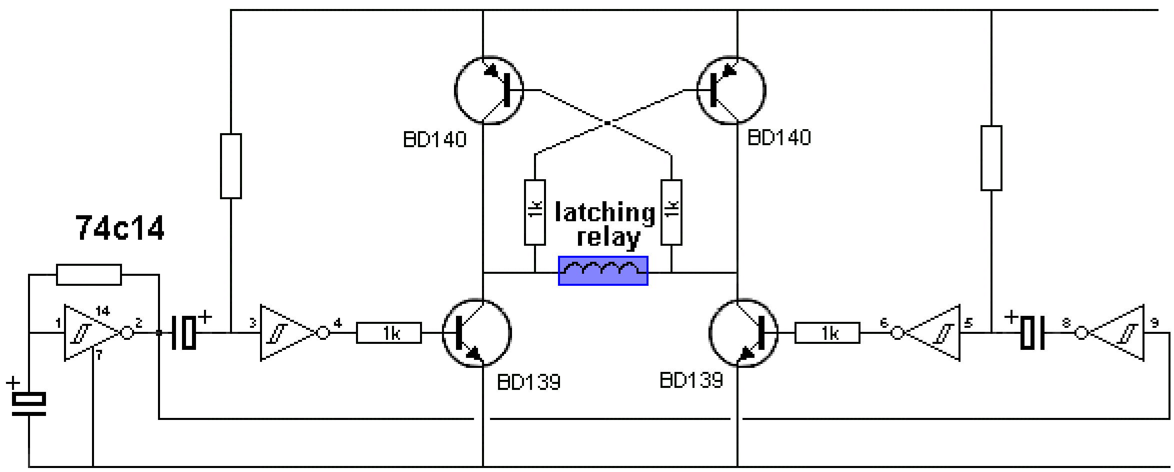
The 10u is designed to delay to BC547 and it will produce the longer pulse to de-activate the relay. You will have to adjust the value of the resistors and electrolytics to get the required pulse length and the required delay. This circuit is just a "starting-point."

This circuit has been requested by: Stephen Derrick-Jehu email: [d-js@xtra.co.nz] Contact him for the success of this circuit, with his 8 ohm 12v EHCOTEC valve B23E-1-ML-4.5vDC.

Specifications:

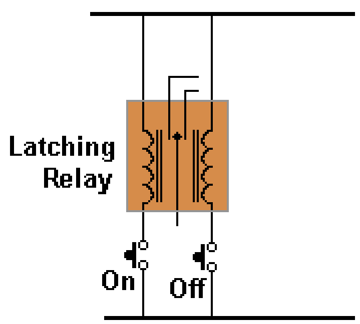
- 4.5-Volt DC minimum coil voltage
- 12-Volt DC maximum coil voltage
- 50 mS (min) pulse opens valve
- 50 mS pulse (min) with reverse polarity closes valve
- 2.5 W power consumption at 4.5vDC

The following circuit pulses a latching relay every 30 seconds. The circuit only consumes current during the 50mS latching period.



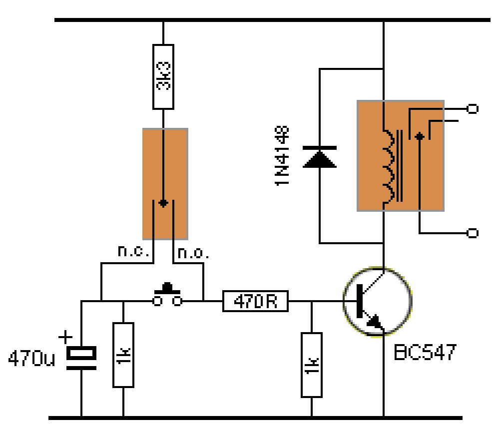
The values for the timing components have not been provided. These can be worked out by experimentation.

Latching Relays are expensive but a 5v Latching Relay is available from: Excess Electronics for $1.00 as a surplus item. It has 2 coils and requires the circuit at the left. A 5v Latching Relay can be use on 12v as it is activated for a very short period of time.



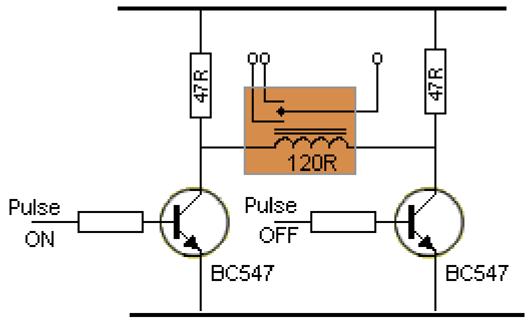
A 2-coil Latching Relay

A double-pole (ordinary) relay and transistor can be connected to provide a toggle action.



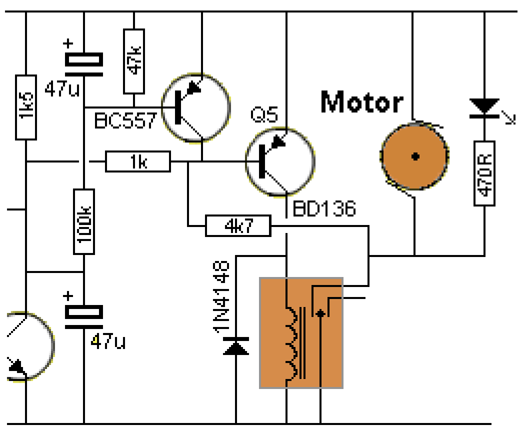
The circuit comes on with the relay de-activated and the contacts connected so that the 470u charges via the 3k3. Allow the 470u to charge. By pressing the button, the BC547 will activate the relay and the contacts will change so that the 3k3 is now keeping the transistor ON. The 470u will discharge via the 1k. After a few seconds the electro will be discharged. If the press-button is now pushed for a short period of time, the transistor will turn off due to the electro being discharged.

A single-coil latching relay normally needs a reverse-voltage to unlatch but the following circuit provides forward and reverse voltage by using 2 transistors in a very clever H-design.

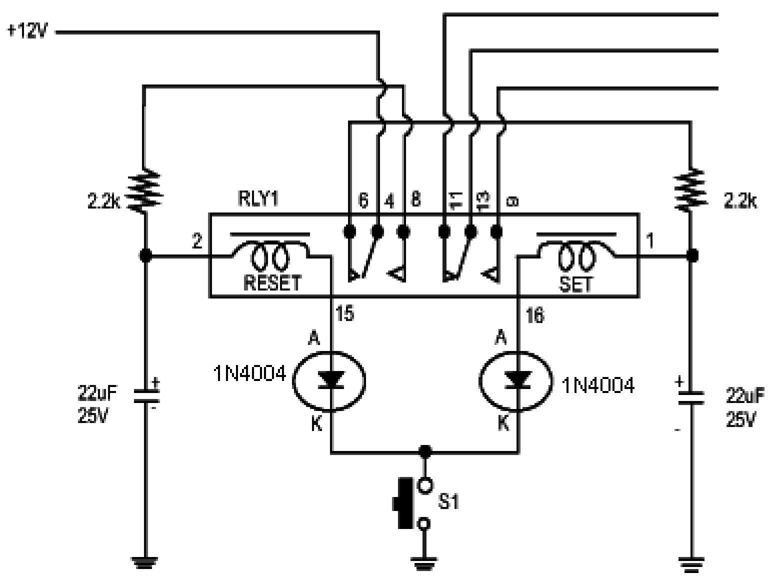


The pulse-ON and pulse-OFF can be provided from two lines of the microcontroller.

A normal relay can be activated by a short tone and de-activated by a long tone as shown via the circuit on the left. This circuit can be found in “27MHz Links” Page 2.



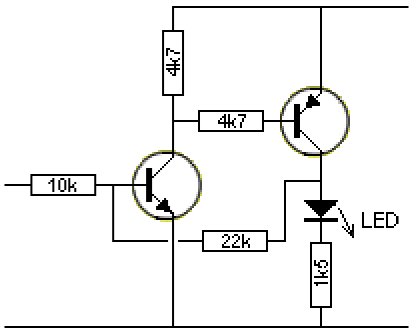
The following circuit will come ON in either SET or RESET state, depending on the state of the armature in the relay.

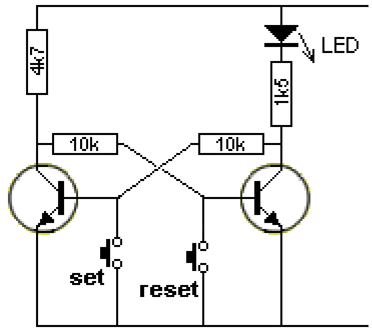


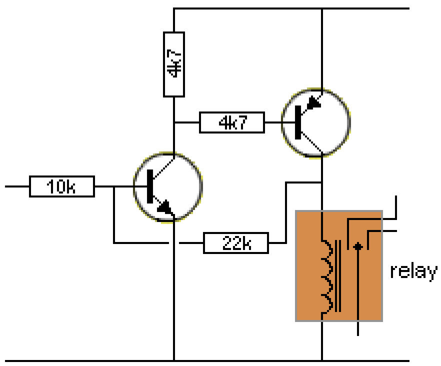
If it comes ON in RESET state, the 2k2 on the SET coil will charge the 22u electrolytic so that when the switch is pressed, the 22u will activate the SET coil and change the state of the relay. The opposite 22u will not get charged and when the switch is pressed after a few seconds, relay will change state.

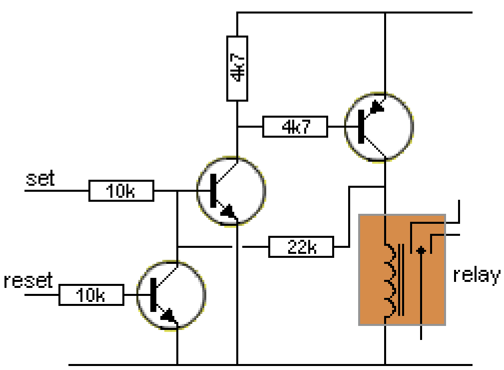
The relay is SY4060 from Jarcar Electronics.

LATCH - ELECTRONIC LATCH - LATCH A SIGNAL



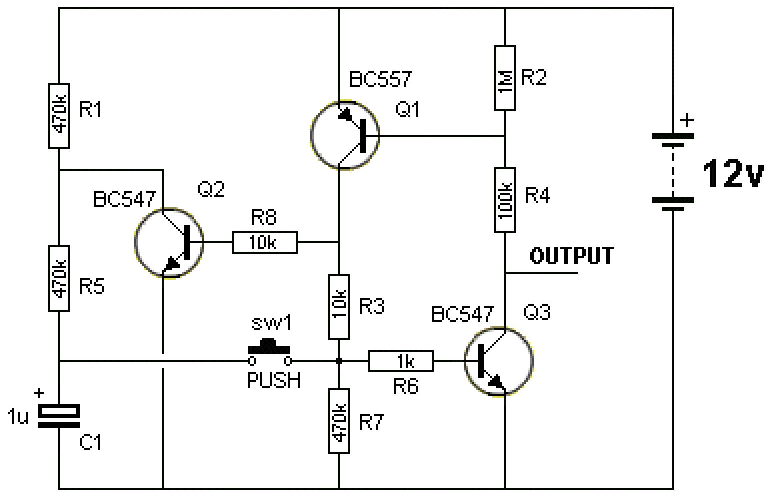






When the circuit sees a voltage about 1v or higher, the circuit latches ON and illuminates the LED or relay. The third circuit provides SET and RESET. The fourth circuit provides SET and RESET via a bi-stable arrangement.

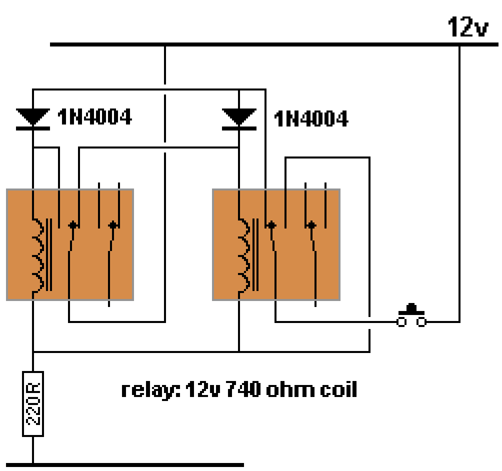
LATCHING A PUSH BUTTON - also called: PUSH-ON PUSH-OFF



When the circuit is turned on, capacitor C1 charges via the two 470k resistors. When the switch is pressed, the voltage on C1 is passed to Q3 to turn it on. This turns on Q1 and the voltage developed across R7 will keep Q1 turned on when the button is released.

Q2 is also turned on during this time and it discharges the capacitor. When the switch is pressed again, the capacitor is in a discharged state and this zero voltage will be passed to Q3 turn it off. This turns off Q1 and Q2 and the capacitor begins to charge again to repeat the cycle.

TOGGLE A PUSH BUTTON - using 2 relays



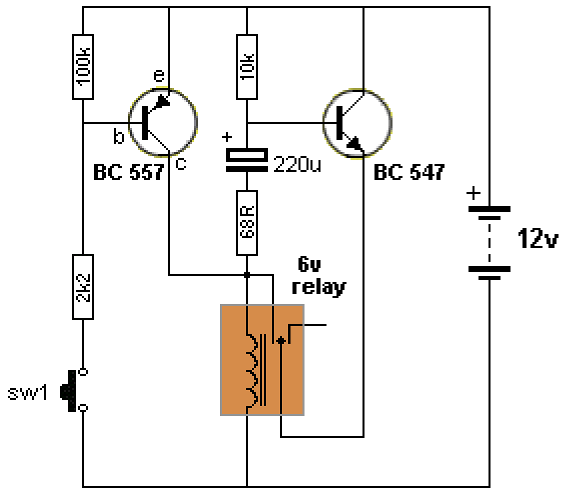
The circuit is shown with the second relay “active.”

Half of each relay is used for the toggle function and the other half can be connected to an application.

The first relay (which is off), applies voltage from its contacts and latches the second relay “on”. The condition changes when the switch is pressed. Voltage is applied to the first relay, latching it “on.” Releasing the switch turns the second relay “off”.

When the switch is pressed again, 12v is applied to both ends of the first relay and it turns off. The second relay turns “on” when the switch is released. There is slight lag in the action, depending on how long the switch is pressed.

TOGGLE A RELAY



This circuit will activate a relay when the switch is pressed and released quickly and turn the relay off when the switch is pressed for about 1 second then released.

The circuit relies on a few component values to operate correctly and they may need to be adjusted to get the circuit to operate exactly as required.

When the switch is pressed, The BC557 turns ON and supplies nearly rail voltage to the relay.

This closes the contacts and the BC547 is capable of delivering a current to the relay.

The transistor acts just like a resistor with a resistance equal to 1/250 the value of the base resistor. This is 40 ohms. If the relay has a coil resistance of 250 ohms, it will see a voltage of about 10v for a 12v supply.

When the switch is released, the BC547 keeps the relay energised.

During this activation, the 220u electrolytic helps in activating the relay.

Here's how: Initially the 220u is charged (quite slowly) via the 10k resistor 68 ohm resistor and the coil of the relay.

It is now fully charged and when the switch is pressed, the negative end of the electrolytic is raised via the collector of the BC557. The positive end rises too and this action raises the emitter and when the relay contacts close, the relay is delivered current fro both the BC557 and and BC547. When the sw is released, the BC547 takes over and the discharging of the 220u into the base, holds the relay closed.

As the 220u gradually discharges, the ability of the BC547 to deliver current reduces slightly and the 10k base resistor takes over and turns the transistor into a 40R resistor. Finally the 220u has a very small voltage across it.

When the switch is pressed again, the BC547 acts as a resistor with a resistance less than 40 ohms and it is able to deliver a voltage slightly higher than that provided by the BC547.

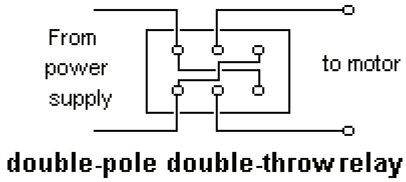
This slightly higher voltage is passed to the negative lead of the 220u and the positive lead actually rises about rail voltage and the electro gets discharged via the 10k resistor.

When the switch is released, the electro has less than 0.6v across it and the BC547 transistor is not able to deliver current to the relay. The relay is de-activated.

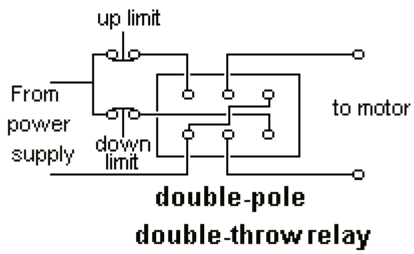
REVERSING A MOTOR - 1

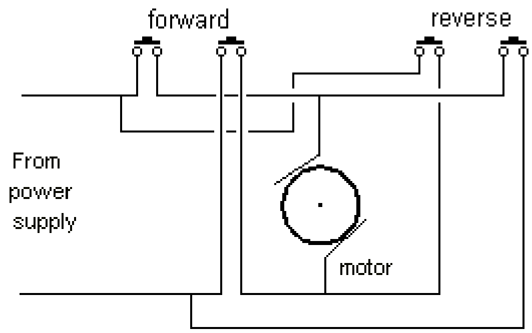
There are a number of ways to reverse a motor. The following diagrams show how to connect a double-pole double throw relay or switch and a set of 4 push buttons. The two buttons must be pushed at the same time or two double pole push-switches can be used.

See H-Bridge below for more ways to reverse a motor.



Adding limit switches:



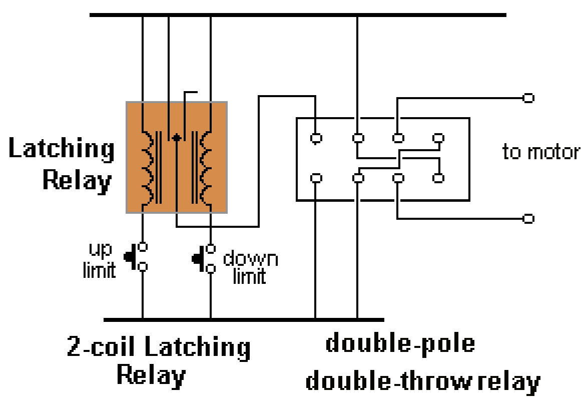


The way the dpdt relay circuit (above) works is this: The relay is powered by say 12v, via a MAIN SWITCH. When the relay is activated, the motor travels in the forward direction and hits the "up limit" switch. The motor stops. When the MAIN SWITCH is turned off, the relay is de-activated and reverses the motor until it reaches th e "down-limit" switch and stops. The MAIN SWITCH must be used to send the motor to the "up limit" switch.

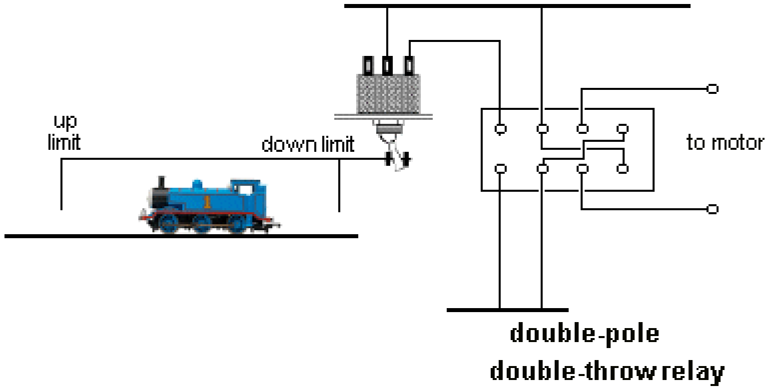
REVERSING A MOTOR-2

AUTOMATIC FORWARD-REVERSE

The following circuit allows a motor (such as a train) to travel in the forward direction until it hits the "up limit" switch. This sends a pulse to the latching relay to reverse the motor (and ends the short pulse). The train travels to the "down limit" switch and reverses.

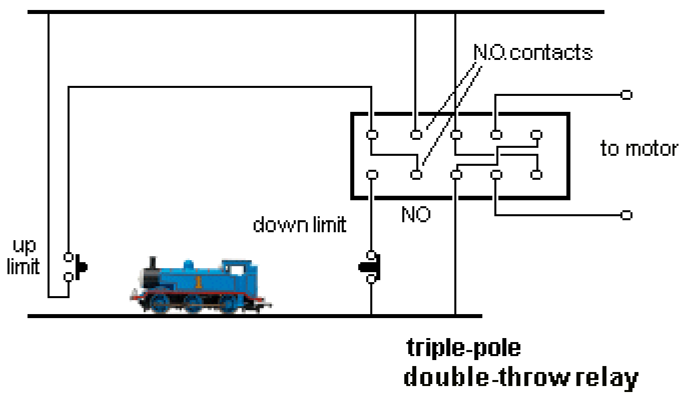


If the motor can be used to click a switch or move a slide switch, the following circuit can be used:



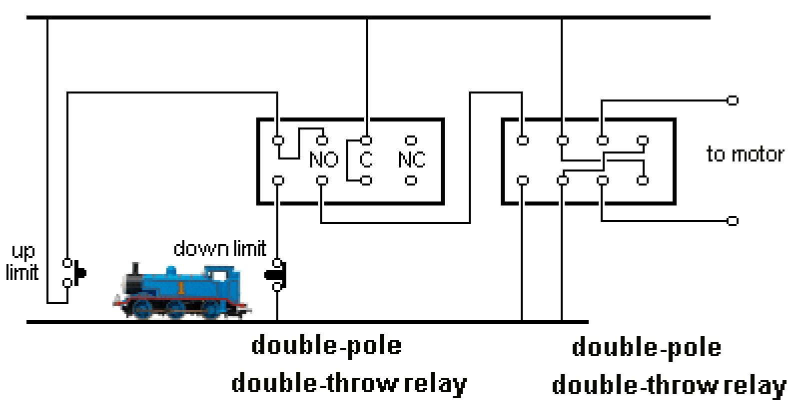
REVERSING A MOTOR-3

If the train cannot physically click the slide switch in both directions, via a linkage, the following circuit should be used:

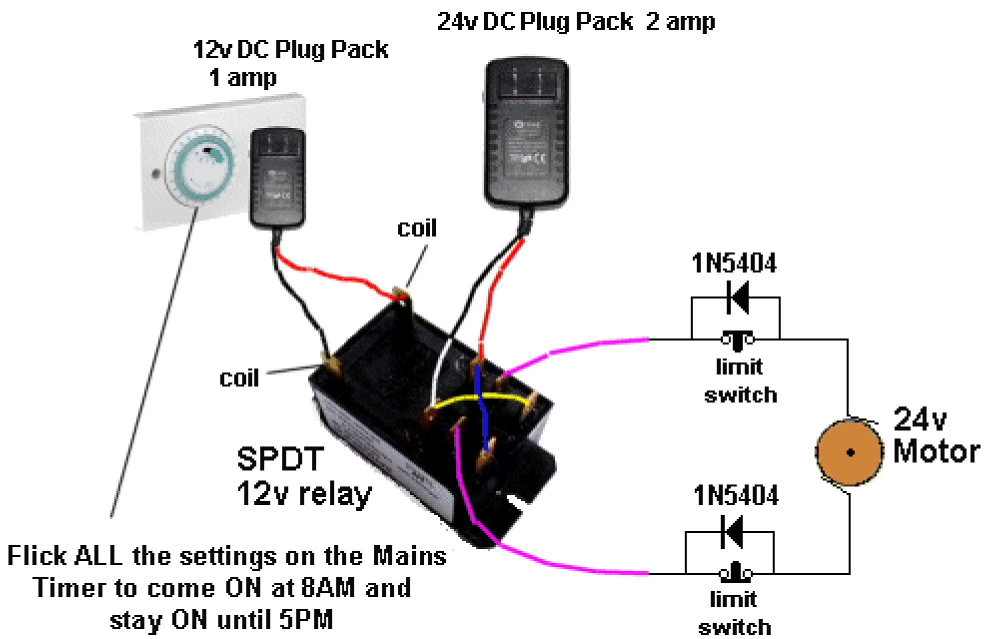


When power is applied, the relay is not energised and the train must travel towards the “up limit.” The switch is pressed and the relay is energised. The Normally Open contacts of the relay will close and this will keep the relay energised and reverse the train. When the down limit is pressed, the relay is de-energised.

If you cannot get a triple-pole change-over relay, use the following circuit:



AUTOMATIC BLINDS

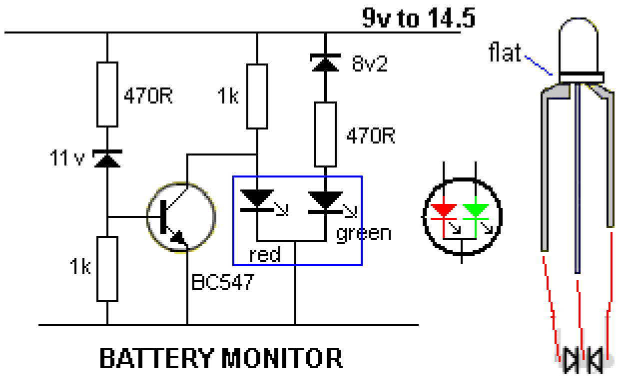


This circuit can be used for anything that needs to be automatically opened or closed via a MAINS TIMER.

Normally the Timer turns on a lamp. Our circuit uses a Wall Wart in the Mains Timer socket and the 12v “Plug Pack” activates a 12v relay.

The relay sends (say) positive out the top lead and when the top limit switch is opened by the motor reaching the end of its travel, it stops. The top 1N5404 prevents current passing to the motor. At 5PM the Mains timer turns the relay OFF and it sends negative out the top lead. The top 3 amp diode allows the motor to reverse and then the limit switch closes. When it reaches the lower limit switch, the switch opens and the lower diode prevents current flowing to the motor.

BATTERY MONITOR MkI

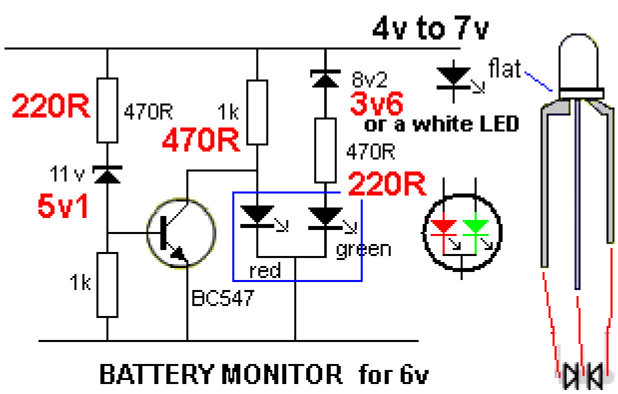


A very simple battery monitor can be made with a dual-colour LED and a few surrounding components. The LED produces orange when the red and green LEDs are illuminated.

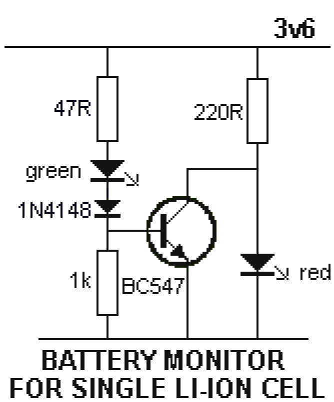
The following circuit turns on the red LED below 10.5v The orange LED illuminates between 10.5v and 11.6v.

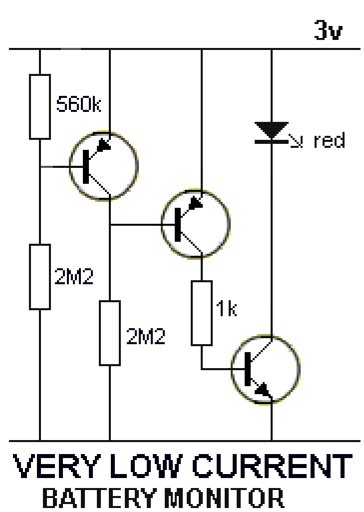
The green LED illuminates above 11.6v

BATTERY MONITOR for 6v



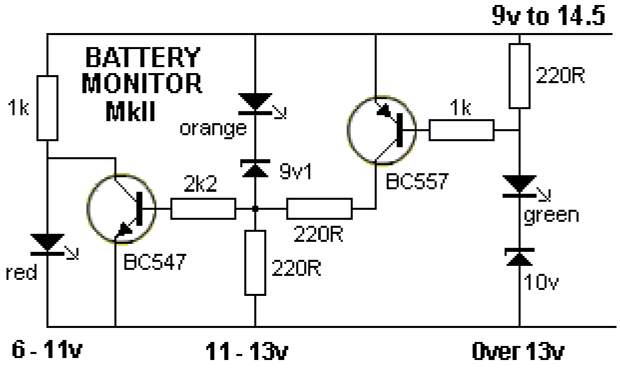
The following circuit monitors a single Li-ION cell. The green LED illuminates when the voltage is above 3.5v and the goes out when the voltage falls below 3.4v. The red LED then illuminates.





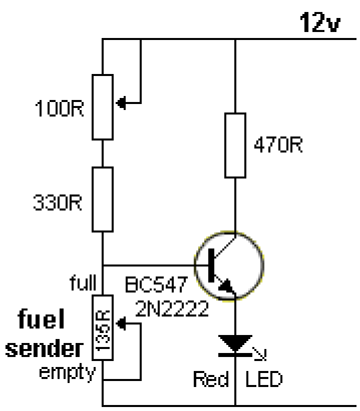
Adjust the 560k for the voltage at which the LED turns ON. No current-limiting resistor is needed as the transistor only allows a few milliamp collector curent.

BATTERY MONITOR MkII



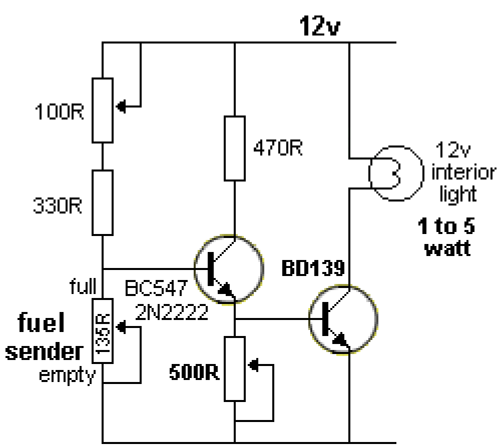
This battery monitor circuit uses 3 separate LEDs. The red LED turns on from 6v to below 11v. It turns off above 11v and The orange LED illuminates between 11v and 13v. It turns off above 13v; the green LED illuminates above 13v.

LOW FUEL INDICATOR

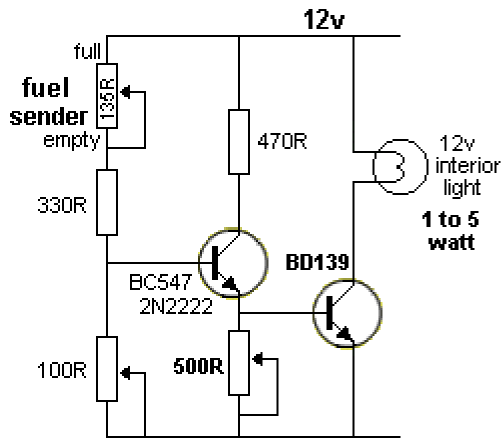


The first circuit has been designed from a request by a reader. He wanted a low fuel indicator for his motorbike. The LED illuminates when the fuel gauge is 90 ohms. The tank is empty at 135 ohms and full at zero ohms. To adapt the circuit for an 80 ohm fuel sender, simply reduce the 330R to 150R. (The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

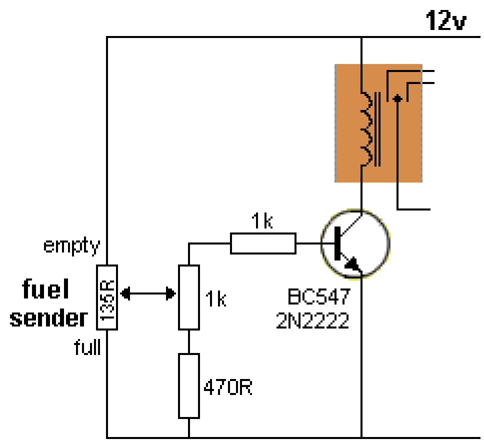
The second circuit uses a power transistor to drive a lamp.



HIGH FUEL INDICATOR

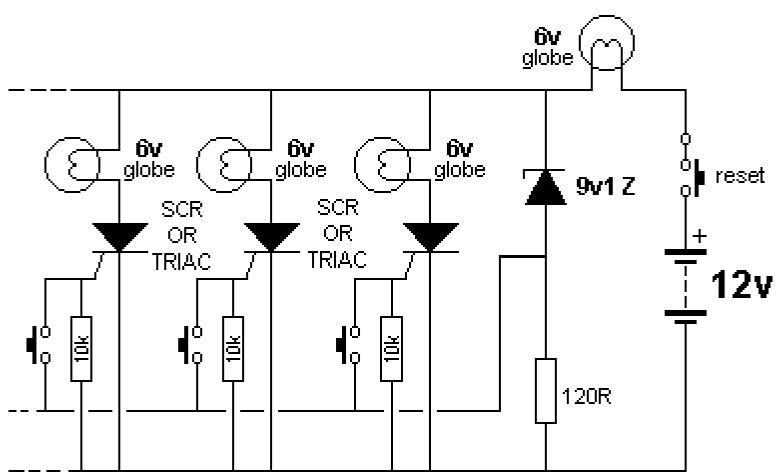


These circuits illuminates a lamp when the fuel has nearly filled the tank. It could also activate an alarm:



Relay DROPS OUT when the output voltage of the fuel sender is about 0.8v.

QUIZ TIMER

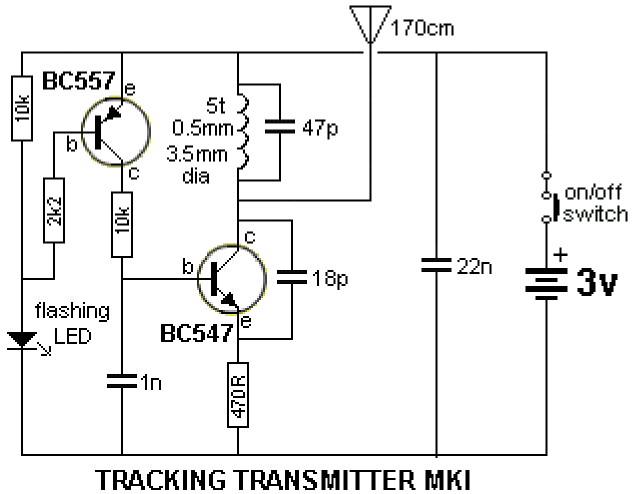


This circuit can be used to indicate: "fastest finger first." It has a globe for each contestant and one for the Quiz Master.

When a button is pressed the corresponding globe is illuminated.

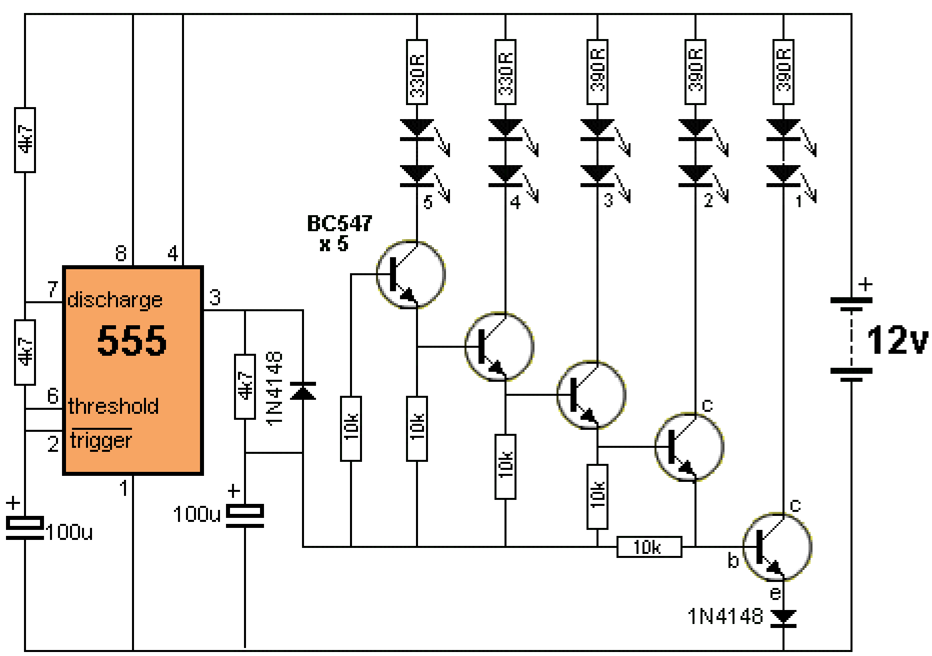
The Quiz Master globe is also illuminated and the cathode of the 9v1 zener sees approx mid-rail voltage. The zener comes out of conduction and no voltage appears across the 120R resistor. No other globes can be lit until the circuit is reset.

TRACKING TRANSMITTER



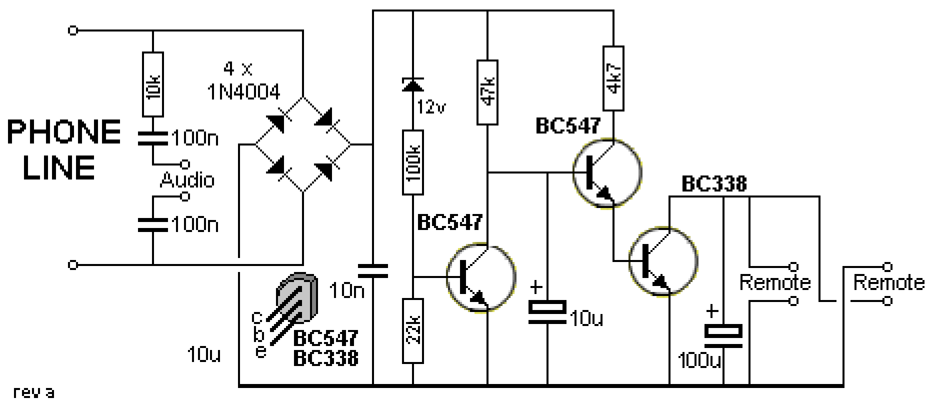
This circuit can be used to track lots of items. It has a range of 200 - 400 metres depending on the terrain and the flashing LED turns the circuit ON when it flashes. The circuit consumes 5mA when producing a carrier (silence) and less than 1mA when off (background snow is detected).

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.

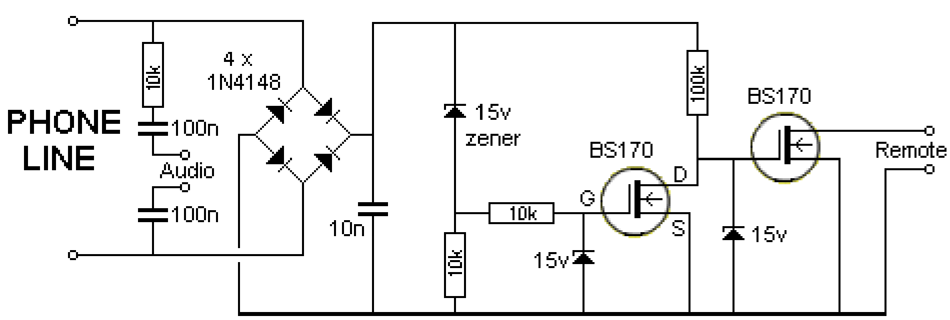
PHONE TAPE 3



This circuit can be used to turn on a tape recorder when the phone line voltage is less than 15v. This is the approximate voltage when the handset is picked up. See Phone Tape-1 and Phone Tape-2 in 200 Transistor Circuits eBook (circuits 1 - 100). When the line voltage is above 25v, the BC547 is turned on and this robs the base of the second BC547 of the 1.2v it needs to turn on.

When the line voltage drops, the first BC547 turns off and the 10u charges via the 47k and gradually the second BC547 is turned on. This action turns on the BC338 and the resistance between its collector-emitter leads reduces. Two leads are taken from the BC338 to the “rem” (remote) socket on a tape recorder. When the lead is plugged into a tape recorder, the motor will stop. If the motor does not stop, a second remote lead has been included with the wires connected the opposite way. This lead will work. The audio for the tape recorder is also shown on the diagram. This circuit has the advantage that it does not need a battery. It will work on a 30v phone line as well as a 50v phone line.

PHONE TAPE 4



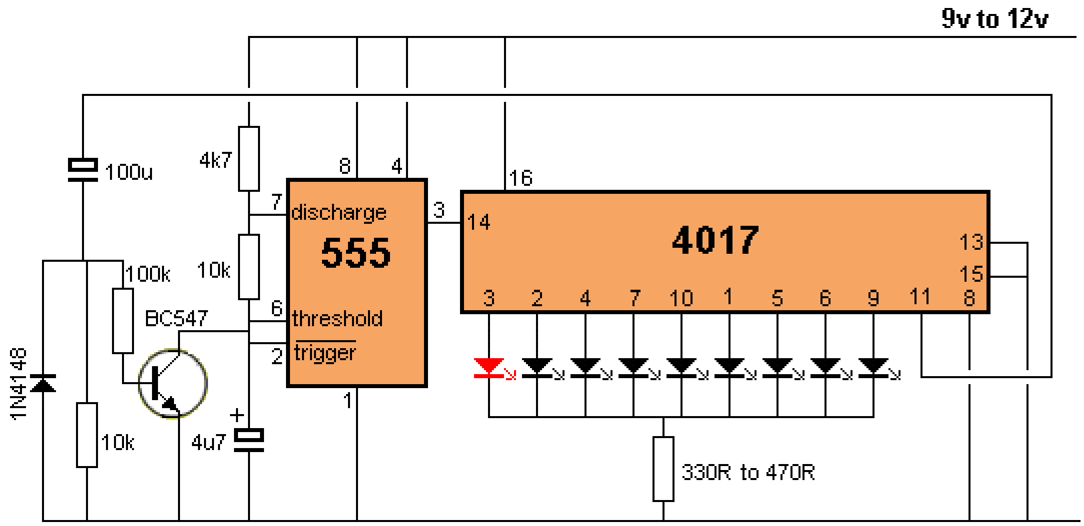
This circuit is identical in operation to the circuit above but uses FET’s (Field Effect Transistors. 15v zeners are used to prevent the gate of each FET from rising above 15v.

A FET has two advantages over a transistor in this type of circuit.

1. It takes very little current into the gate to turn it on. This means the gate resistor can be very high.
2. The voltage developed across the output of a FET is very low when the FET is turned on. This means the motor in the tape recorder will operate at full strength.

This circuit has not been tested and the 10k resistor (in series with the first 15v zener) creates a low impedance and the circuit may not work on some phone systems.

SEQUENCER

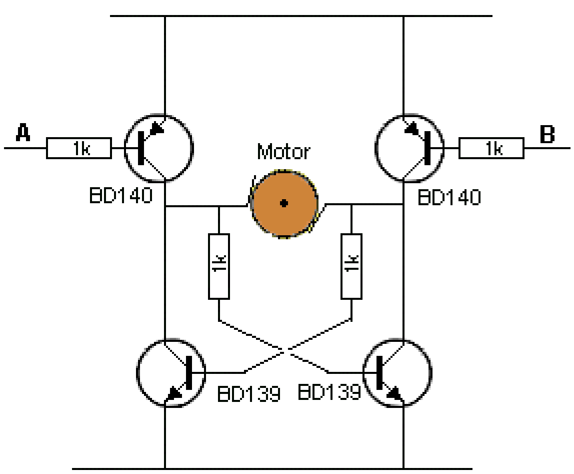


SEQUENCER WITH 3 SECOND INTERVAL

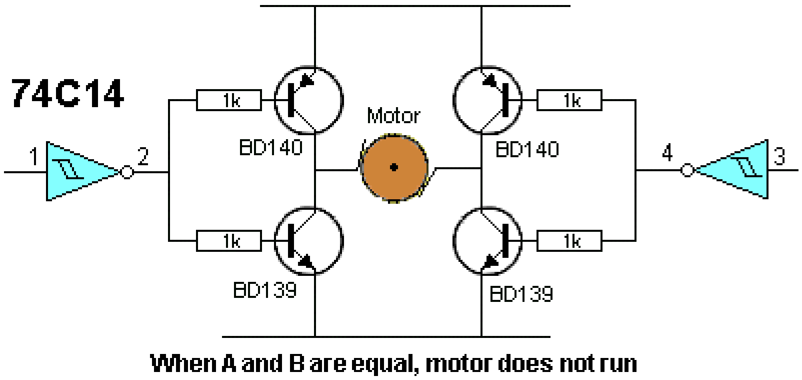
This circuit has been requested by a reader. He wanted to have a display on his jacket that ran 9 LEDs then stopped for 3 seconds. Note the delay produced by the 100u and 10k produces 3 seconds by the transistor inhibiting the 555 (taking pin 6 LOW). Learn more about the 555 - see the article: "The 555" on Talking Electronics website by clicking the title on the left index. See the article on CD 4017. See "Chip Data eBook" on TE website in the left index.

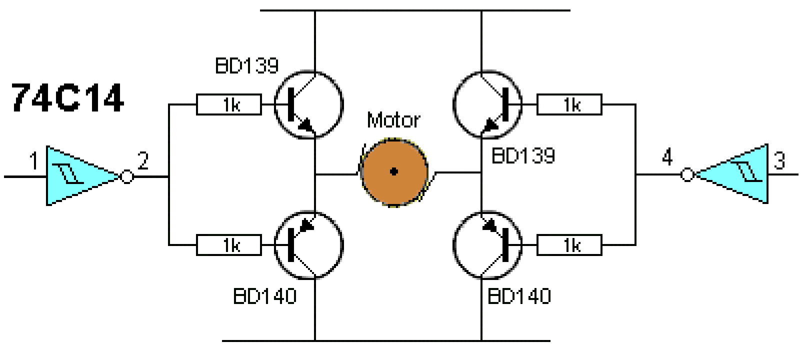
H-BRIDGE

These circuits reverse a motor via two input lines. Both inputs must not be LOW with the first H-bridge circuit. If both inputs go LOW at the same time, the transistors will "short-out" the supply. This means you need to control the timing of the inputs. In addition, the current capability of some H-bridges is limited by the transistor types.



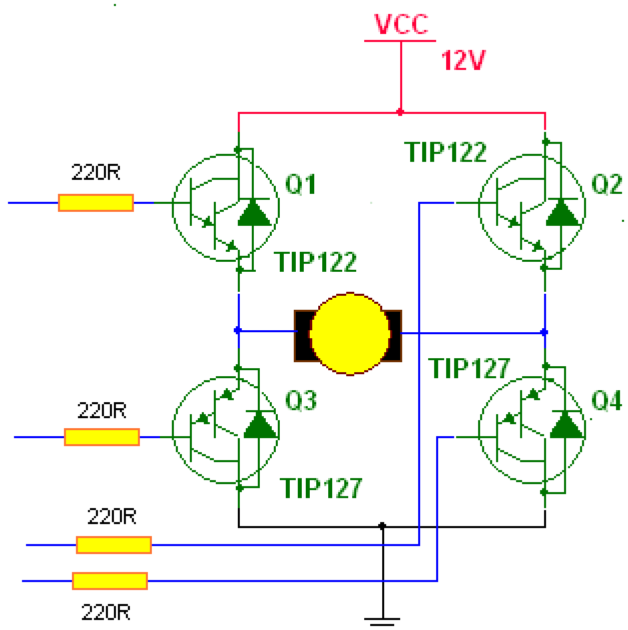
A and B must NEVER both be low



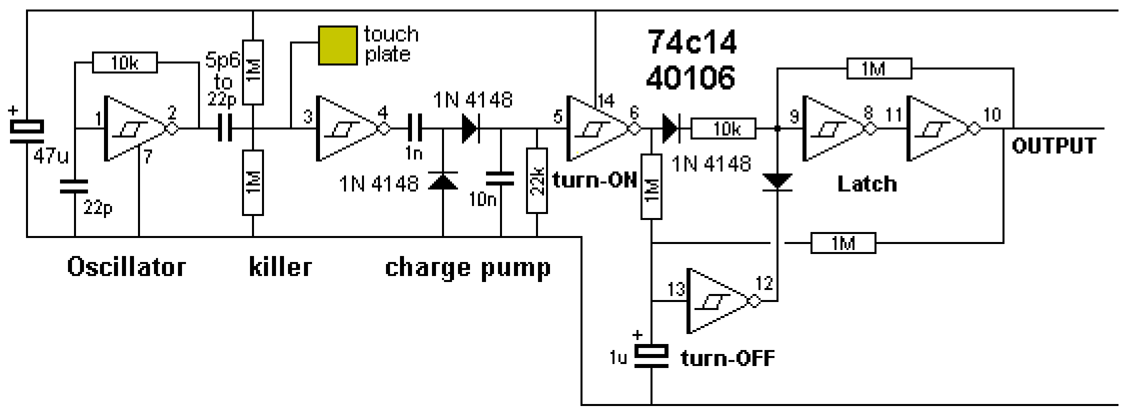


The driver transistors are in “emitter follower” mode in this circuit.

H-Bridge using Darlington transistors:

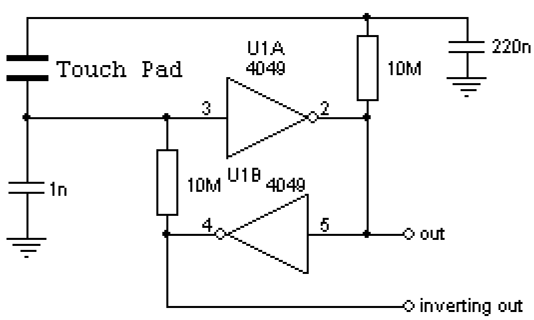


TOUCH-ON TOUCH-OFF SWITCH



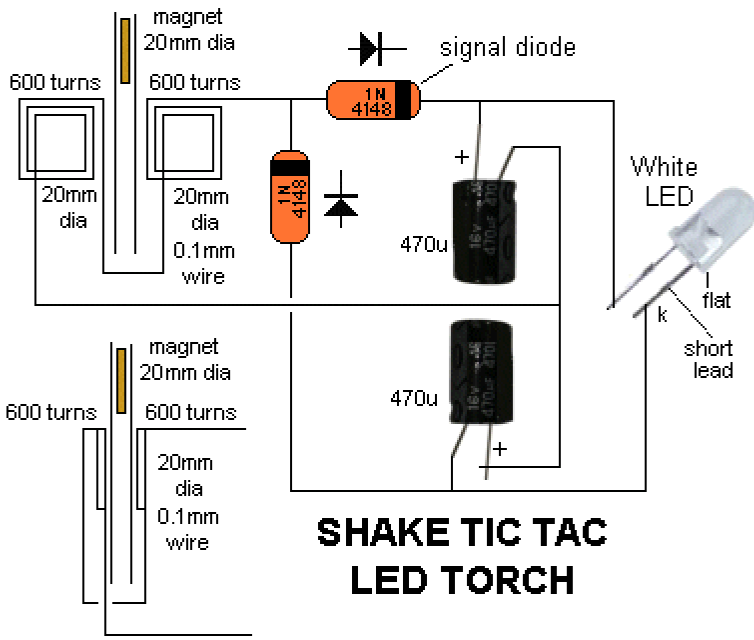
This circuit will create a HIGH on the output when the Touch Plate is touched briefly and produce a low when the plate is touched again for a slightly longer period of time. Most touch switches rely on 50Hz mains hum and do not work when the hum is not present. This circuit does not rely on "hum."

SIMPLE TOUCH-ON TOUCH-OFF SWITCH



This circuit will create a HIGH on the output when the Touch Plate is touched briefly and produce a low when the plate is touched again.

SHAKE TIC TAC LED TORCH



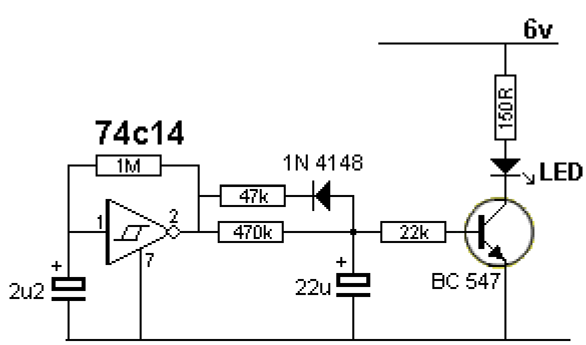
In the diagram, it looks like the coils sit on the "table" while the magnet has its edge on the table. This is just a diagram to show how the parts are connected. The coils actually sit flat against the slide (against the side of the magnet) as shown in the diagram: The output voltage depends on how 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.

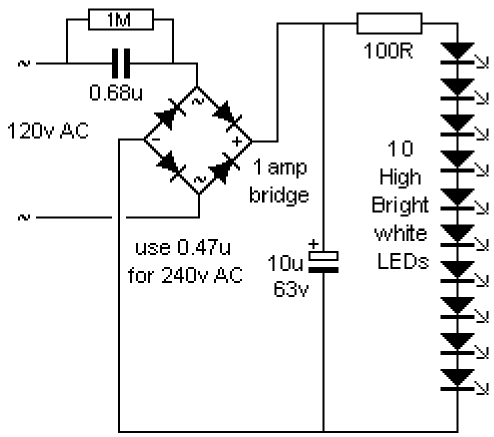
The voltage across each electrolytic is combined to produce a voltage for the white LED. When the combined voltage is greater than 3.2v, the LED illuminates. The electrolytics help to keep the LED illuminated while the magnet starts to make another pass.

FADING LED



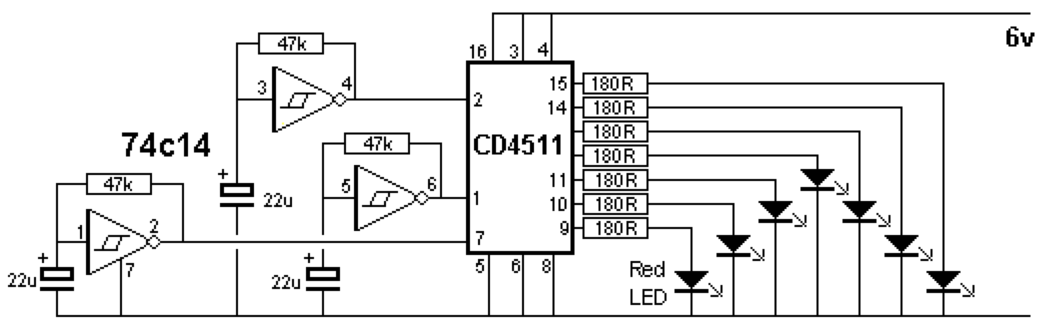
The circuit fades the LED ON and OFF at an equal rate. The 470k charging and 47k discharging resistors have been chosen to create equal on and off times.

MAINS NIGHT LIGHT



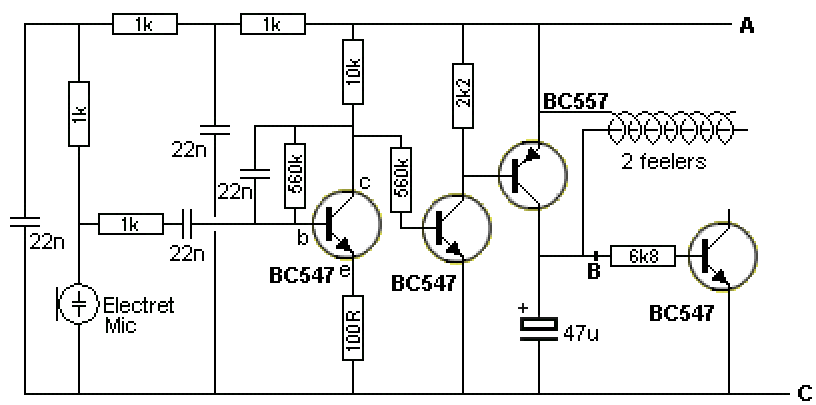
The circuit illuminates a column of 10 white LEDs. The 10u prevents flicker and the 100R also reduces flicker.

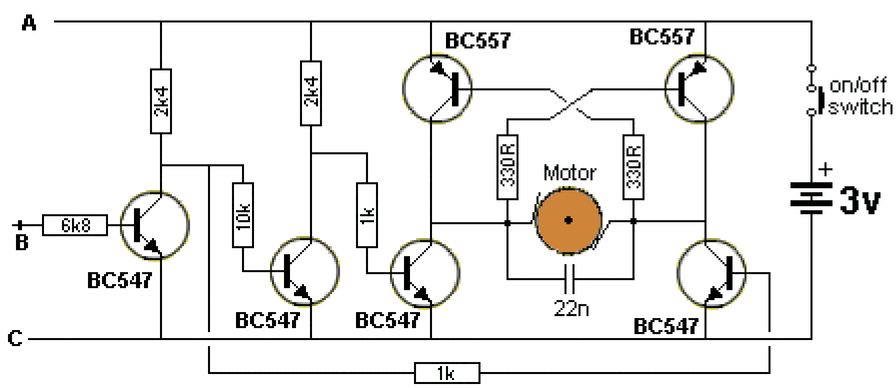
RANDOM BLINKING LEDS



This circuit blinks a set of LEDs in a random pattern according to the slight differences in the three Schmitt Trigger oscillators. The CD4511 is BCD to 7-segment Driver

HEX BUG





This is the circuit from a HEX BUG. It is a surface-mount bug with 6 legs. The pager motor is driven by an H-Bridge and "walks" to a wall where a feeler (consisting of a spring with a stiff wire down the middle) causes the motor to reverse.

In the forward direction, both sets of legs are driven by the compound gearbox but when the motor is reversed, the left legs do not operate as they are connected by a clutch consisting of a spring-loaded inclined plane that does not operate in reverse.

This causes the bug to turn around slightly.

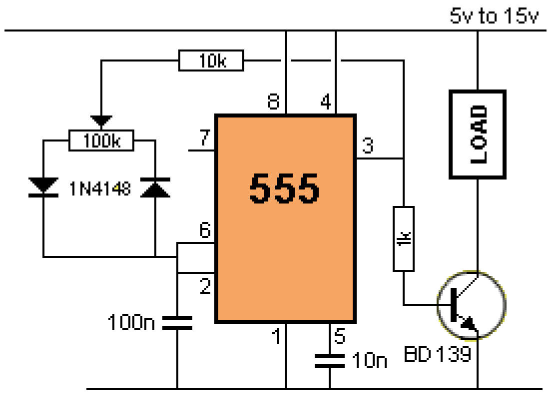
The circuit also responds to a loud clap. The photo shows the 9 transistors and accompanying components:

GEARBOX

Hex Bug gearbox consists of a compound gearbox with output "K" (eccentric pin) driving the legs. You will need to see the project to understand how the legs operate.

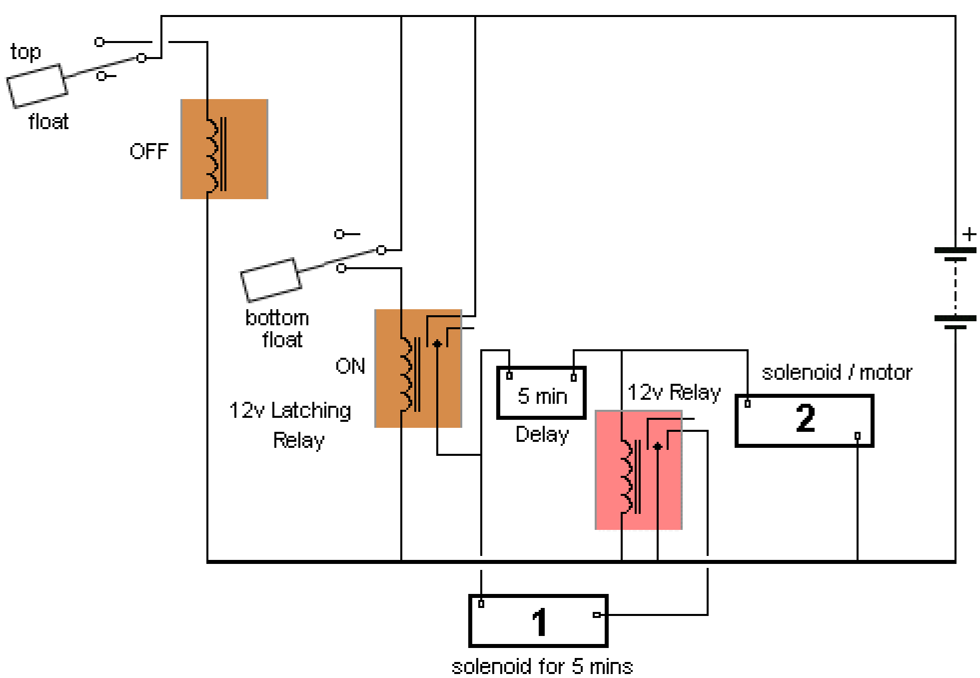
When the motor is reversed, the clutch "F" is a housing that is spring-loaded to "H" and drives "H via a square shaft"G". Gearwheel"C" is an idler and the centre of "F" is connected to "E" via the shaft. When "E" reverses, the centre of "F" consists of a driving inclined plane and pushes "F" towards "H" in a clicking motion. Thus only the right legs reverse and the bug makes a turn. When "E" is driven in the normal direction, the centre of "F" drives the outer casing "F" via an action called an "Inclined Dog Clutch" and "F" drives "G" via a square shaft and "G" drives "H" and "J" is an eccentric pin to drive the legs. The drawing of an Inclined Dog Clutch shows how the clutch drives in only one direction. In the reverse direction it rides up on the ramp and "clicks" once per revolution. The spring "G" in the photo keeps the two halves together. See Ladybug Robot in "100 IC Circuits" for an op-amp version of this project.

PWM CONTROLLER



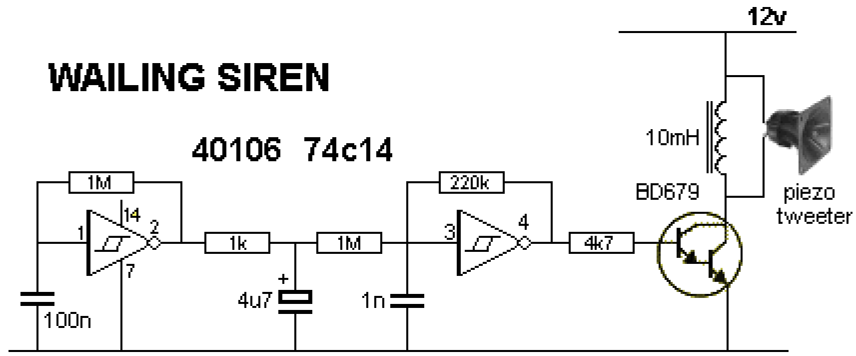
This 555 based PWM controller features almost 0% to 100% pulse width regulation using the 100k variable resistor, while keeping the oscillator frequency relatively stable. The frequency is dependent on the 100k pot and 100n to give a frequency range from about 170Hz to 200Hz.

LIMIT SWITCHES



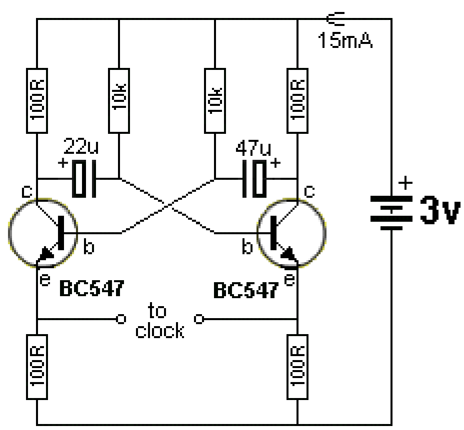
This circuit detects when the water level is low and activates solenoid (or pump) 1 for 5 minutes (adjustable) to allow dirty water to be diverted, before filling the tank via solenoid 2.

WAILING SIREN



This circuit produces a penetrating (deafening) up/down siren sound.

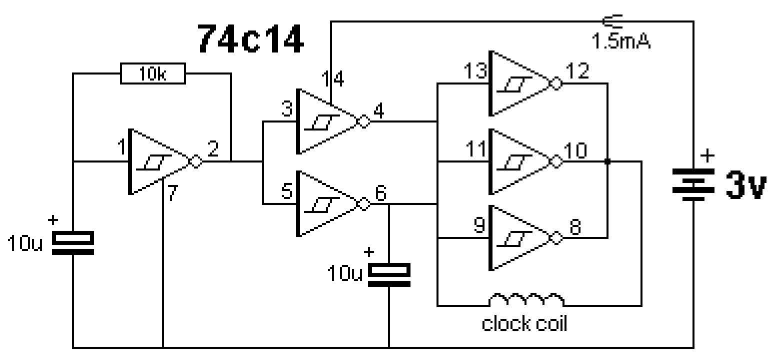
MODEL RAILWAY TIME



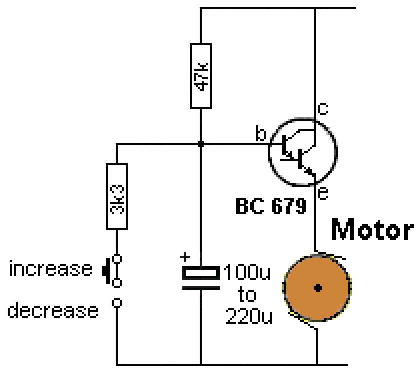
Here is a simpler circuit than MAKE TIME FLY! from our first book of 100 transistor circuits.

For those who enjoy model railways, the ultimate is to have a fast clock to match the scale of the layout. This circuit will appear to "make time fly" by revolving the seconds hand once every 6 seconds. The timing can be adjusted by the electrolytics in the circuit. The electronics in the clock is disconnected from the coil and the circuit drives the coil directly. The circuit takes a lot more current than the original clock (1,000 times more) but this is the only way to do the job without a sophisticated chip.

Model Railway Time Circuit Connecting the circuit to the clock coil For those who want the circuit to take less current, here is a version using a Hex Schmitt Trigger **74c14** chip:

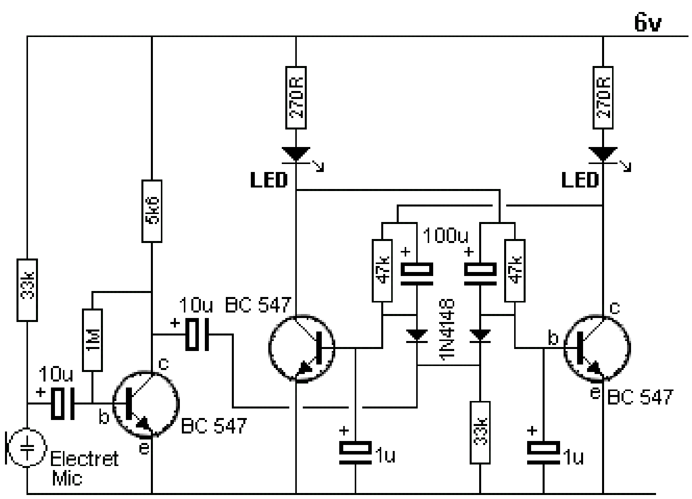


SLOW START-STOP



To make a motor start slowly and slow down slowly, this circuit can be used. The slide switch controls the action. The Darlington transistor will need a heatsink if the motor is loaded.

CLAP SWITCH



This circuit toggles the LEDs each time it detects a clap or tap or short whistle.

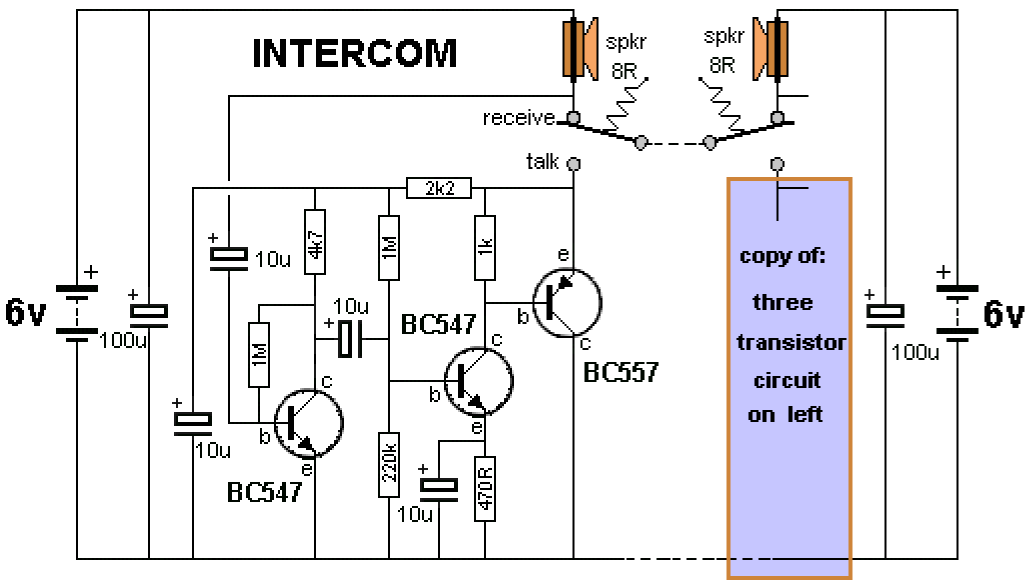
The second 10u is charged via the 5k6 and 33k and when a sound is detected, the negative excursion of the waveform takes the positive end of the 10u towards the 0v rail. The negative end of the 10u will actually go below 0v and this will pull the two 1N4148 diodes so the anode ends will have near to zero volts on them.

As the voltage drops, the transistor in the bi-stable circuit that is turned on, will have 0.6v on the base while the transistor that is turned off, will have zero volts on the base. As the anodes of the two signal diode are brought lower, the transistor that is turned on, will begin to turn off and the other transistor will begin to turn on via its 100u and 47k. As it begins to turn on, the transistor that was originally turned on will get less "turn-on" from its 100u and 47k and thus the two switch over very quickly. The collector of the third transistor can be taken to a buffer transistor to operate a relay or other device.

See a simple Clap Switch using a CD4017 IC in 100 IC Circuits

INTERCOM

Here is a 2-station intercom using common 8R mini speakers.



The “press-to-talk” switches should have a spring-return so the intercom can never be left ON. The secret to preventing instability (motor-boating) with a high gain circuit like this is to power the speaker from a separate power supply! You can connect an extra station (or two extra stations) to this design.

Request from Kim Edwards:

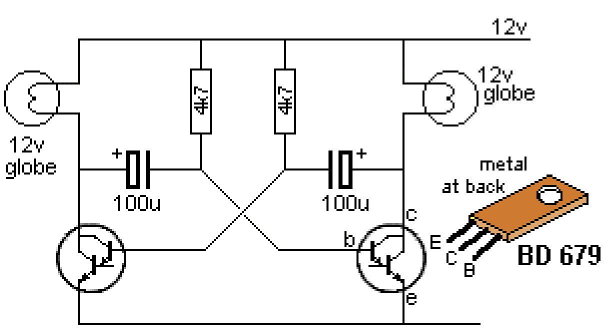
> Please analyse this circuit for me. The circuit is not normal as it must consume no current when sitting around and either end must be able to call the other end.

Start with the first transistor. It is self-biased with about half rail voltage on the collector. The second transistor is self-biased with about 1v on the base (via the 220k and 1M). 0.4v across 470R makes about 1v across the 1k resistor. The emitter of the BC557 will be about 0.4v lower than supply-rail.

This will produce about 1v p-p output via the speaker.

Increasing the 220k to 470k will increase the volume. The 10u to the speaker allows AC signal to enter the amplifier and the 10u on the supply-rail keeps the voltage from fluctuating too much as the supply is coming via the speaker. The 100u improves the current from the battery when the battery is weak.

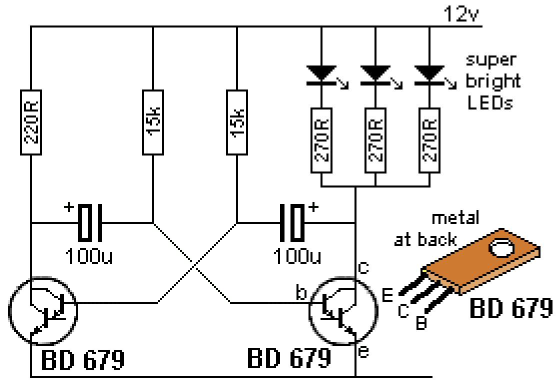
WARNING BEACON



Here is a 12v Warning Beacon suitable for a car or truck break- down on the side of the road. The key to the operation of the circuit is the high gain of the Darlington transistors. The circuit must be kept “tight” (thick wires) to be sure it will oscillate.

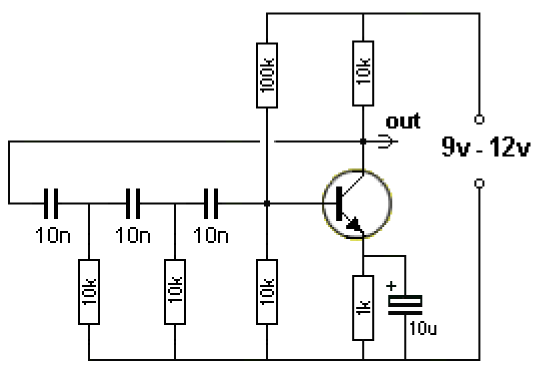
A complete kits of parts and PC board costs $5.00 plus postage from Talking Electronics. Email HERE for details.

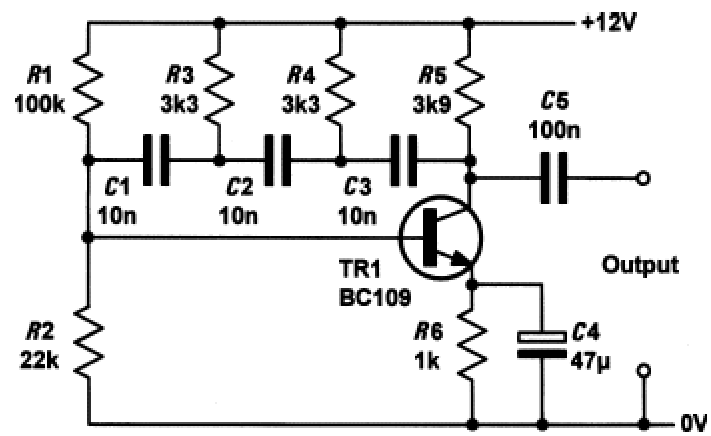
Here is the modification for 3-5 super-bright LEDs:



Click HERE for LED Turning Indicator project.

PHASE-SHIFT OSCILLATOR also called SINEWAVE OSCILLATOR





These circuits produces a sinewave very nearly equal to rail voltage.

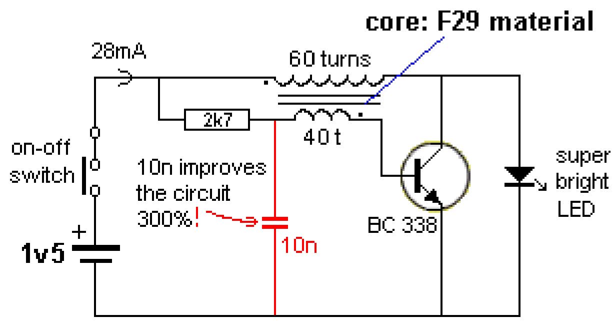
The important feature is the need for the emitter resistor and 10u /47u bypass electrolytic. It is a most-important feature of the circuit. It provides reliable start-up and guaranteed operation. For 6v operation, the 100k is reduced to 47k. The three 10n capacitors and two 10k resistors (actually 3) determine the frequency of operation (700Hz).

The 100k and 10k base-bias resistors can be replaced with 2M2 between base and collector.

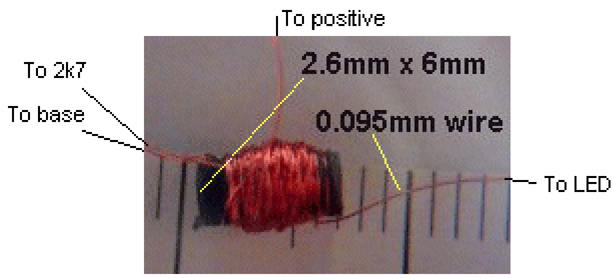
This type of circuit can be designed to operate from about 10Hz to about 200kHz.

Both these circuits are NOT VERY RELIABLE. They work with some transistors better than others. They stop working when you touch some of the parts. The frequency changes when you add a 100u across the power rails. They are too fiddly to be recommended. Place a piezo diaphragm across the collector load and experiment yourself. Try changing the 1k and try 6v to 12v to see what I mean.

BLOCKING OSCILLATOR also called FLYBACK OSCILLATOR



LED TORCH CIRCUIT

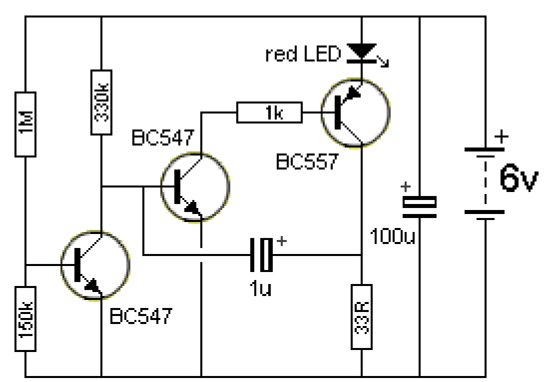


Transformer Details

The circuit produces high voltage pulses (spikes) of about 40v p-p (when the LED is not connected), at a frequency of 200kHz. The super-bright LED on the output absorbs the pulses and uses the energy to produce illumination. The voltage across the LED will be about 3.6v The winding to the base is connected so that it turns the transistor ON harder until it is saturated. At this point the flux cannot increase any more and the transistor starts to turn off. The collapsing magnetic field in the transformer produces a very high voltage and that's why we say the transformer operates in FLYBACK mode.

This type of circuit will operate from 10kHz to a few MHz.

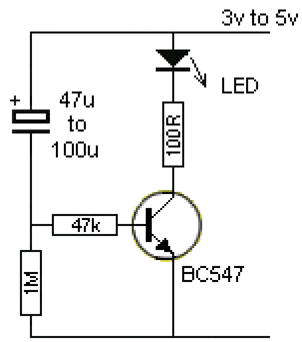
LOW VOLTAGE FLASHER



This circuit flashes when the voltage drops to 4v.

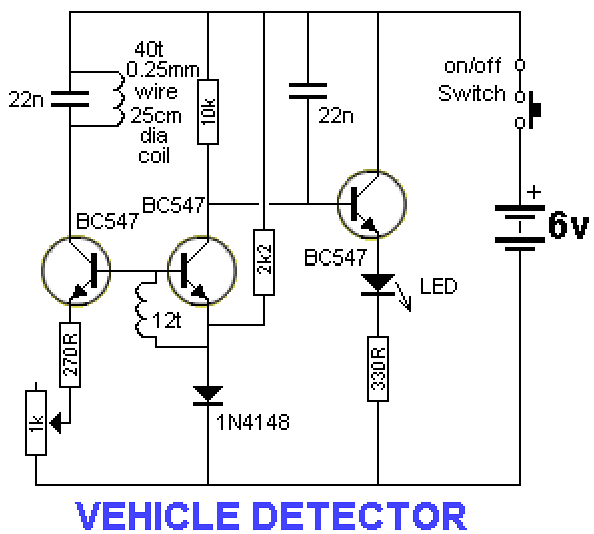
The voltage "set-point" can be adjusted by changing the 150k on the base of the first transistor.

POWER ON



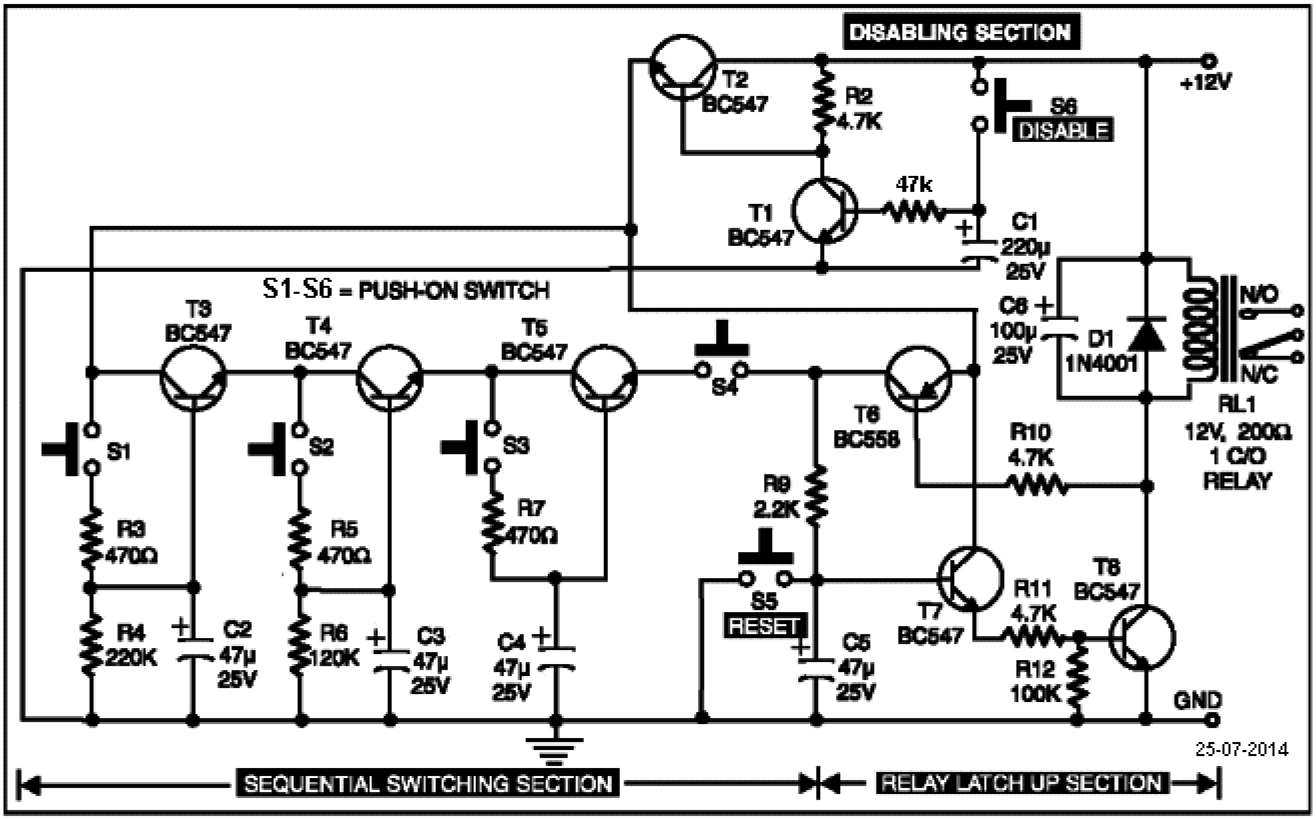
This LED illuminates for a few seconds when the power is turned on. The circuit relies on the 47u discharging into the rest of the circuit so that it is uncharged when the circuit is turned on again.

CAR LOOP DETECTOR



A 25cm dia coil (consisting of 40 turns and 12 turns) is placed in the centre of a driveway (between two sheets of plastic). When a vehicle is driven over the coil, it responds by the waveform collapsing. This occurs because the tank circuit made up of the 40 turns is receiving just enough feedback signal from the 12 turns to keep it oscillating. When metal is placed near the coil, it absorbs some of the electromagnetic waves and the amplitude decreases. This reduces the amplitude in the 12 turns and the oscillations collapses. The second transistor turns off and the 10k pulls the base of the third transistor (an emitter-follower) to the 6v rail and turns on the LED.

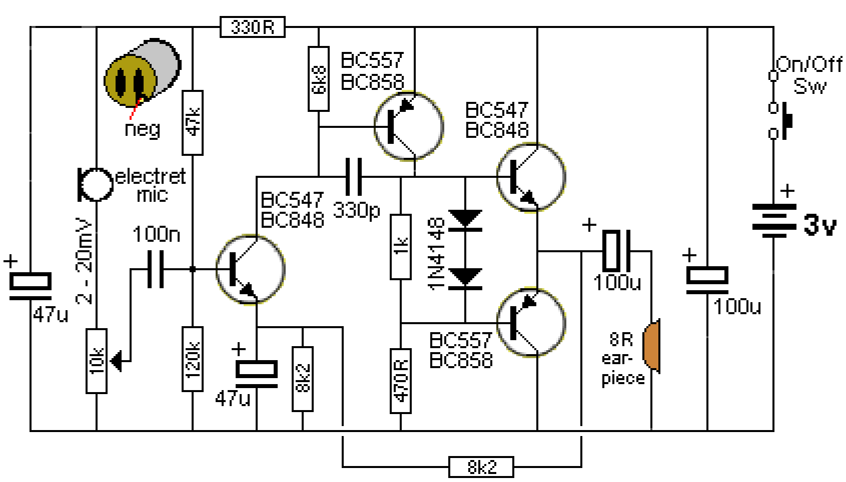
ALARM USING 4-BUTTONS



To open the lock, buttons S1, S2, S3, and S4 must be pressed in this order. They must be pressed for more than 0.7 seconds and less than 1.3 seconds.

Reset button S5 and disable button S6 are also included with the other buttons and if the disable button is pressed, the circuit will not accept any code for 60 seconds. Each of the 3v3 zeners can be replaced with two red LEDs and this will show how you are progressing through the code. Make sure the LEDs are not visible to other users.

AUDIO AMPLIFIER (mini)



This project is called “mini” because its size is small and the output is small.

It uses surface mount technology.

HOW THE CIRCUIT WORKS

The output is push-pull and consumes less than 3mA (with no signal) but drives the earpiece to a very loud level when audio is detected.

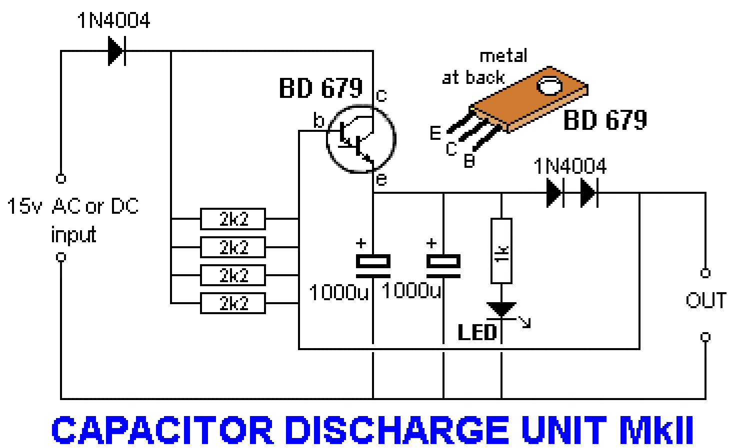
The whole circuit is DC coupled and this makes it extremely difficult to set up.

Basically you don't know where to start with the biasing. The two most critical components are 8k2 between the emitter of the first transistor and 0v rail and the 470R resistor.

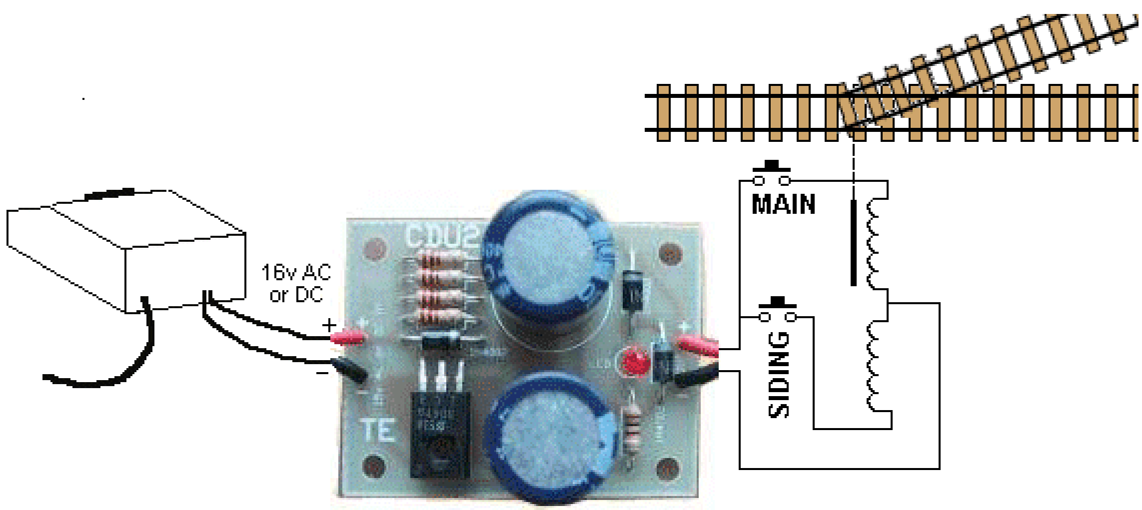
The 8k2 across the 47u sets the emitter voltage on the BC 547 and this turns it on. The collector is directly connected to the base of a BC 557, called the driver transistor. Both these transistors are now turned on and the output of the BC 557 causes current to flow through the 1k and 470R resistors so that the voltage developed across each resistor turns on the two output transistors. The end result is mid-rail voltage on the join of the two emitters.

The 8k2 feedback resistor provides major negative feedback while the 330p prevents high-frequency oscillations occurring.

CAPACITOR DISCHARGE UNIT MkII (CDU2)



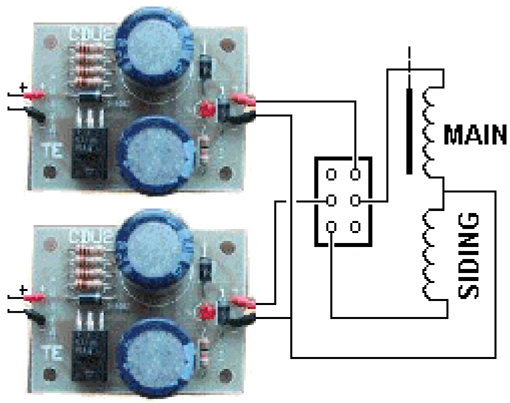
This project is available as a kit for $10.80 plus $6.50 post; email Talking Electronics for details.



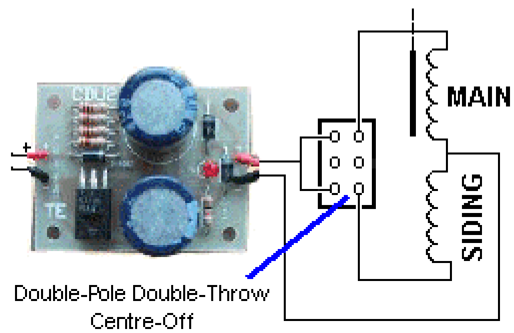
This circuit will operate a two-solenoid point-motor and prevent it overheating and causing any damage. The circuit produces energy to change the points and ceases to provide any more current. This is carried out by the switching arrangement within the circuit, by sampling the output voltage.

If you want to control the points with a DPDT toggle switch or slide switch, you will need two CDU2 units.

HOW THE CIRCUIT WORKS

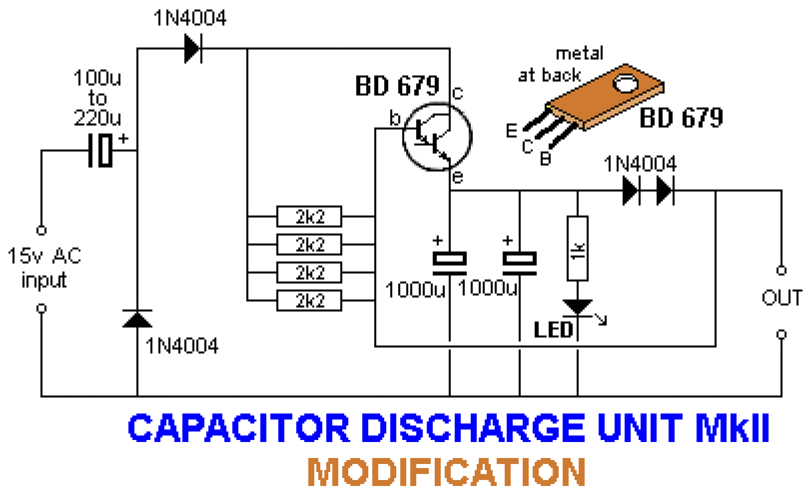


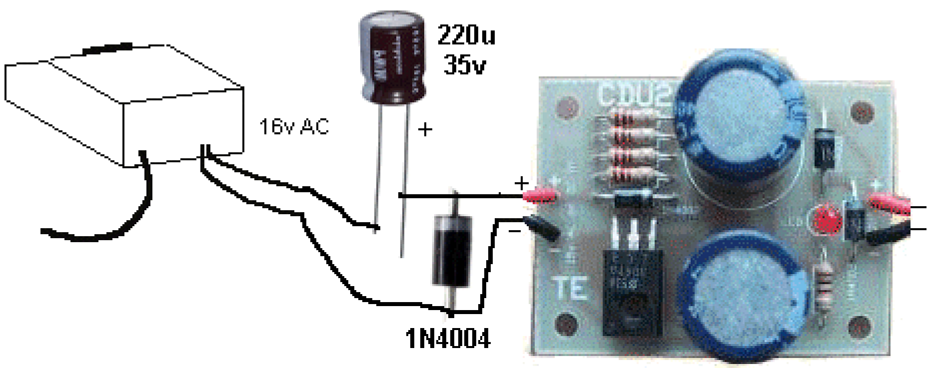
The circuit is supplied by 16v AC or DC and the diode on the input is used to rectify the voltage if AC is supplied. If nothing is connected to the output, the base of the BD679 is pulled high and the emitter follows. This is called an emitter-follower stage. The two 1,000u electrolytics charge and the indicator LED turns on. The circuit is now ready.



When the Main or Siding switch is pressed, the energy from the electrolytics is passed to the point motor and the points change. As the output voltage drops, the emitter-follower transistor is turned off and when the switch is released, the electrolytics start to charge again. The point-motor can be operated via a Double-Pole Double-Throw Centre-Off toggle switch, providing the switch is returned to the centre position after a few seconds so that the CDU unit can charge-up.

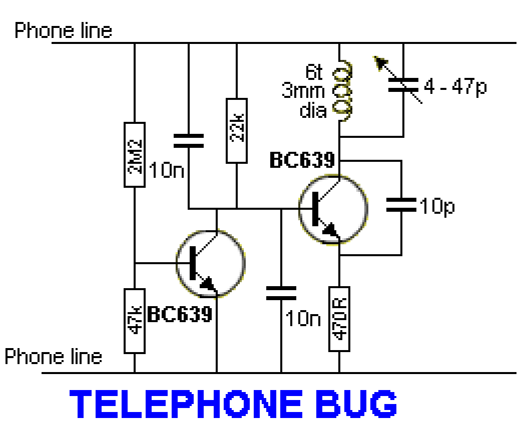
CAPACITOR DISCHARGE UNIT MkII (CDU2) - modification



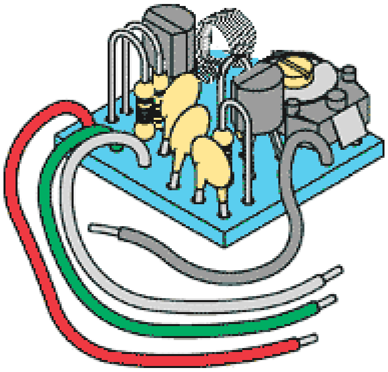


If your ransformer does not supply 15vAC to 16vAC, you can increase the input voltage by adding a 100u to 220u electrolytic and 1N4004 diode to the input to create a voltage doubling arrangement. You can also change one or both the 1,000u electrolytics for 2,200u. This will deliver a much larger pulse to the point-motor and guarantee operation.

PHONE BUG

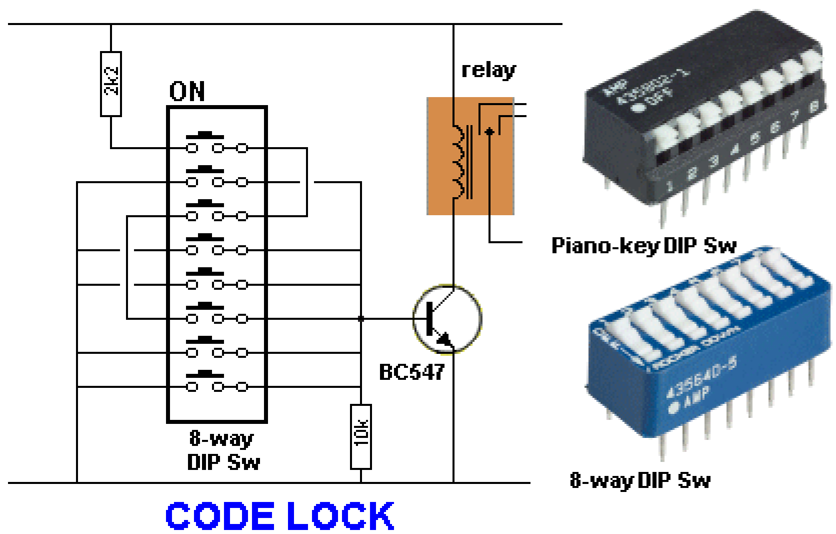


see also [PHONE TRANSMITTER A] and [PHONE TRANSMITTER B] projects from the first part.



This circuit connects to a normal phone line and when the voltage drops to less than 15v, the first transistor is turned off and enables the second transistor to oscillate at approx 100MHz and transmit the phone conversation to a nearby FM radio. The transistors must be 65v devices. Do not use BC547.

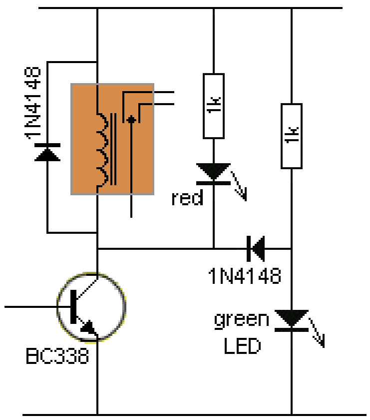
CODE LOCK



This circuit turns on a relay when the correct code is entered on the 8-way DIP switches. Two different types of DIP switches are shown. Keep the top switch off and no current will be drawn by the circuit.

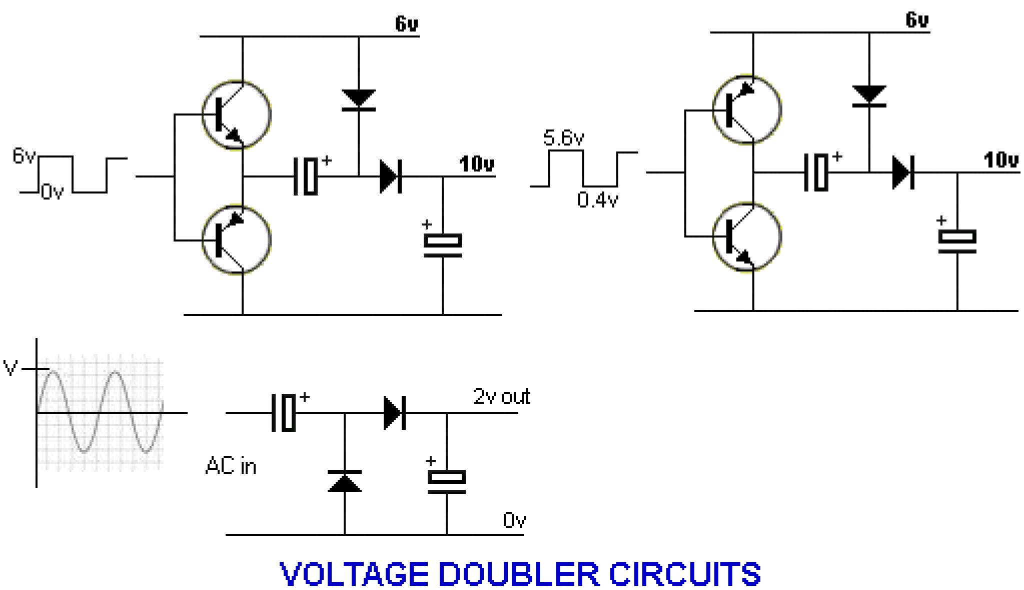
There are 256 different combinations and because the combination is in binary, it would be very difficult for a burglar to keep up with the settings of the switches.

LEDS SHOW RELAY STATE



The green LED indicates the relay is not energised and the red LED shows the relay is energised.

VOLTAGE MULTIPLIERS

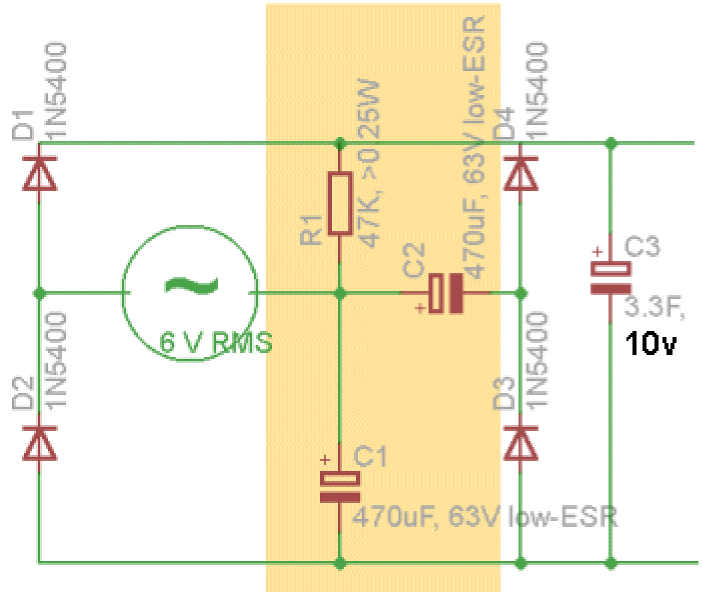


The first circuit takes a square wave (any amplitude) and doubles it - minus about 2v losses in the diodes and base-emitter of the transistors.

The second circuit must rise to at least 5.6v and fall to nearly 0.4v for the circuit to work. Also the rise and fall times must be very fast to prevent both transistors coming on at the same time and short-circuiting.

The third circuit doubles an AC voltage. The AC voltage rises “V” volts above the 0v rail and “V” volts below the 0v rail.

VOLTAGE DOUBLER



This is a voltage doubler circuit from a bicycle dynamo design found on the web. The dynamo produces 6v AC and charges a 3.3FARAD super cap via 2 diodes and an electrolytic. As you will see, C2, D3 and D4 are not needed and can be removed.

This is how the circuit works. The voltage at the mid point of diodes D1 and D2 can fall to -0.6v and rise to rail voltage plus 0.6v without any current being supplied from the dynamo. When the voltage rises more than 0.6v above rail voltage, the dynamo needs to deliver current and this will allow the rail voltage to increase. We start with the dynamo producing negative from the left side and positive on the right side.

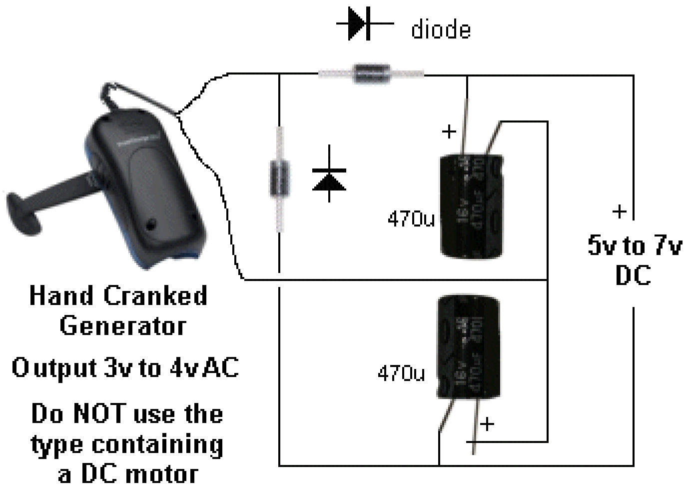
The left side will fall to -0.6v below the 0v rail and the right side will charge C1 and C2 will simply rise in exactly the same manner as we described the left side of the dynamo being able to rise.

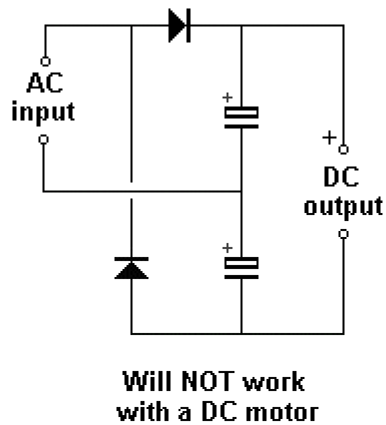
Suppose C1 charges to about 7v (which it will be able to do after a few cycles). The voltage from the dynamo now reverses and the left side is positive and the right side is negative. The right side is already sitting at a potential of 7v (via C1) and as the left side increases, it raises the rail voltage higher by an amount that could be as high as 7v minus 0.6v.

The actual rail voltage will not be as high as this as the 3.3 Farad capacitor will be charging, but if energy is not taken from the circuit it will rise to nearly 14v or even higher according to the peak voltage delivered by the dynamo. When the dynamo is delivering energy to the positive rail, it is “pushing down” on the C1 and some of its stored energy is also delivered. This means it will have a lower voltage across it when the next cycle comes around. C2, D3 and D4 are not needed and can be removed. In fact, C1 will always have rail voltage on it due to the 47 resistor, so the voltage doubling will start as soon as the dynamo operates.

DYNAMO VOLTAGE DOUBLER

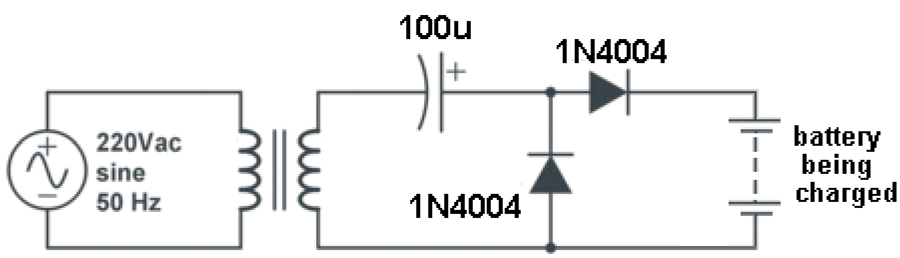
Here is a simple circuit to increase the voltage from a BICYCLE DYNAMO (or HAND CRANKED GENERATOR that has a spinning magnet - NOT a DC motor) and change the AC voltage it produces, to DC, and charge a small battery:





BATTERY-CHARGER DOUBLER

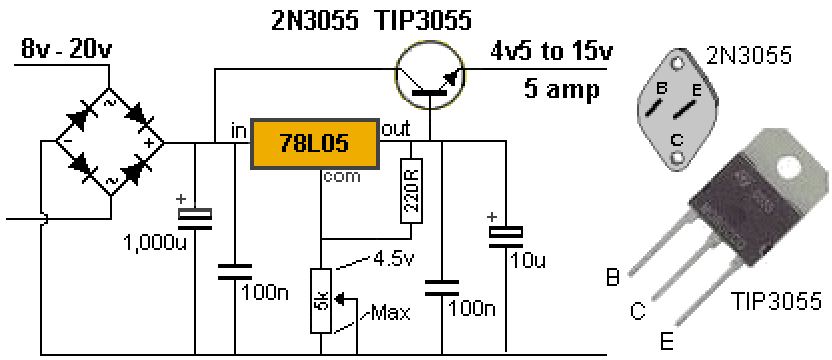
This circuit will charge a battery from an AC source where the AC voltage is too low to charge the battery.

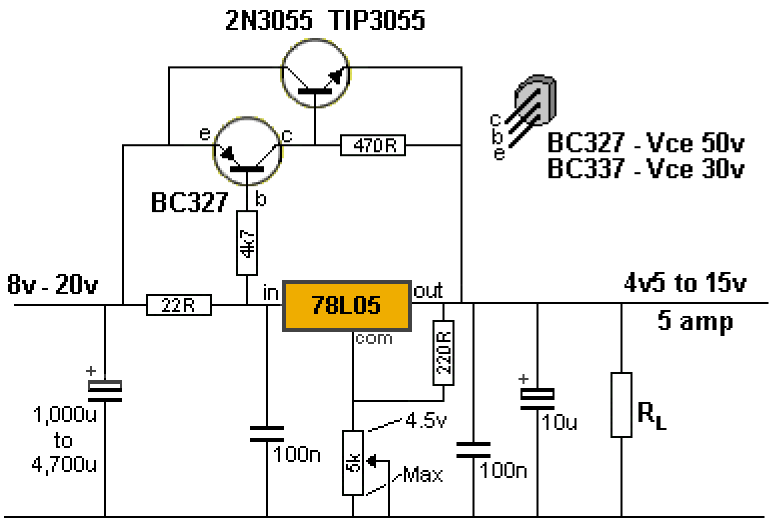


This circuit increases the voltage and rectifies it to produce pulsing DC. The 100u electrolytic limits the current and can be increased to 1,000u to provide a higher current.

Even though the voltage will be increased to about twice the previous voltage, this will not affect the battery as the important quantity is CURRENT and TIME. You need to monitor the battery and determine when it is fully charged.

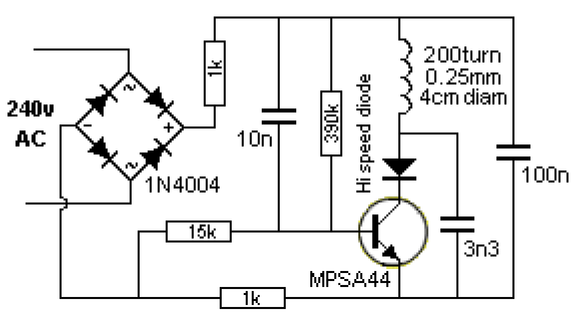
ADJUSTABLE HIGH CURRENT REGULATED POWER SUPPLY

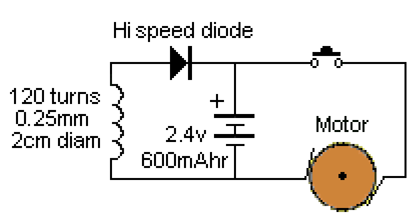




There are two ways to add a 2N3055 (TIP3055) as the pass transistor for a high current power supply. This is handy as most hobbyists will have one of these in their parts box. RL must be low enough to guarantee at least a 30mA. It can be a separate resistor or part of the actual load.

INDUCTIVELY COUPLED POWER SUPPLY



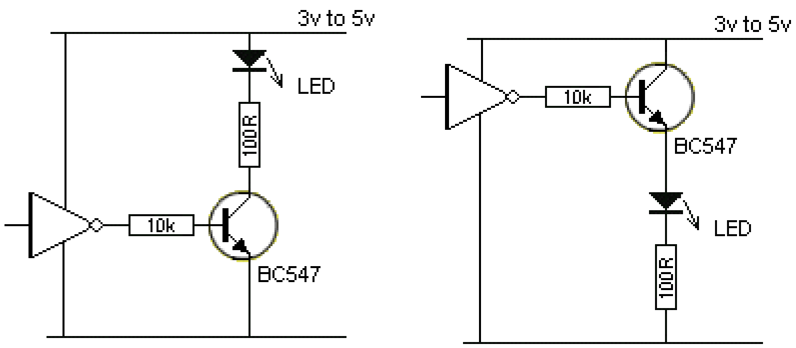


This circuit is from an Interplak Model PB-12 electric toothbrush.

A coil in the charging base (always plugged in and on) couples to a mating coil in the hand unit to form a step down transformer. The MPSA44 transistor is used as an oscillator at about 60 kHz which results in much more efficient energy transfer via the air core coupling than if the system were run at 50 or 60Hz. The amplitude of the oscillations varies with the full wave rectified 100Hz or 120Hz unfiltered DC.

The battery charger is nothing more than a diode to rectify the signal from the 120 turn coil in the charging base. Thus the battery is in constant trickle charge as long as the hand unit is in the base. The battery pack is a pair of 600mAhr AA NiCd cells.

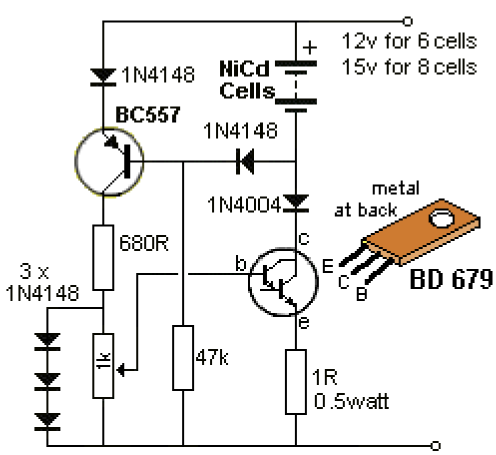
POWERING A LED



Sometimes the output of a gate does not have sufficient current to illuminate a LED to full brightness.

Here are two circuits. The circuits illuminate the LED when the output signal is HIGH. Both circuits operate the same and have the same effect on loading the output of the gate.

NiCd BATTERY CHARGER

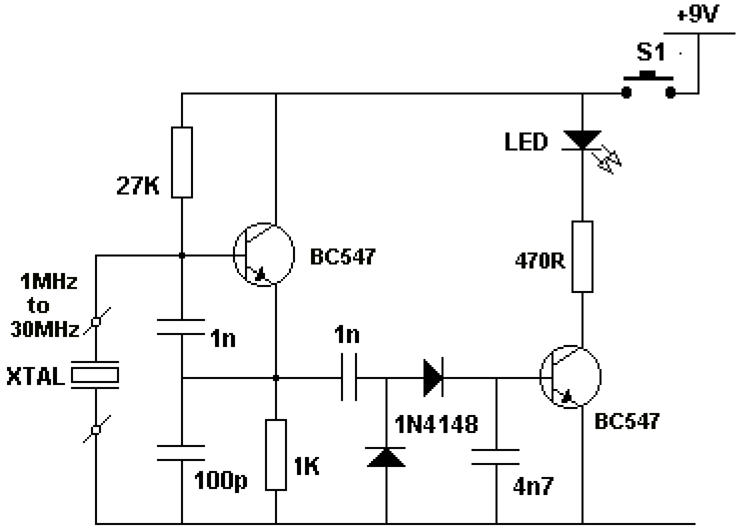


This NiCd battery charger can charge up to 8 NiCd cells connected in series. This number can be increased if the power supply is increased by 1.65v for each additional cell. If the BD679 is mounted on a good heatsink, the input voltage can be increased to a maximum of 25v. The circuit does not discharge the battery if the charger is disconnected from the power supply.

Usually NiCd cells must be charged at the 14 hour rate. This is a charging current of 10% of the capacity of the cell for 14 hours. This applies to a nearly flat cell. For example, a 600 mAh cell is charged at 60mA for 14 hours. If the charging current is too high it will damage the cell. The level of charging current is controlled by the 1k pot from 0mA to 600mA. The BC557 is turned on when NiCd cells are connected with the right polarity. If you cannot obtain a BD679, replace it with any NPN medium power Darlington transistor having a minimum voltage of 30v and a current capability of 2A. By lowering the value of the 1 ohm resistor to 0.5 ohm, the maximum output current can be increased to 1A.

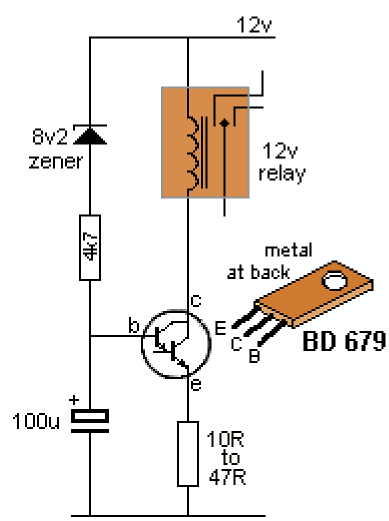
CRYSTAL TESTER

This circuit will test crystals from 1MHz to 30MHz.



When the crystal oscillates, the output will pass through the 1n capacitor to the two diodes. These will charge the 4n7 and turn on the second transistor. This will cause the LED to illuminate.

LOW VOLTAGE CUT-OUT



This circuit will detect when the voltage of a 12v battery reaches a low level. This is to prevent deep-discharge or maybe to prevent a vehicle battery becoming discharged to a point where it will not start a vehicle. This circuit is different to anything previously presented. It has HYSTERESIS. Hysteresis is a feature where the upper and lower detection-points are separated by a gap.

Normally, the circuit will deactivate the relay when the voltage is 10v and when the load is removed. The battery voltage will rise slightly by as little as 50mV and turn the circuit ON again. This is called "Hunting." The off/on timing has been reduced by adding the 100u. But to prevent this totally from occurring, a 10R to 47R is placed in the emitter lead. The circuit will turn off at 10v but will not turn back on until 10.6v when a 33R is in the emitter. The value of this resistor and the turn-on and turn-off voltages will also depend on the resistance of the relay.

THE DARLINGTON TRANSISTOR

Normally a single transistor-stage produces a gain of about 100.

If you require a very high gain, two stages can be used. Two transistors can be connected connected in many ways and the simplest is DIRECT COUPLING. This is shown in the circuit below. An even simpler method is to combine two transistors in one package to form a single transistor with very high gain, called DARLINGTON TRANSISTOR.

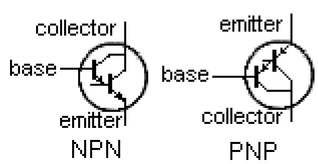
These are available as:

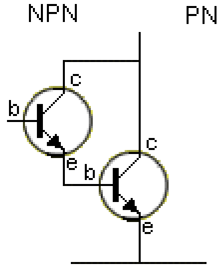
- BD679 NPN-Darlington
- 2N6284 NPN-Darlington
- BC879 NPN-Darlington
- BC880 PNP-Darlington
- TIP122 NPN-Darlington
- TIP127 PNP-Darlington

These devices consist of two NPN or PNP transistors but the same result can be obtained by using a PNP/NPN pair. This is called a Sziklai pair. This arrangement will have to be created with two separate transistors.

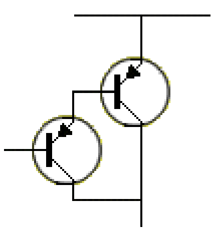
The Darlington transistor can also be referred to as: "Super Transistor, Super Alpha Pair, Sziklai pair, Complementary Pair, Darlington transistors have a gain of 1,000 to 30,000. When the gain is 1,000:1 an input of 1mA will produce a current of 1 amp in the collector-emitter circuit. The only disadvantage of a Darlington Transistor is the minimum voltage between collector-emitter when fully saturated. It is 0.6v to 1.5v depending on the current through the transistor.

A normal transistor has a collector-emitter voltage (when saturated) of 0.2v to 0.5v. The higher voltage means the transistor will heat up more and requires good heatsinking. In addition, a Darlington transistor needs 1.2v between base and emitter before it will turn on. A Sziklai pair only requires 0.6v for it to turn on.

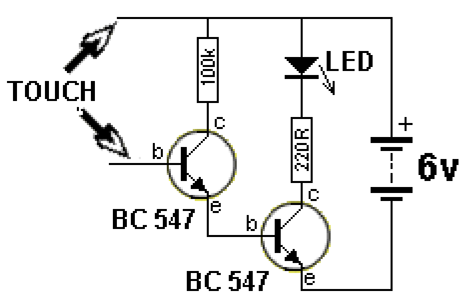




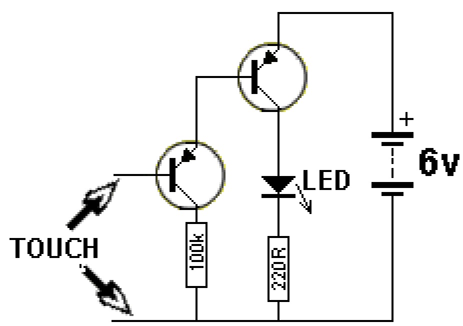
Darlington using two NPN transistors



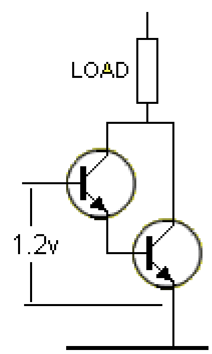
Darlington using two PNP transistors



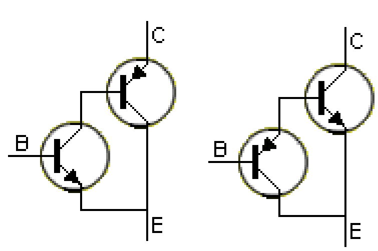
Circuit shows the HIGH GAIN of two NPN transistors



Circuit shows the HIGH GAIN of two PNP transistors



Super Alpha Pair
NPN



Sziklai Pair   Sziklai Pair

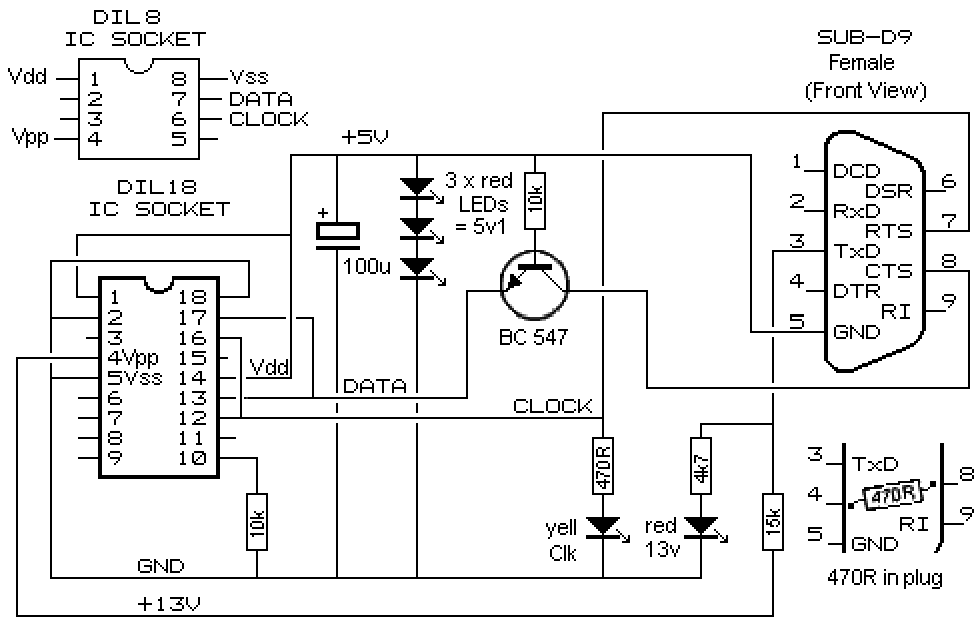
PIC PROGRAMMER

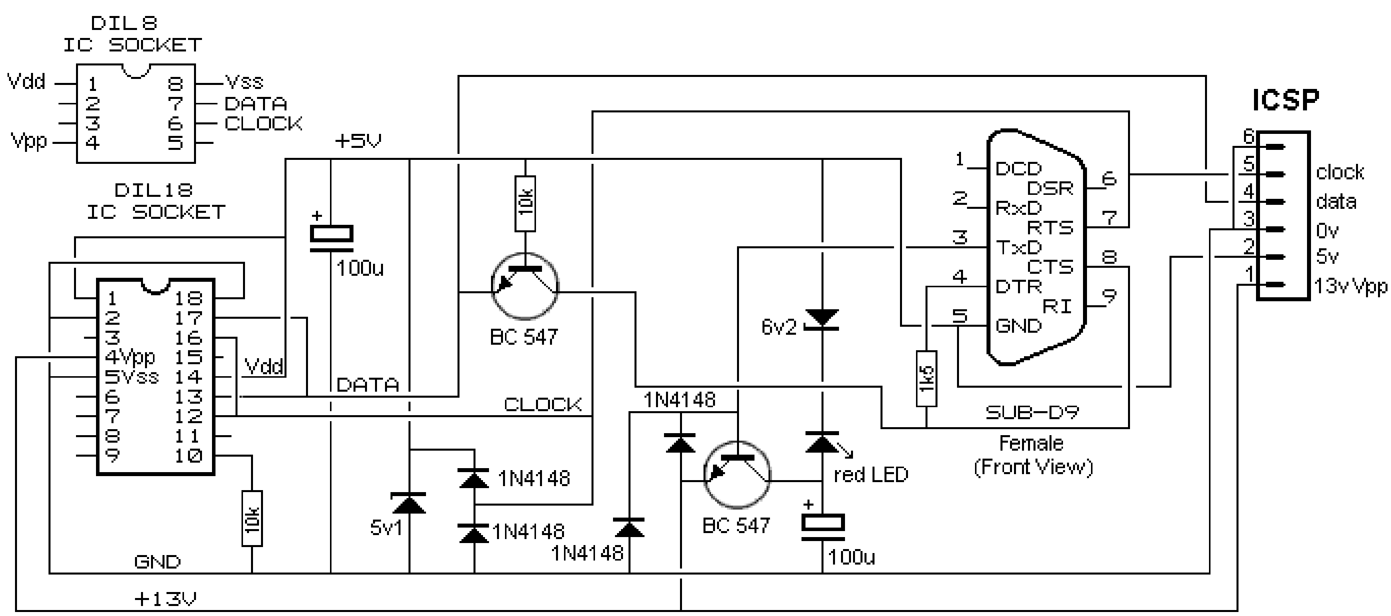
The simplest programmer to program PIC chips is connected to your computer via the serial port. This is a 9-pin plug/socket arrangement called a SUB-D9 with the male plug on the computer and female on a lead that plugs into the computer.

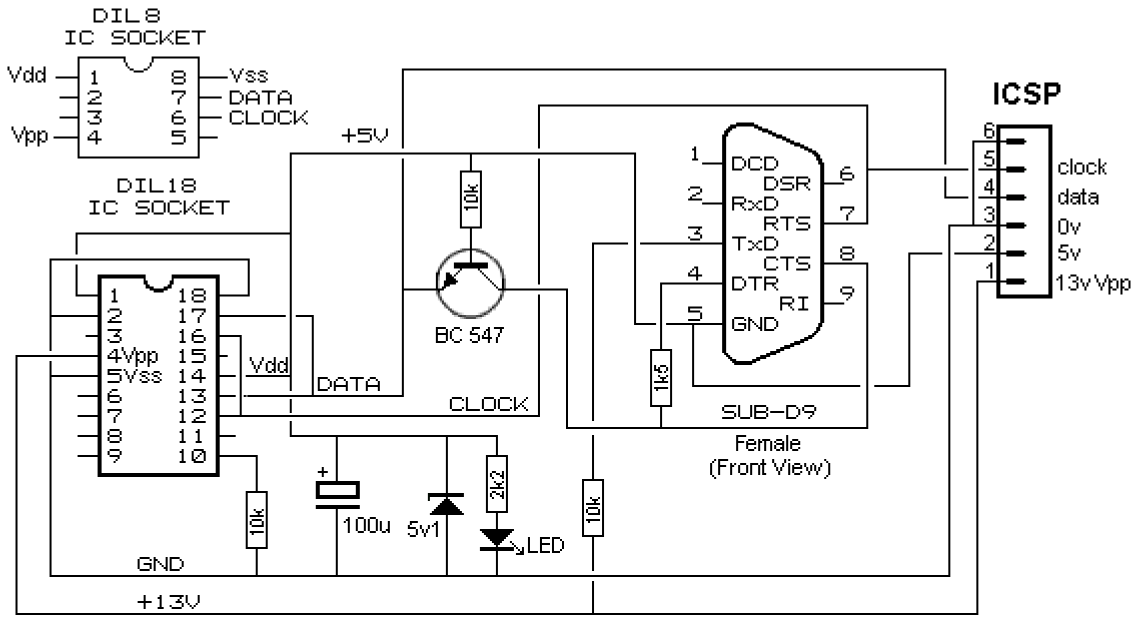
The signals that normally appear on the pins are primary designed to talk to a modem but we use the voltages and the voltage-levels to power a programmer. The voltages on the pins are On or Off. On (binary value "1") means the pin is between -3 and -25 volts, while Off (binary value "0") means it is between +3 and +25 volts, depending on the computer. But many serial ports produce voltages of only +8v and -8V and the programmer circuit uses this to produce a voltage of about 13.5v to put the PIC chip into programming mode. This is the minimum voltage for the programmer to work. Any computers with a lower voltage cannot be used. That's why the circuit looks so unusual. It is combining voltages to produce 13v5. Here are two circuits.

The first circuit is used in our PIC PROGRAMMER - 12 parts project.

Circuit 2 uses more components to produce the same result and circuit 3 uses less components.

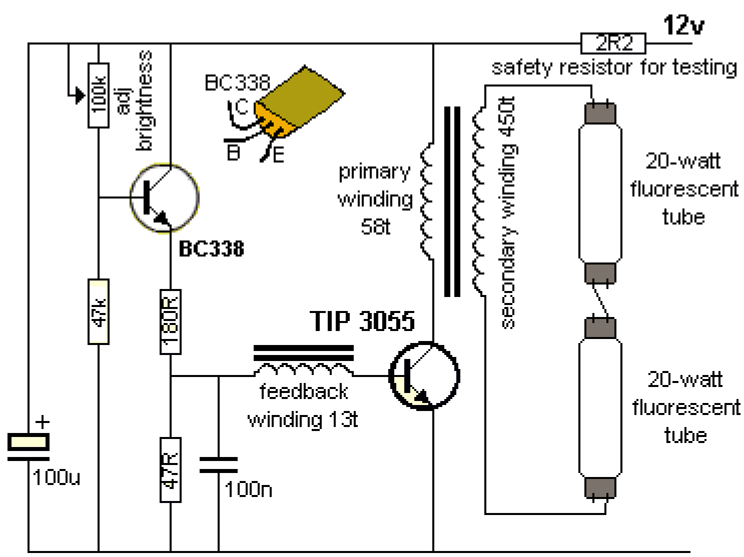






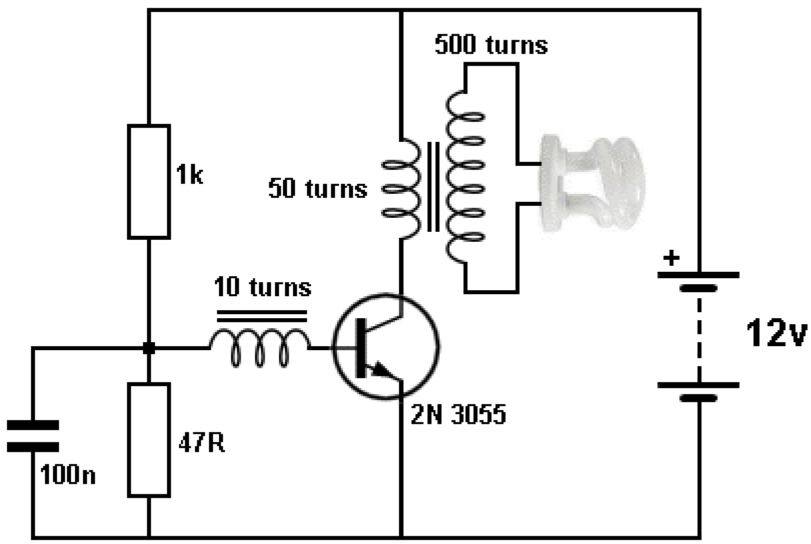
FLUORESCENT INVERTER

The simple circuit will drive up to two 20watt fluoro tubes from a 12v supply.



The circuit also has a brightness adjustment to reduce the current from the battery. See Fluorescent Inverter article for more details.

5-WATT CFL DRIVER



Both circuits are almost identical and this circuit has the brightness section removed and the 100u removed. The removal of the 100u reduces the brightness but it also reduces the current from 500mA to 250mA to make a very efficient circuit for an emergency situation.

Note: Driving a 20 watt tube (normal 2-foot tube) produces much-more illumination than a 5 watt CFL.

This circuit will drive a 5watt CFL tube from an old CFL lamp from 6v or 12v. It makes a very handy emergency light.

The transformer is made by winding 500 turns for the secondary.

This consists of winding about 10 turns on top of each other before advancing along the rod. The rod can be round or flat, from an old AM radio. It is called a ferrite rod. The 500 turns have to be added before reaching the end and this means 100 turns has to take up 1/5th of the distance. This reduces the voltage between the turns as the enamel will only withstand 100 volts.

Before you start winding, use at least 3 layers of "sticky-tape" to prevent the high voltage shorting to the rod.

The size of the wire is not important and anything 0.25mm or thinner will be suitable. After winding the secondary, the primary is 50 turns and the feedback is 10 turns.

The primary can be 0.5mm wire and the feedback 0.25mm.

Connect the transistor, components and tube and turn the circuit ON very briefly. If the tube does not illuminate immediately, reverse the wires to the feedback winding.

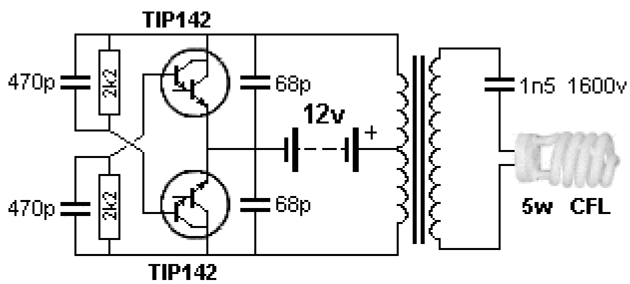
The transistor must be 2N 3055 (or the plastic version, TIP 3055). It will get warm when illuminating the lamp and needs to be heatsinked. The lamp must not be removed as the circuit will overload and damage the transistor.

The circuit takes 250mA when driving a 5 watt CFL (or 18 watt fluorescent tube) on 12v supply. The 1k base resistor can be reduced to 820R and the brightness will increase slightly but the current will increase to 500mA.

The circuit is more-efficient on 6v. The 1k base resistor is reduced to 220R and the transistor remains cool.

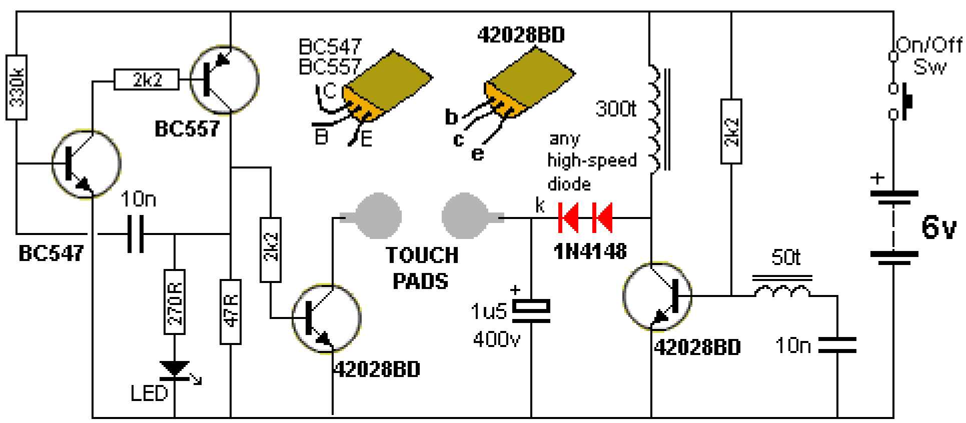
CFL DRIVER

This circuit will drive a 5watt Compact Fluorescent Lamp from 12v:



ZAPPER - 160v

This project will give you a REAL SHOCK.



It produces up to 160v and outputs this voltage for a very short period of time. The components are taken from an old CFL (Compact Fluorescent Lamp) as the transistors are high voltage types and the 1u5 electro @400v can also be taken from the CFL as well as the ferrite core for the transformer.

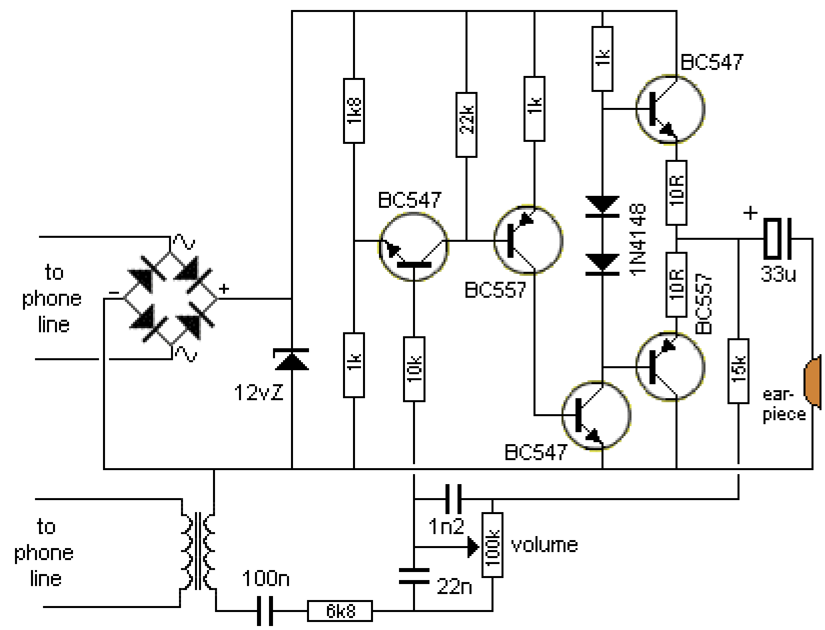
The CFL has a 1.5mH choke with a DC resistance of 4 ohms. This resistance is too low for our circuit and the wire is removed and the core rewound with 50 turns for the feedback winding and 300 turns of 0.1mm wire to produce a winding with a resistance of about 10 ohms for the primary.

The oscillator is "flyback" design that produces spikes of about 160v and these are fed to a high-speed diode (two 1N4148 diodes in series) to charge a 1u5 electrolytic to about 160v. If you put your fingers across the electrolytic you will hardly feel the voltage. You might get a very tiny tingle at the end of your fingers. But if this voltage is delivered, then turned off, you get an enormous shock and you pull yours fingers off the touch pads.

That's what the other part of the circuit does. It turns on a high-voltage transistor for a very short period of time and this is what makes the circuit so effective.

TELEPHONE AMPLIFIER

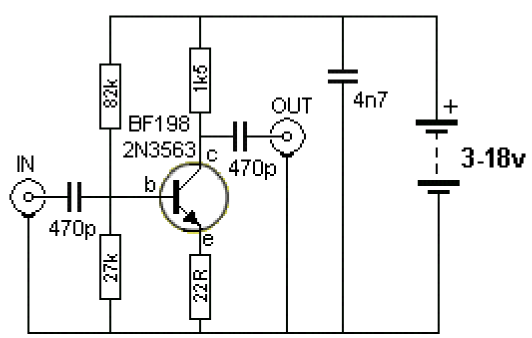
This amplifier circuit is used in all home telephones to amplify the signal from the line to the earpiece.



The voltage is taken from the line via a bridge that delivers a positive rail, no matter how the phone wires are connected.

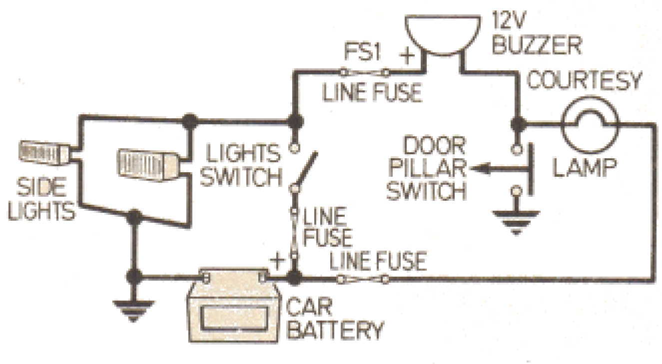
A transformer is used to pick off a signal from the phone line and this is passed through a 22n to the input of the amplifier. Negative feedback is provided by a 15k and 1n2 capacitor. The operating point for the amplifier is set by the 100k pot and this serves to provide an effect on the gain of the amplifier and thus the volume.

VHF AERIAL AMPLIFIER



This amplifier circuit can be used to amplify VHF television signals. The gain is between 5dB and 28dB. 300ohm twin feeder can be used for the In/Out leads.

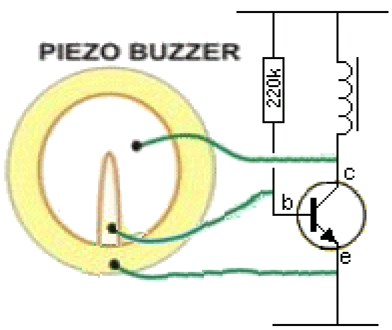
CAR LIGHTS ALERT



This circuit will alert the driver if the lights have been left on. A warning sound will be emitted from the 12v buzzer when the driver's door is opened and the lights are on.

HOW A PIEZO BUZZER WORKS

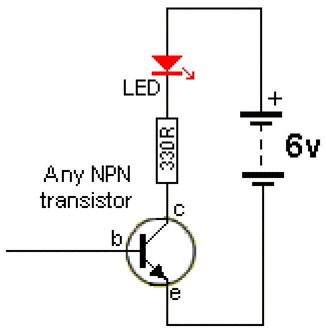
A Piezo Buzzer contains a transistor, coil, and piezo diaphragm and produces sound when a voltage is applied. The buzzer in the circuit above is a PIEZO BUZZER.



The circuit starts by the base receiving a small current from the 220k resistor. This produces a small magnetic flux in the inductor and after a very short period of time the current does not increase. This causes the magnetic flux to collapse and produce a voltage in the opposite direction that is higher than the applied voltage.

3 wires are soldered to pieces of metal on the top and bottom sides of a ceramic substrate that expands sideways when it sees a voltage. The voltage on the top surface is passed to the small electrode and this positive voltage is passed to the base to turn the transistor ON again. This time it is turned ON more and eventually the transistor is fully turned ON and the current through the inductor is not an INCREASING CURRENT by a STATIONARY CURRENT and once again the magnetic flux collapses and produces a very high voltage in the opposite direction. This voltage is passed to the piezo diaphragm and causes the electrode to "Dish" and produce the characteristic sound. At the same time a small amount is "picked-off" and sent to the transistor to create the next cycle.

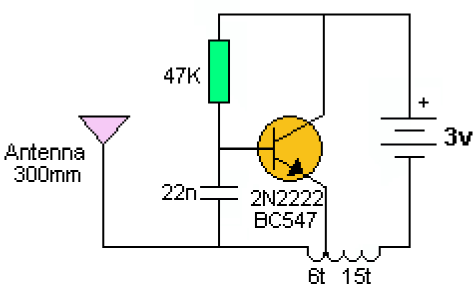
MAINS DETECTOR



This circuit detects the “Active” wire of 110v AC or 240v AC via a probe and does not require “continuity.” This makes it a safe detector. It uses the capacitance of your body to create current flow in the detecting part of the circuit and the sensitivity will depend on how you hold the insulating case of the project. No components of the circuit must be exposed as this will result in ELECTROCUTION.

SIMPLEST FM BUG

This circuit is the simplest FM circuit you can get.

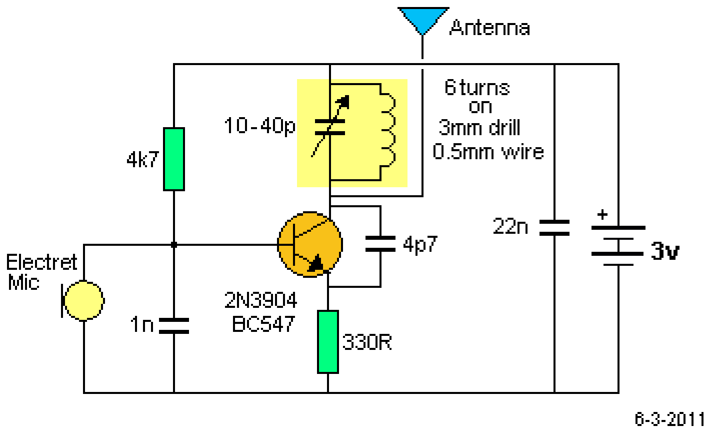


It has no microphone but the coil is so MICROPHONIC that it will pick up noises in the room via vibrations on a table.

The circuit does not have any section that determines the frequency. In the next circuit and all those that follow, the section that determines the frequency of operation is called the TUNED CIRCUIT or TANK CIRCUIT and consists of a coil and capacitor. This circuit does not have this feature. The transistor turns on via the 47k and this puts a pulse through the 15 turn winding. The magnetic flux from this winding passes through the 6 turn winding and into the base of the transistor via the 22n capacitor. This pulse is amplified by the transistor and the circuit is kept active.

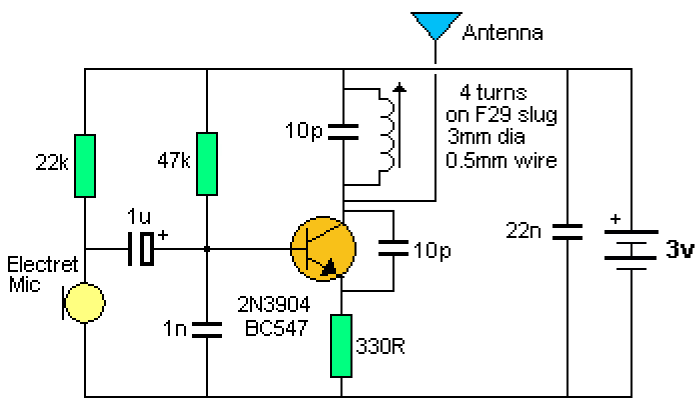
The frequency is determined by the 6 turn coil. By moving the turns together, the frequency will decrease. The circuit transmits at 90MHz. It has a very poor range and consumes 16mA. The coil is wound on a 3mm drill and uses 0.5mm wire.

A GOOD ONE-TRANSISTOR CIRCUIT



This circuit uses a TUNED CIRCUIT or TANK CIRCUIT to create the operating frequency. For best performance the circuit should be built on a PC board with all components fitted close to each other.

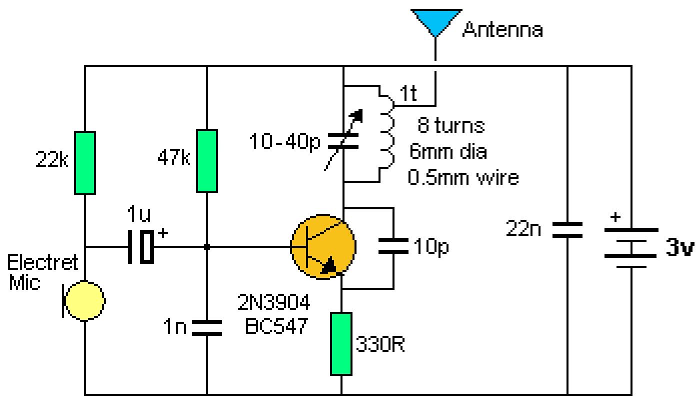
AN IMPROVED DESIGN



This design uses a “slug tuned coil” to set the frequency. This means the slug can be screwed in and out of the coil. This type of circuit does not offer any improvement in stability over the previous circuit. (In later circuits we will show how to improve stability. The main way to improve stability is to add a “buffer” stage. This separates the oscillator stage from the output.)

The antenna is connected to the collector of the transistor and this “loads” the circuit and will cause drift if the bug is touched. The range of this circuit is about 200 metres and current consumption is about 7mA. The microphone has been separated from the oscillator and this allows the gain of the microphone to be set via the 22k resistor. Lowering the resistor will make the microphone more sensitive. This circuit is the best you can get with one transistor.

MORE STABILITY



If you want more stability, the antenna can be tapped off the top of the tank circuit. This actually does two things. It keeps the antenna away from the highly active collector and turns the coil into an auto-transformer where the energy from the 8 turns is passed to a single turn. This effectively increases the current into the antenna. And that is exactly what we want.

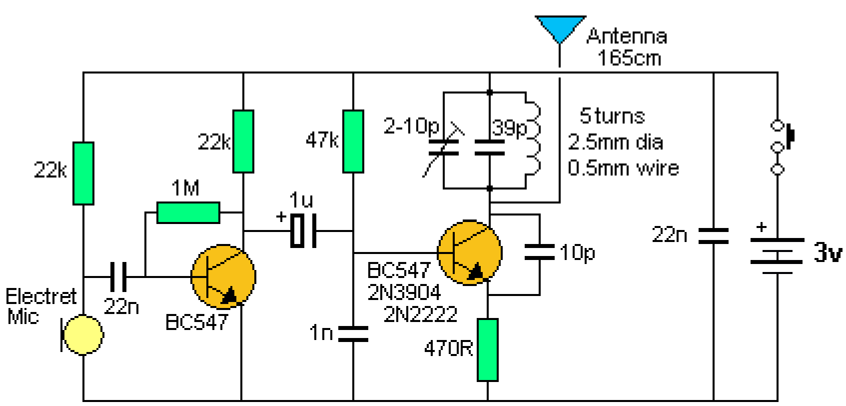
The range is not as far but the stability is better. The frequency will not drift as much when the bug is held. As the tap is taken towards the collector, the output increase but the stability deceases.

2-TRANSISTOR CIRCUIT

The next progressive step is to add a transistor to give the electret microphone more sensitivity. The electret microphone contains a Field Effect Transistor and you can consider it to be a stage of amplification. That's why the electret microphone has a very good output.

A further stage of amplification will give the bug extremely good sensitivity and you will be able to pick up the sound of a pin dropping on a wooden floor.

Many of the 1 transistor circuits over-drive the microphone and this will create a noise like bacon and eggs frying. The microphone's used by Talking Electronics require a load resistor of 47k for a 6v supply and 22k for a 3v supply. The voltage across the microphone is about 300mV to 600mV. Only a very simple self-biasing common-emitter stage is needed. This will give a gain of approx 70 for a 3v supply. The circuit below shows this audio amplifier, added to the previous transmitter circuit. This circuit is the best design using 2 transistors on a 3v supply. The circuit takes about 7mA and produces a range of about 200 - 400metres.



Five points to note in the circuit above:

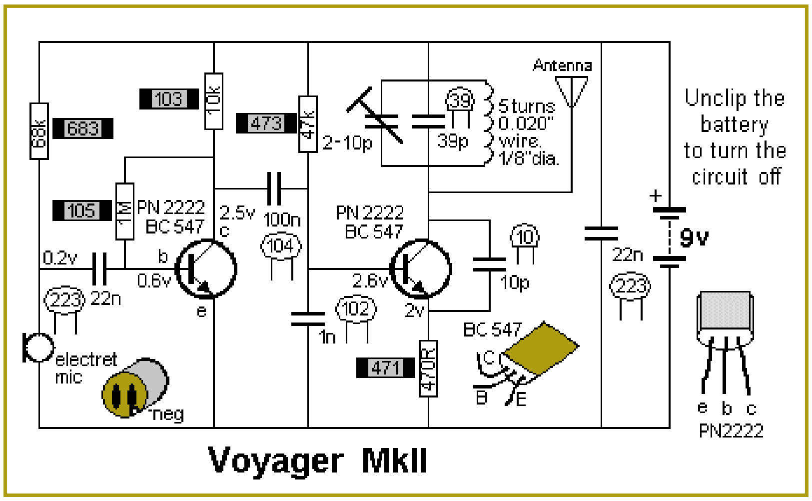
1. The tank circuit has a fixed 39p and is adjusted by a 2-10p trimmer. The coil is stretched to get the desired position on the band and the trimmer fine tunes the location.
2. The microphone coupling is a 22n ceramic. This value is sufficient as its capacitive reactance at 3-4kHz is about 4k and the input to the audio stage is fairly high, as noted by the 1M on the base.

3. The 1u between the audio stage and oscillator is needed as the base has a lower impedance as noted by the 47k base-bias resistor.
4. The 22n across the power rails is needed to keep the rails "tight." Its impedance at 100MHz is much less than one ohm and it improves the performance of the oscillator enormously.
5. The coil in the tank circuit is 5 turns of enameled wire with air core. The secret to long range is high activity in the oscillator stage. The tank circuit (made up of the coil and capacitors across it) will produce a voltage higher than the supply voltage due to the effect known as "collapsing magnetic field" and this occurs when the coil collapses and passes its reverse voltage to the capacitor. The antenna is also connected to this point and it receives this high waveform and passes the energy to the atmosphere as electromagnetic radiation.

When the circuit is tightly constructed on a PC board, the frequency will not drift very much if the antenna is touched.

THE VOYAGER

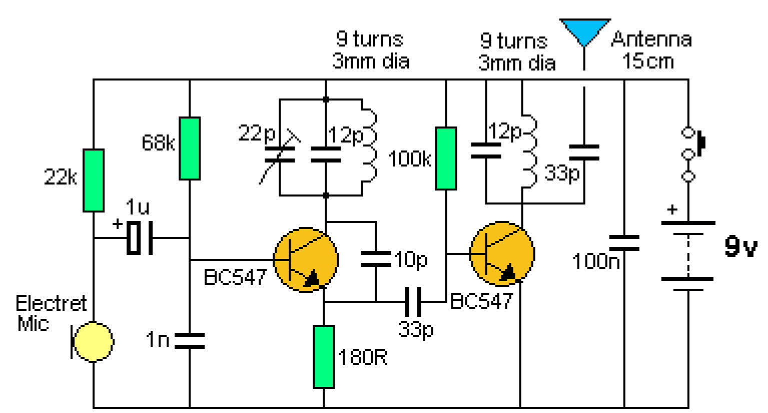
The only way to get a higher output from two transistors is to increase the supply voltage.



The following circuit is available from Talking Electronics as a surface-mount kit, with some components through-hole. The project is called THE VOYAGER.

All the elements of good design have been achieved in this project. The circuit has a slightly higher output than the 3v circuit above, but most of the voltage is lost across the emitter resistor and not converted to RF. The main advantage of this design is being able to connect to a 9v battery. In a technical sense, about half the energy is wasted as the stages actually require about 4v - 5v for maximum output.

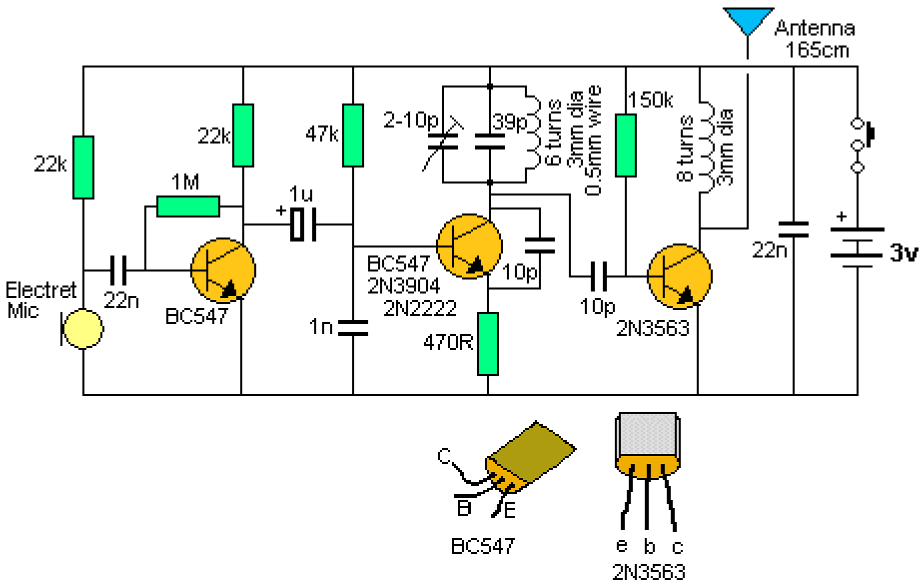
HAND-HELD MICROPHONE



This circuit is suitable for a hand-held microphone.

It does not have an audio stage but that makes it ideal as a microphone, to prevent feedback. The output has a buffer stage to keep the oscillator away from the antenna. This gives the project the greatest amount of stability -rather than the highest sensitivity.

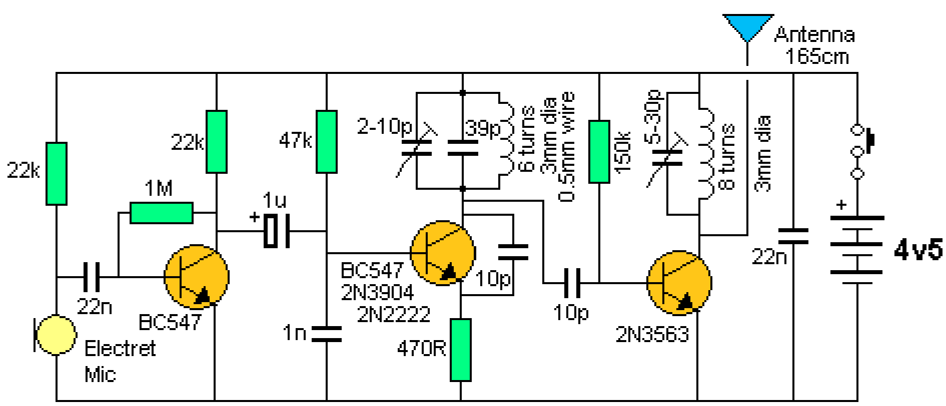
INCREASING THE RANGE



To increase the range, the output must be increased. This can be done by using an RF transistor and adding an inductor. This effectively converts more of the current taken by the circuit (from the battery) into RF output. The output is classified as an untuned circuit. A BC547 transistor is not suitable in this location as it does not amplify successfully at 100MHz. It is best to use an RF transistor such as 2N3563.

MORE RANGE

More output can be obtained by increasing the supply voltage and adding a capacitor across the inductor in the output stage to create a tuned output.



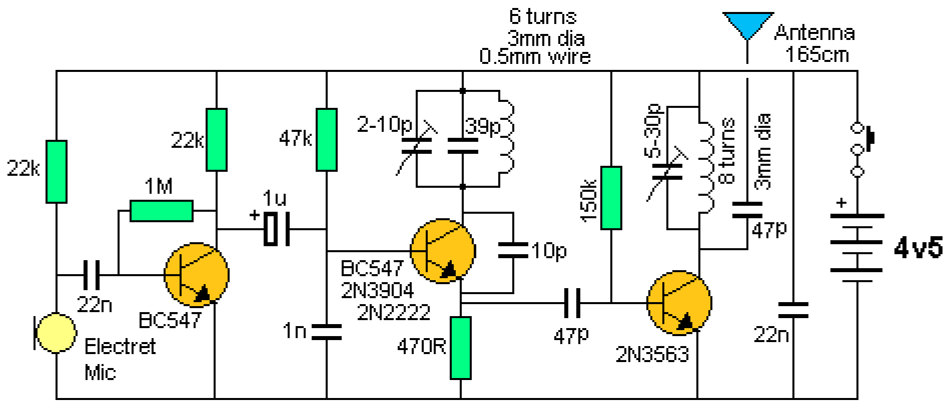
A tuned output stage delivers more output.

The 5-30p must be adjusted each time the frequency of the bug is changed. This is best done with a field strength meter. See Talking Electronics Field Strength Meter project.

The 2N3563 is capable of passing 15mA in the buffer stage and about 30% is delivered as RF. This makes the transmitter capable of delivering about 22mW.

EMITTER TAP

The following circuit taps the emitter of the oscillator stage.

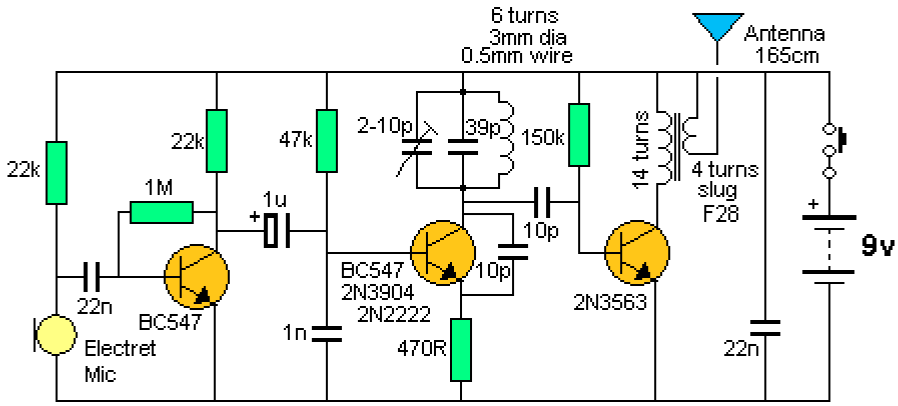


The collector or the emitter can be tapped to produce about the same results, however tapping the emitter "loads" the oscillator less. The 47p capacitor is adjusted to "pick-off" the desired amount of energy from the oscillator stage. It can be reduced to 22p or 10p.

Tapping the emitter of the oscillator transistor

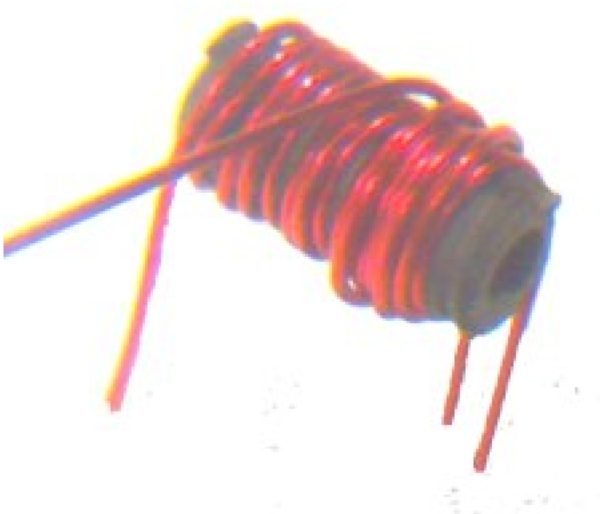
GOING FURTHER

The next stage to improve the output, matches the impedance of the output stage to the impedance of the antenna.



The impedance of the output stage is about 1k to 5k, and the impedance of the antenna is about 50 ohms.

This creates an enormous matching problem but one effective way is with an RF transformer.



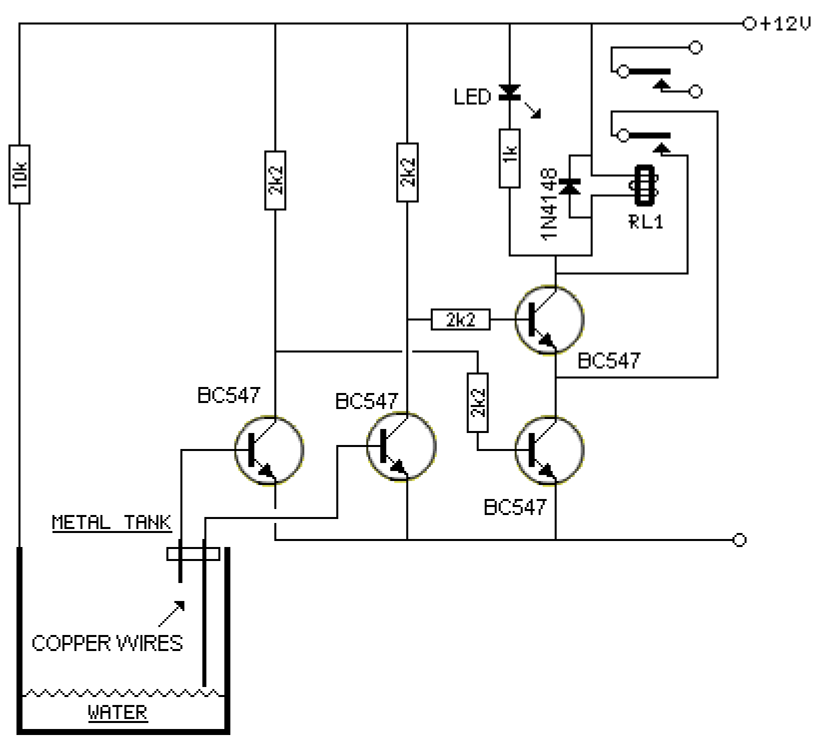
An RF transformer is simply a transformer that operates at high frequency. It can be air cored or ferrite cored. The type of ferrite needed for 100MHz is F28. The circuit above uses a small ferrite slug 2.6mm dia x 6mm long, F28 material.

To create an output transformer for the circuit above, wind 11 turns onto the slug and 4 turns over the 11 turns. The ferrite core will do two things. Firstly it will pass a high amount of energy from the primary winding to the antenna and secondly it will

THE **RF TRANSFORMER** prevent harmonics passing to the antenna. The transformer approximately doubles the output power of the transmitter.

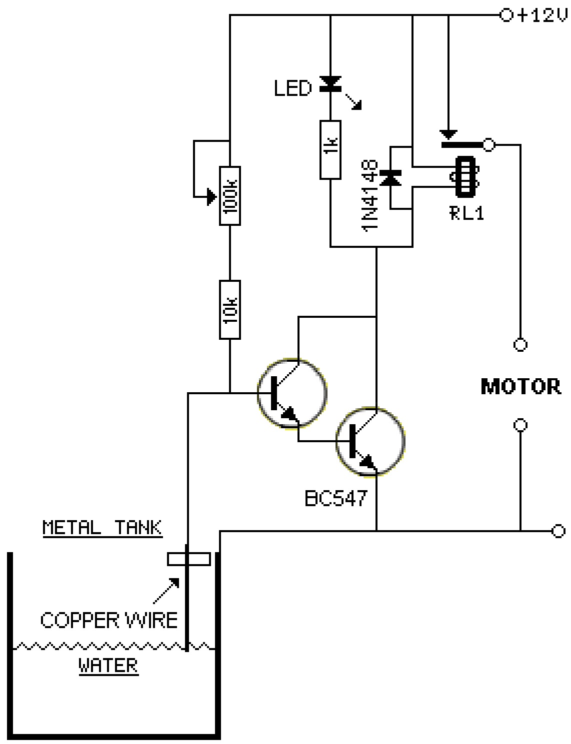
WATER LEVEL DETECTOR

This circuit can be used to automatically keep the header tank filled. It uses a double-pole relay.



CIRCUIT 2

The circuit below is the simplest design and consumes almost zero current when the tank is full. When the water is LOW, the circuit is turned ON via the 100k pot and 10k resistor.

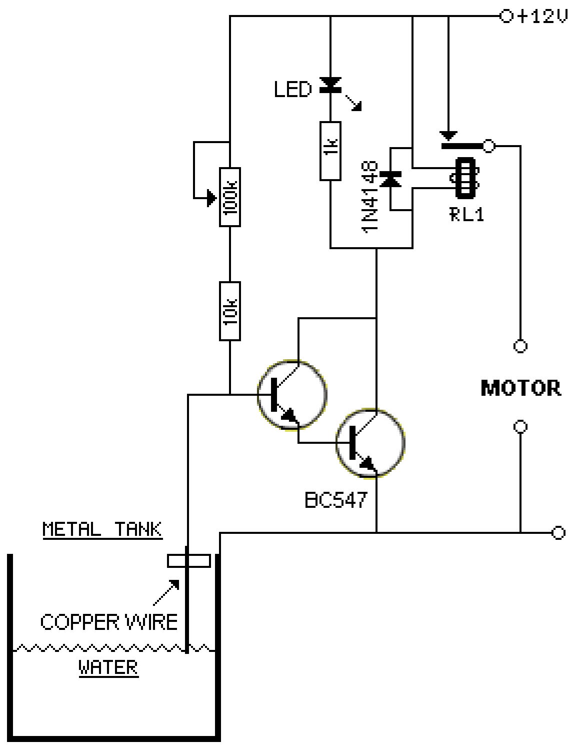


When the water reaches the copper wire, the voltage on the base of the first transistor reduces and the current into the Darlington arrangement is too small to keep the relay energised and the motor turns OFF.

As the water-level drops, the current into the Darlington pair increases and a point is reached when the relay pulls-in again.

CIRCUIT 3

This simple circuit will show the water level in a tank.



It has a HIGH, MEDIUM and LOW levels and as the water touches the pads, the LEDs start to illuminate. This produces a range of levels to let you know exactly the level of the water.

The sensor pads can be cut from a tin-can or you can use the lid of a tin.

The main sensor is placed at the bottom of the water so the low-level LED will let you know the tank is almost empty. The circuit has been drawn to show the transistors are placed on the top of the tank with wires going to each of the sensor pads. The LEDs and resistors are mounted on a wall in your house with the 3v supply and a push-switch. You will need a 4-wire connection between the two units and this can be 4-core telephone cable.

The transistors are wired as emitter-followers and this saves 4 resistors (base-bias resistors). It also allows the LEDs to come on slowly as the water rises so you get a wide indication of the water level. You can add more sensors if required. Simply repeat the circuit above for 3 more levels.

Any NPN transistor can be used and any value resistor between 100 ohms and 330 ohms can be used and the voltage can be increased to 6v if you are using a high-value resistor.

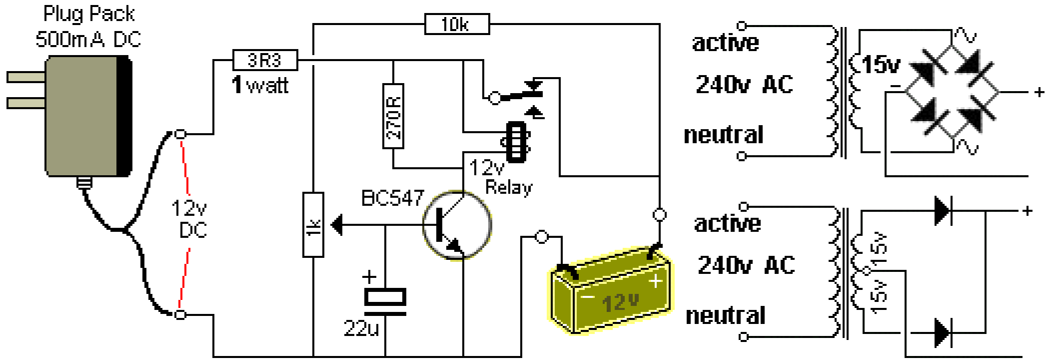
The circuit only takes current when the switch is pressed but it can be left ON all the time to let you know the water level, if needed.

You don't need a circuit board. Simply hammer a few nails into a length of wood to hold the sensors and connect the transistors to the nails by soldering.

Make sure the sensor pads are away form the wood and don't hold any water when the level goes down as the circuit is so sensitive that the LEDs will not go out.

BATTERY CHARGER - world's simplest automatic charger

This is the world's simplest automatic battery charger.



It consists of 6 components, when connected to a 12v DC plug pack. The plug pack must produce more than 15v on no-load (which most plug packs do.) An alternative 15v transformer and a centre-tapped transformer is also shown. A centre-tapped transformer is referred to as: 15v-CT-15v or 15-0-15 The relay and transistor are not critical as the 1k pot is adjusted so the relay drops-out at 13.7v.

To improve the "pull-in" and "drop-out" voltages, the 10k can be replaced with a 12v zener. The zener can be made up of two 6v zeners or any combination in series and include ordinary diodes (drop 0.6v).

The plug pack can be 300mA, 500mA or 1A and its current rating will depend on the size of the 12v battery you are charging.

For a 1.2AH gel cell, the charging current should be 100mA. However, this charger is designed to keep the battery topped-up and it will deliver current in such short bursts, that the charging current is not important.

This applies if you are keeping the battery connected while it is being used. In this case the charger will add to the output and deliver some current to the load while charging the battery. If you are charging a flat cell (flat 12v battery - a discharged 12v battery), the current should not be more than 100mA.

For a 7AH battery, the current can be 500mA. And for a larger battery, the current can be 1Amp.

Most 12v Plug Packs produce 15v to 16v on NO-LOAD and we are using this feature to charge the battery. We are also using the poor regulation of the plug pack to charge the battery without the plug pack overheating.

SETTING UP

Connect the charger to a battery and place a digital meter across the battery. Adjust the 1k pot so the relay drops out as soon as the voltage rises to 13.7v.

Place a 100R 2watt resistor across the battery and watch the voltage drop.

The charger should turn on when the voltage drops to about 12.5v. This voltage is not extremely critical. It happens to be the "hysteresis" of the circuit and is determined by the value of the load in the collector of the transistor.

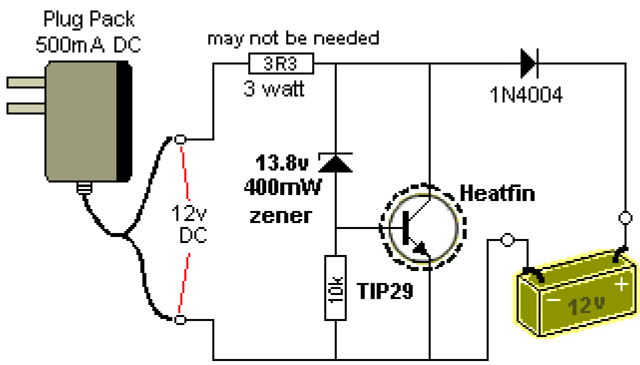
The 22u stops the relay "squealing" or "hunting" when a load is connected to the battery and the charger is charging. As the battery voltage rises, the charging current reduces and just before the relay drops out, it squeals as the voltage rises and falls due to the action of the relay. The 22u prevents this "chattering".

To increase the Hysteresis: In other words, decrease the voltage where the circuit cuts-in, add a 270R across the coil of the relay. This will increase the current required by the transistor to activate the relay and thus increase the gap between the two activation points. The pull-in point on the pot will be higher and you will have re-adjust the pot, but the drop-out point will be the same and thus the gap will be wider.

In our circuit, the cut-in voltage was 11.5v with a 270R across the relay.

Note: No diode is needed across the relay because the transistor is never fully turned off and no back EMF (spike) is produced by the relay.

AUTOMATIC BATTERY CHARGER



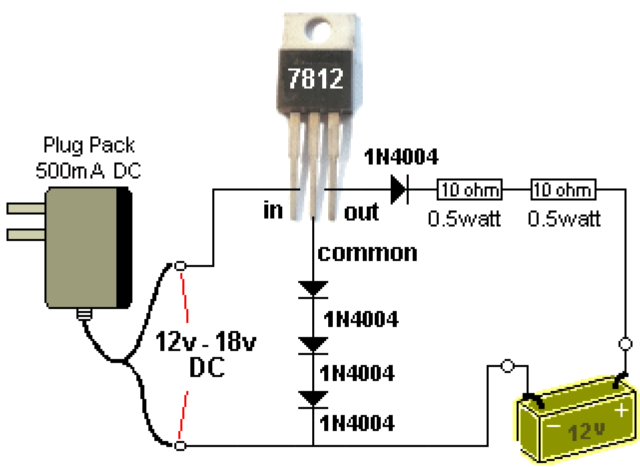
- trickle charger.

This circuit will automatically keep a battery fully charged with the charge-current reducing when the battery voltage reaches 13.8v. The battery can be used at any time and the charger will maintain full charge.

The transistor acts like a POWER ZENER (with the 13.8v zener on the base) and the supply rail does not rise above 13.8v + 0.6v = 14.4v. The 1N4004 removes the 0.6v to deliver 13.8v to the battery.

If the plug pack is replaced with a supply capable of delivering a voltage higher than 16v (on no-load), the 3R3 (3watt) resistor will be needed. The transistor simply removes the charging current from the battery and wastes it as heat.

BATTERY CHARGER MkII



- a very simple design to keep a battery "topped up."

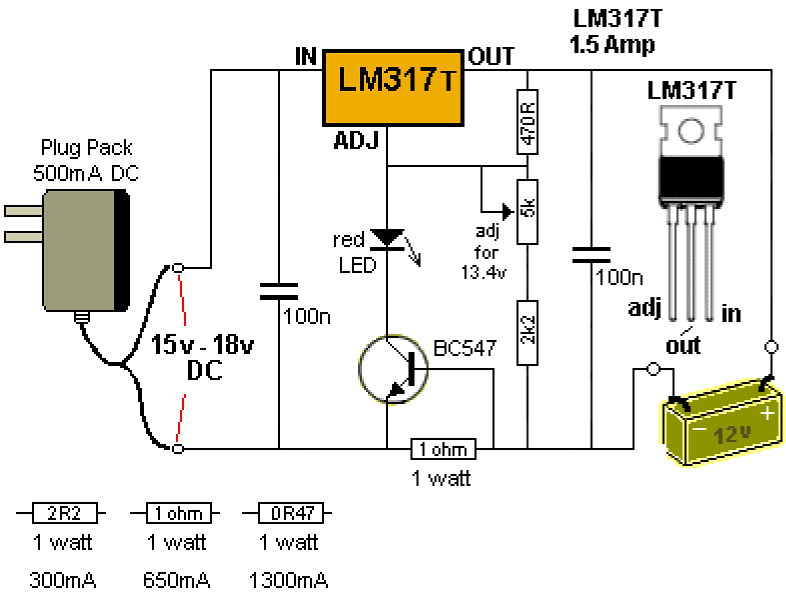
This is a very simple battery charger to keep a battery "nearly fully charged." It consists of 7 components, when connected to a 12v - 18v DC plug pack. The plug pack must produce more than 15v on no-load (which most 12v plug packs do.) For a 1.2AH gel cell, up to a 45Ahr car or boat battery, this charger will keep the battery topped-up and can be connected for many months as the battery will not lose water due to "gassing."

The output voltage is 13.2v and this is just enough to keep the battery from discharging, but will take a very long time to charge a battery, if it is flat because a battery produces a "floating charge" of about 13.6v when it is being charged (at a reasonable current) and this charger is only designed to deliver a very small current.

There is a slight difference between a "old-fashioned" car battery (commonly called "an accumulator") and a sealed battery called a Gel Cell. The composition of the plates of a gel cell is such that the battery does not begin to "gas" until a high voltage is reached. That is why it can be totally closed and only has rubber bungs that "pop" if gas at high pressure develops due to gross over-charging. That's why the charging voltage must not be too high and when the battery is fully charged, the charging current must drop to a very low level.

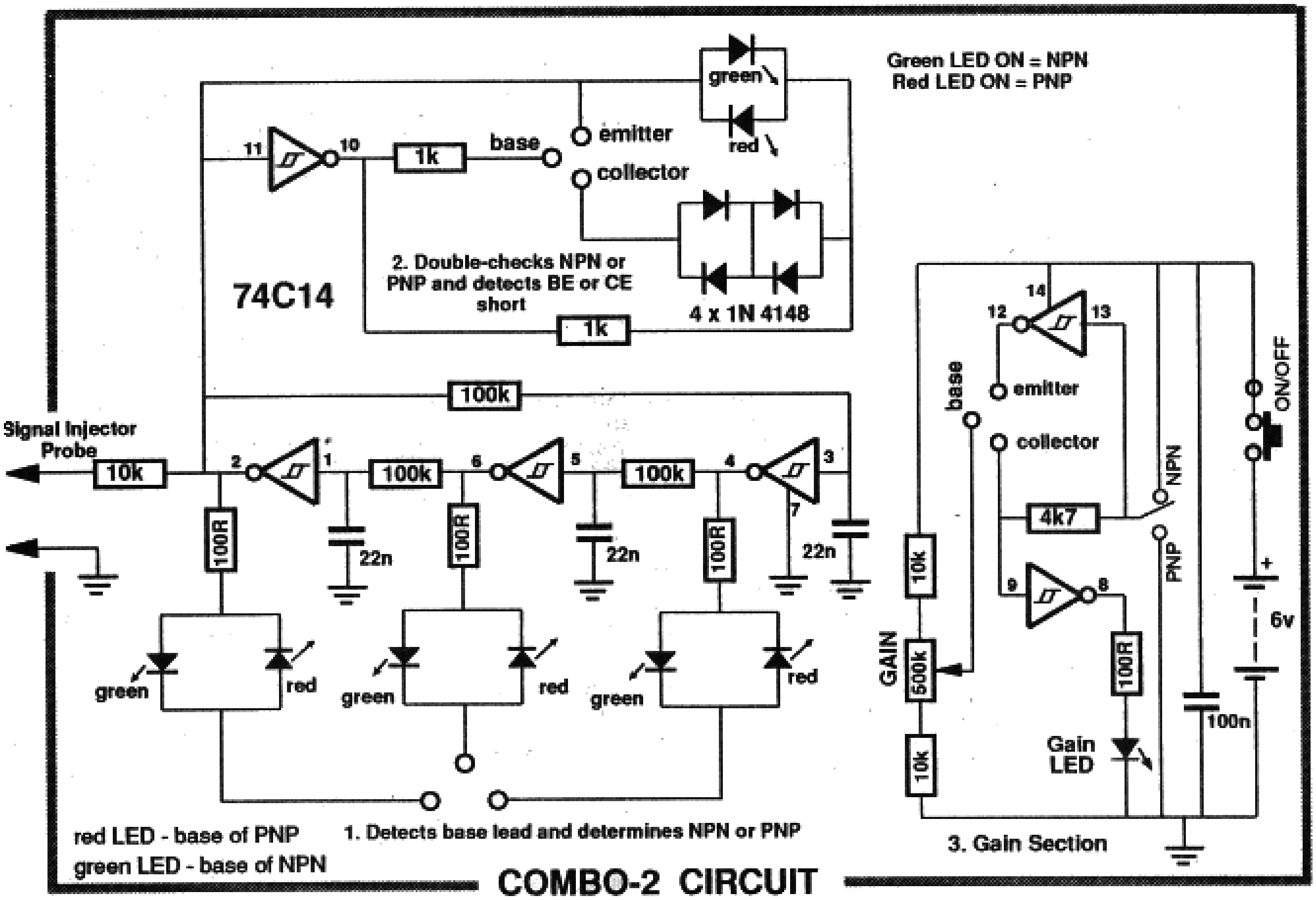
GELL CELL BATTERY CHARGER

This circuit will charge gell cell batteries at 300mA or 650mA or 1.3A, depending on the CURRENT SENSING resistor in the 0v rail. Adjust the 5k pot for 13.4v out and when the battery voltage reaches this level, the current will drop to a few milliamps. The plug pack will need to be upgraded for the 650mA or 1.3A charge-current. The red LED indicates charging and as the battery voltage rises, the current-flow decreases. The maximum is shown below and when it drops about 5%, the LED turns off and the current gradually drops to almost zero.



TRANSISTOR TESTER COMBO 2

This circuit uses an IC but it has been placed in this eBook as it is a transistor tester.

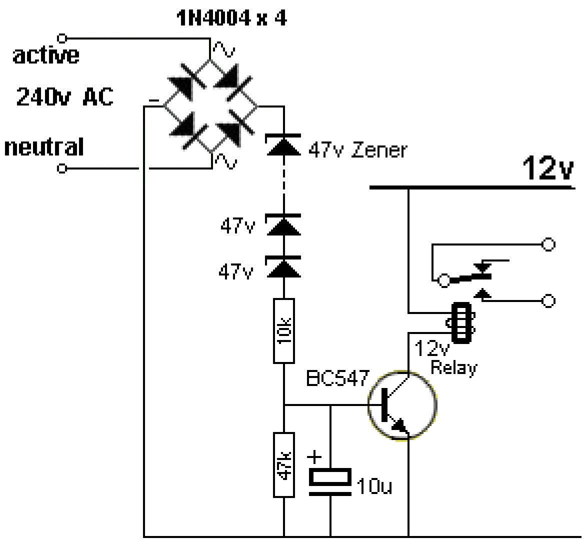


The circuit uses a single IC to perform 3 tests:

1. Place the transistor in any orientation into the three terminals of circuit 1 (below, left) and a red LED will detect the base of a PNP transistor an a green LED will indicate the base of an NPN transistor.
2. You now now the base lead and the type of transistor. Place the transistor in Test 2 circuit (top circuit) and when you have fitted the collector and emitter leads correctly (maybe have to swap leads), the red or green LED will come on to prove you have fitted the transistor correctly.
3. The transistor can now be fitted in the GAIN SECTION. Select PNP or NPN and turn the pot until the LED illuminates. The value of gain is marked on the PCB that comes with the kit. The kit has ezy clips that clip onto the leads of the transistor to make it easy to use the project. The project also has a probe at one end of the board that produces a square wave - suitable for all sorts of audio testing and some digital testing.

Project cost: $22.00 from Talking Electronics.

LOW MAINS DROPOUT



This circuit will turn off a device if the main drops by a say 15v. The actual voltage is adjustable. The first thing to remember is this: The circuit detects the PEAK voltage and this is the voltage of the zener diodes.

For 240v mains, the peak is 338v.

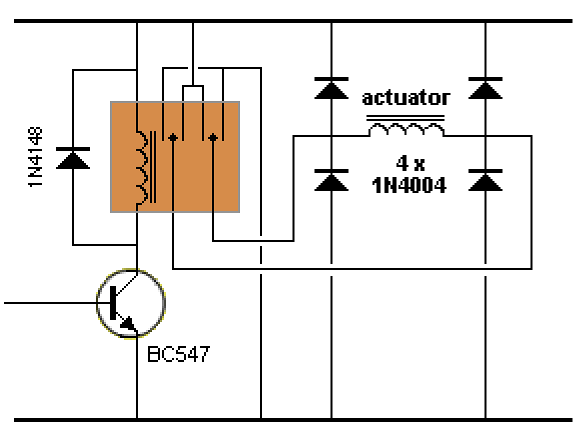
For a voltage drop of about 12v(RMS), the zener diodes need to have a combined voltage of 320v (you will need 6 x 47v + 1 x 20v + 1 x 18v). The 10k resistor will have about 18v across it and the current will be nearly 2mA. The wattage will be 36mW. For a voltage drop of about 27v(RMS), you will need zeners for a total of 300v by using 6 x 47v + 1 x 18v. The voltage across the 10k resistor will be 38v and the current will be nearly 4mA. The wattage dissipated by the 10k resistor will be 150mW.

The 10u prevents very sharp dips or drops from activating the circuit.

As the voltage drops, this drop in voltage will be passed directly to the top of the 10k resistor and as the voltage drops, the current into the base of the transistor will reduce. This current is amplified by the transistor and when it is not sufficient to keep the relay activated, it will drop-out.

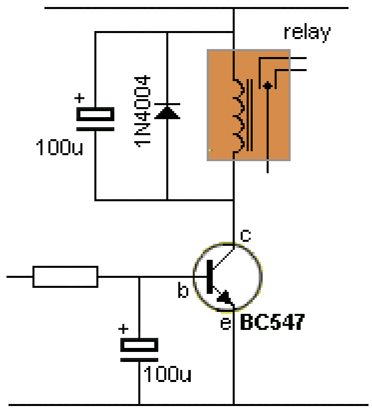
PROTECTING THE CONTACTS OF A RELAY

The contacts of a relay can be protected from the damaging effects of reversing an actuator.



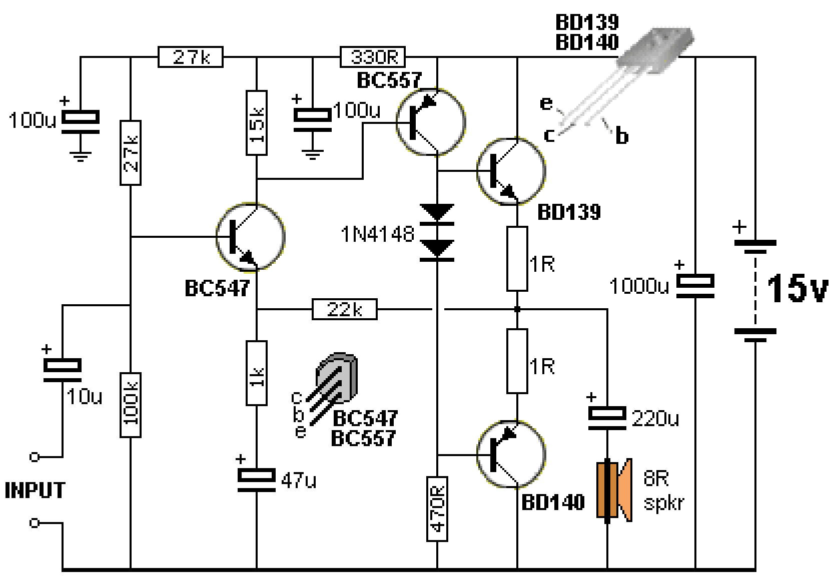
The circuit shows a double-pole double-throw relay driving an actuator. The 4 “bridge diodes” around the actuator “squelch” the back-emf from damaging the contacts.

REDUCING RELAY CHATTER



To reduce the relay clicking or chattering during the activation of the relay driver transistor, an electrolytic can be placed between the base and 0v rail. In addition an electro can be placed across the relay if there is a possibility of the supply voltage glitching or temporally failing.

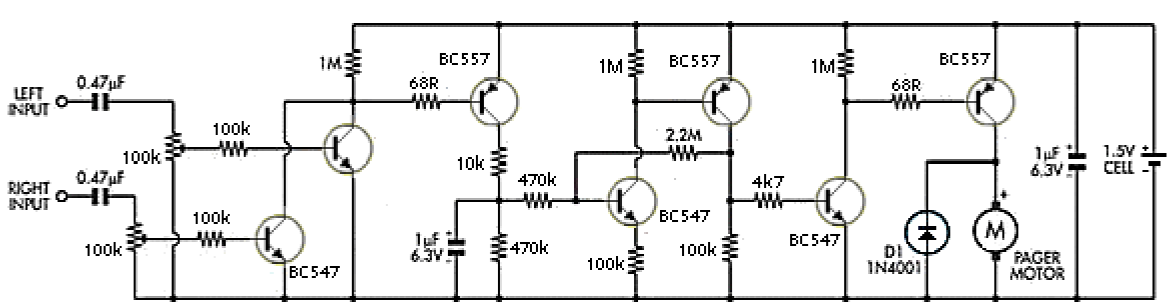
4 TRANSISTOR AMPLIFIER.



This circuit is fully documented in The Transistor Amplifier as Fig 105.

VIBRATING VU INDICATOR

This circuit can be used to monitor the output of a stereo to warn when the level is too high.

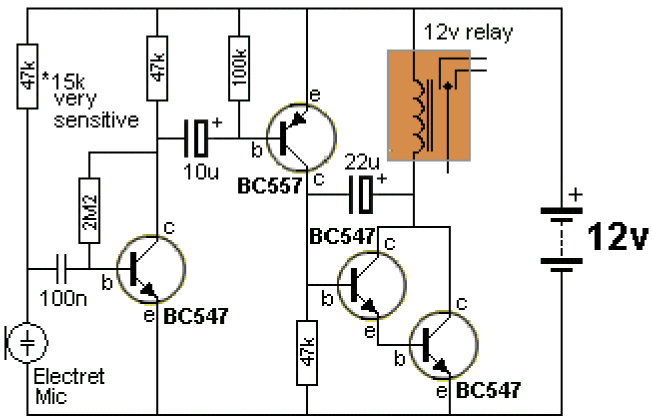


The output is a pager motor and will vibrate so you don't have to keep watching VU levels. The first two transistors are connected so an overload in either channel will trigger the pager motor. No power switch is needed as all transistors are turned OFF when no audio is being detected.

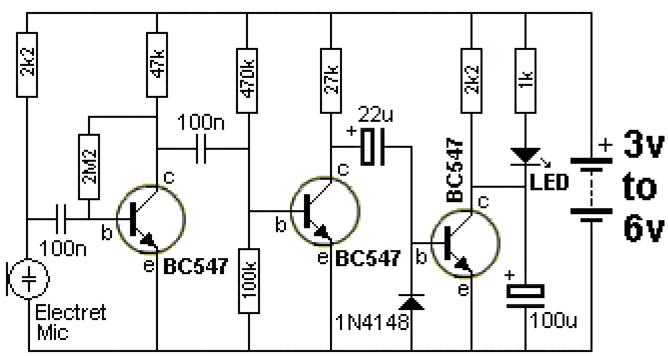
VOX

These circuits detect audio and operate a relay or produce an output pulse. See full details in: The Transistor Amplifier eBook - under VOX

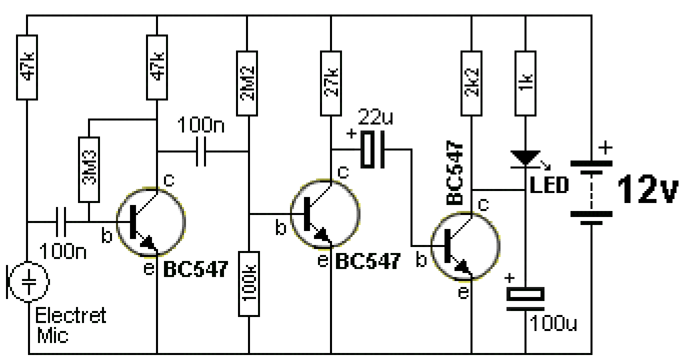
Sensitive VOX Circuit:



3v to 6v VOX Circuit:

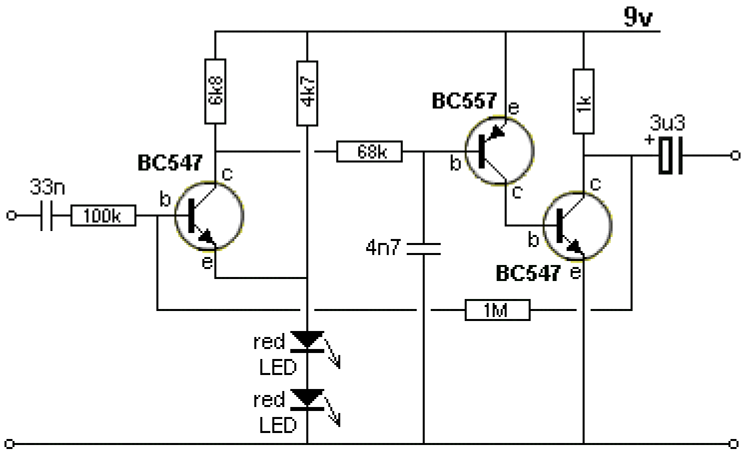


12v VOX Circuit:



OP-AMP WITH 3 TRANSISTORS

This circuit shows how a simple operational amplifier can be made with 3 transistors.

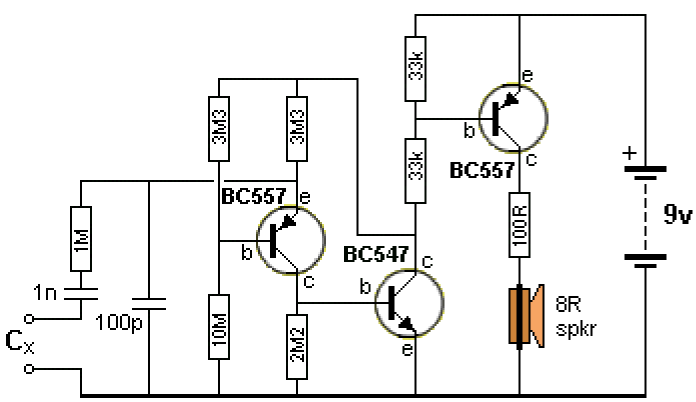


It is really an AC-coupled single-ended class A amp, with an open-loop gain of about 5,000, but as a demonstration-circuit, you can treat it as a simple op-amp. The output is biased at approximately one-half the supply voltage using the combined voltage drops across the two LEDs, the emitter-base voltage of the input transistor and the 1v drop across 1M feedback resistor. The 68k and 4n7 form a compensation network that prevents the circuit from oscillating.

You can configure this op amp as an active filter or as an oscillator. It drives a load of 1k. The square-wave response is good at 10kHz, and the output reduces by 3dB at 50kHz.

CAPACITOR TESTER

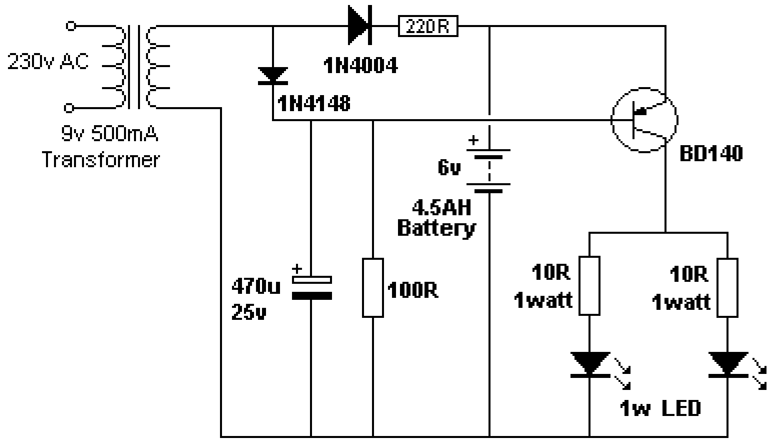
Circuit designed by: Charles Wenzel charles@wenzel.com



This circuit will test very small capacitors. The tone from the speaker will change when a capacitor is placed across the test-points "Cx."

The operation of the circuit is explained in our eBook: The Transistor Amplifier (high impedance circuit).

HIGN BRIGHT LED - EMERGENCY LIGHT



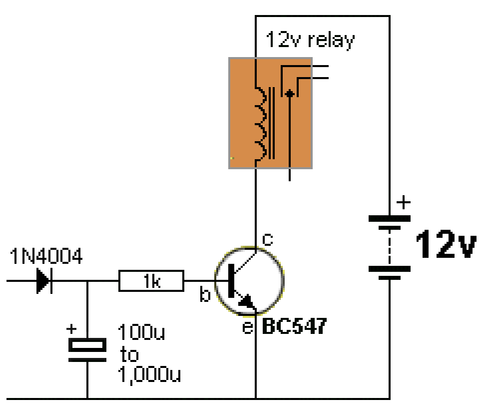
This circuit will illuminate two 1watt High-bright LEDs when the power fails. The charging current is about 20-30mA. It will take about 7 days to charge the battery and this will allow illumination for 5 hours, once per week.

A charging current more than 50mA will gradually "dry-out" the battery and shorten its life.

If the project is used more than 5 hours per week, the charging current can be increased.

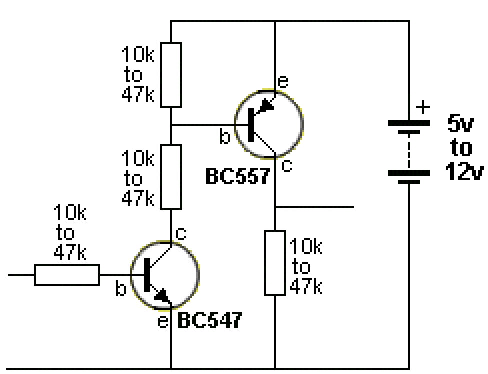
The 220R charging resistor can be reduced to 150R or 100R (1watt).

RELAY OFF DELAY



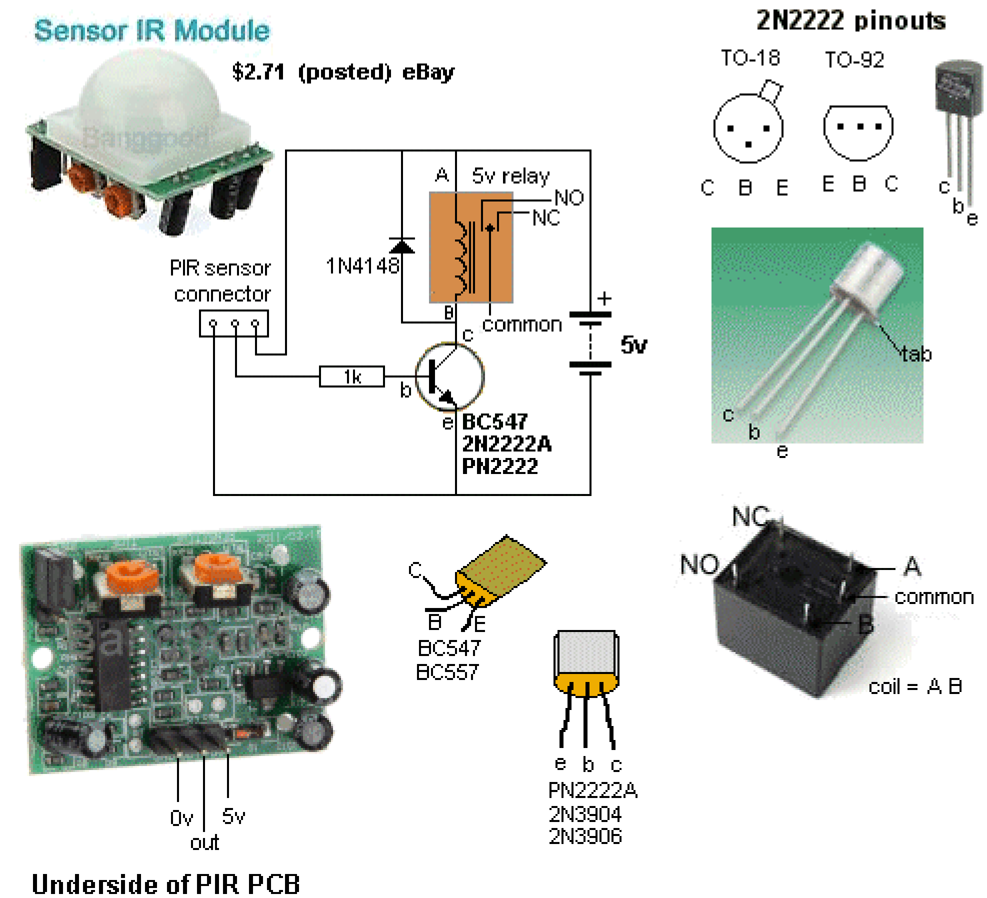
This circuit turns ON a relay when the input is above 2v and the relay turns OFF after 2 seconds when the signal is removed. The OFF delay can be increased or decreased.

AMPLIFYING A DIGITAL SIGNAL



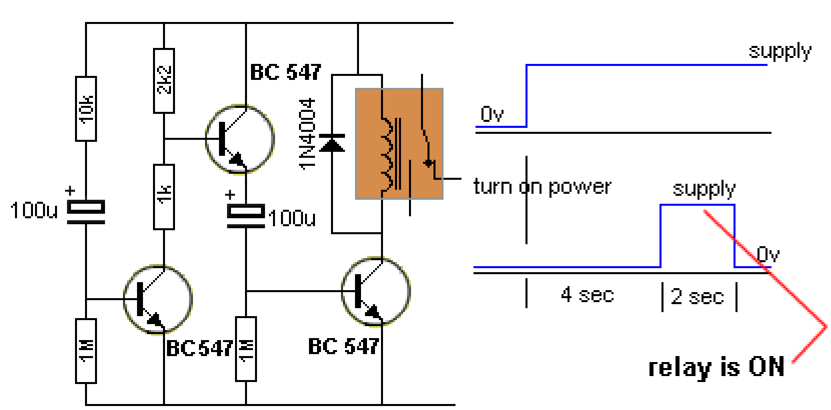
A Digital signal is only detected as a HIGH or LOW. However if the digital signal does not have sufficient amplitude, it may not be detected AT ALL. This circuit detects a low amplitude signal and produces a high-amplitude signal.

PIR DETECTOR (see also LED Strip Passage Light)



This circuit detects movement and operates a relay. The PIR module has "Sensitivity" and "Time Delay" pots. They can be purchased on eBay for $2.71 including postage!

DELAY before Turn On then turns OFF



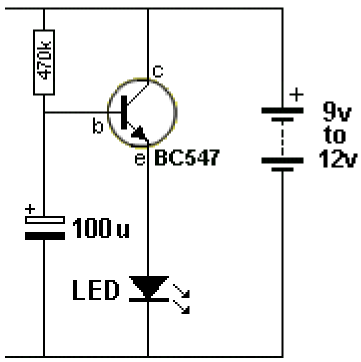
This circuit turns ON the relay 4 seconds after the power is applied and then turns it OFF after 2 seconds.

This is a request from a reader.

You will need to change the component values to suit your own timing.

10 SECOND DELAY

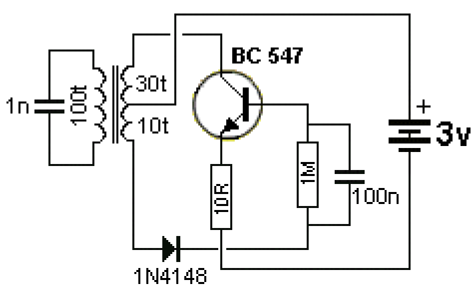
This clever circuit turns on the LED 10 seconds after the power has been switched ON. The secret to its performance is the gain of the transistor.



With a gain of 200, the transistor will appear as a 470/200 = 2k3 resistor for the LED and for a 12v supply, this will create a current of 12-1.7 / 2300 = 4.4mA through the LED. The 100u will take about 10 seconds to charge to a point where the base is 1.7v + 0.6v = 2.3v above the 0v rail. When the electro charges to this voltage, the LED starts to come on.

The transistor effectively becomes a 2k3 resistor and that's why no additional current-limiting resistor for the LED is needed. The transistor is the current-limiting device!

FERRET FINDER

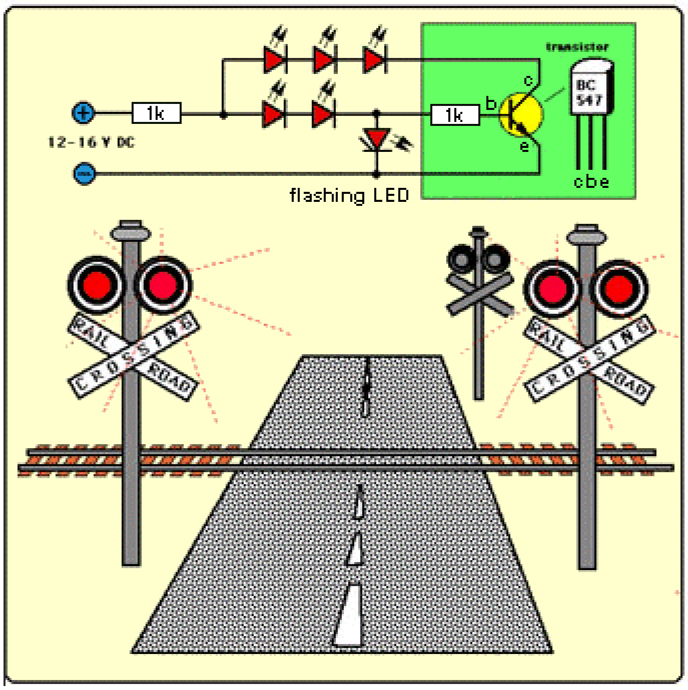


This circuit produces a beep-beep-beep at approx 190kHz on a Long Wave Band radio.

The transformer (coil) is wound on 10mm dia ferrite rod 10mm long. The secondary winding is 0.25mm wire. The 135t is 0.01mm wire. The PC board is 16mm x 14mm.

The secret to the circuit working is the "transformer." The ferrite must be very short so the flux produced by the circuit saturates the core and the excess is passed to the surroundings. A kit for the Ferret Finder is available from talking electronics for $5.00 plus postage.

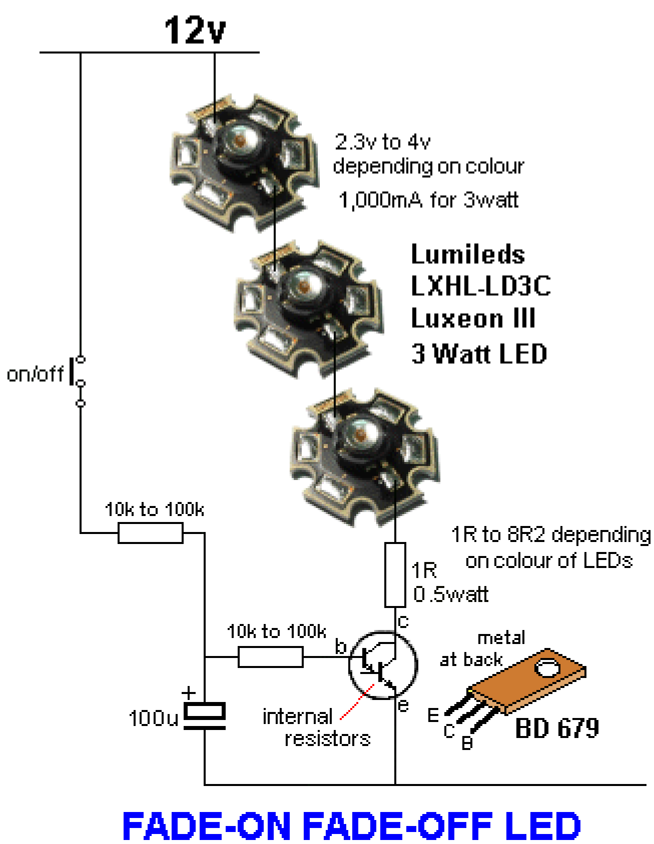
FLASHING LIGHTS FOR MODEL RAILWAY CROSSING



A flashing LED is used to create the timing for the flash-rate and the transistor provides the alternate flash for the second set of LEDs.

FADE-ON FADE-OFF LED

The LEDs in is circuit fade on when the power is applied and fade-off when switched off:

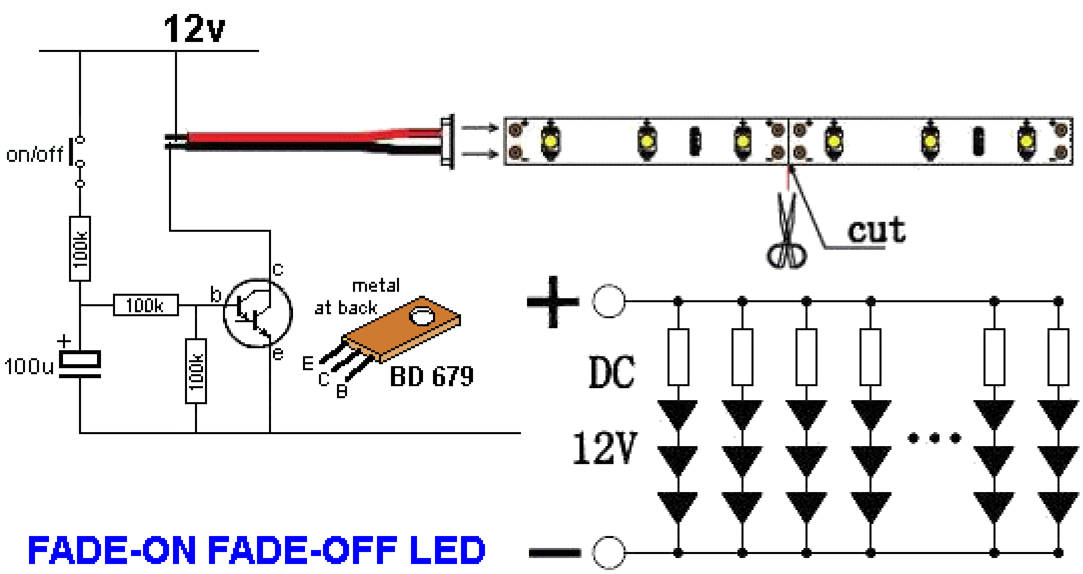


If you just want fade-ON and fade-OFF, this circuit is all you need. The Darlington transistor has internal resistors between the base and emitter of each transistor and these will reduce the input impedance of the transistor considerably. That's why you may have to use fairly low-value resistors on the delay section. Using two separate (normal) transistors will allow the resistor-values to be 100k.

You can also drive "rope lights."

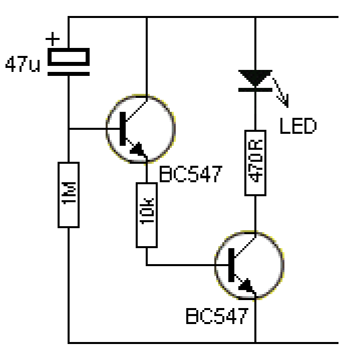
These can be surface-mount LEDs or totally-sealed LEDs and generally have two wires connected to one end for the 12v supply.

Three LEDs are generally connected in series inside the "rope" with a dropper resistor and some "ropes" can be cut after each set of three LEDs as shown in the diagram below:



Each set of three LEDs draws about 20mA so a rope of 24 LEDs takes about 160mA. Adjust the first two 100k resistors and 100u to set the fade-IN and fade-OUT feature.

3-SECOND DELAY



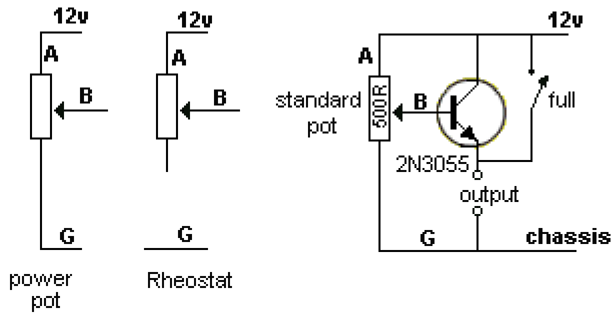
When this circuit is connected to a supply (from 3v to 12v), the LED turns on and gradually fades after about 3 seconds.

REPLACING A "POWER POT"

A Power Potentiometer (also called a rheostat) is a potentiometer with a rating of 1watt or more and these can be very expensive. A 10watt pot can cost as much as $25 to $35.

This type of pot can be replaced very cheaply by using an ordinary 500R pot and a power transistor.

The power pot generally "burns out" when it is at least resistance and this circuit replaces the pot with one slight exception.

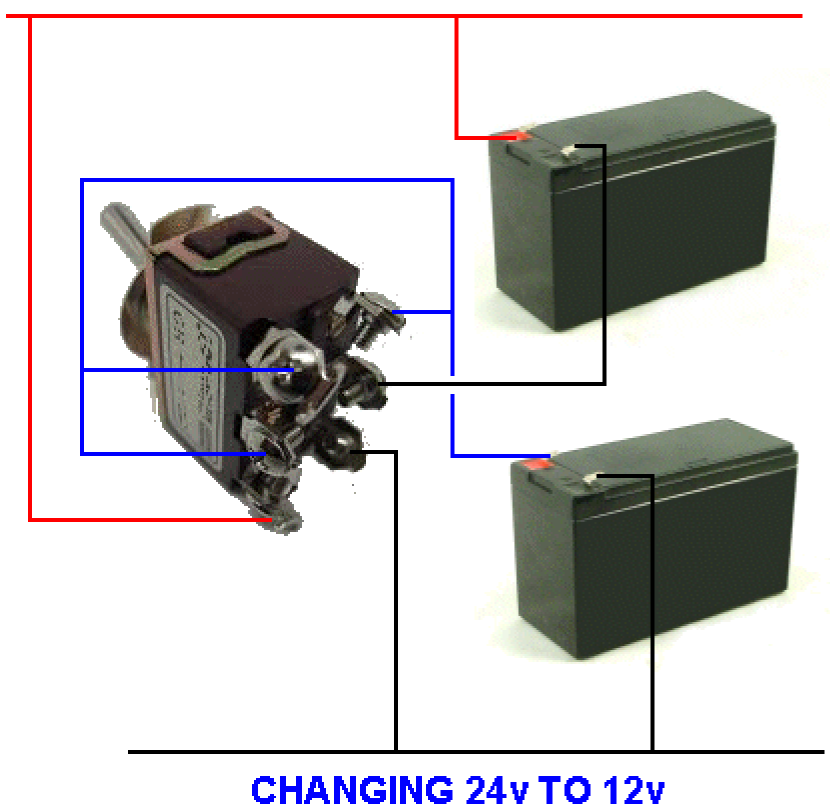


The circuit does not deliver full rail voltage. The output is about 0.9v below rail voltage. A switch has been included to produce full rail output: 10 watt POWER POT If the Power Pot is a rheostat, it will have two terminals. One terminal called "A" will go to rail voltage and the other terminal (the centre terminal - called the wiper) we will call "B," will go to the load.

Build the circuit above and take A and B to the same points as before and "G" goes to Ground or "earth" or "Chassis."

CHANGING 24v to 12v

This circuit allows to you charge a 24v project from a 12v charger. It converts the two 12v batteries from series to parallel:



ZENER DIODE TESTER

All diodes are Zener diodes. For instance a 1N4148 is a 120v zener diode as this is its reverse breakdown voltage.

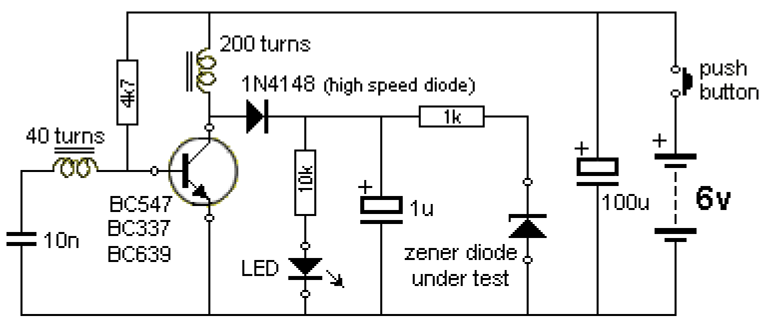
And a zener diode can be used as an ordinary diode in a circuit with a voltage that is below the zener value.

For instance, 20v zener diodes can be used in a 12v power supply as the voltage never reaches 20v, and the zener characteristic is never reached.

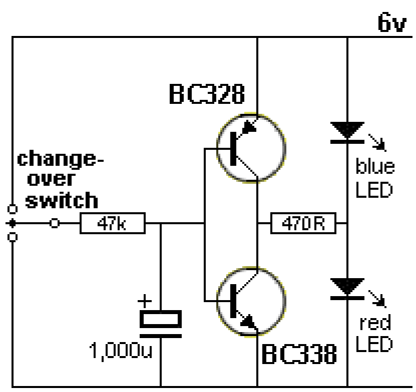
Most diodes have a reverse breakdown voltage above 100v, while most zeners are below 70v. A 24v zener can be created by using two 12v zeners in series and a normal diode has a characteristic voltage of 0.7v. This can be used to increase the voltage of a zener diode by 0.7v. To tests a zener diode you need a power supply about 10v higher than the zener of the diode. Connect the zener across the supply with a 1k to 4k7 resistor and measure the voltage across the diode. If it measures less than 1v, reverse the zener.

If the reading is high or low in both directions, the zener is damaged.

Here is a zener diode tester. The circuit will test up to 56v zeners.



LED FADER



This circuit was requested by a theatrical group to slowly change the colour of a set of LEDs over a period of 1-2 seconds.

POINT MOTOR DRIVER

One of the first things (you will want) when expanding a model railway is a second loop or siding.

This needs a set of points and if they are distant from the operator, they will have to be electrically operated. There are a number of controllers on the market to change the points and some of them take a very high current. (You can get a low-current Point Motor).

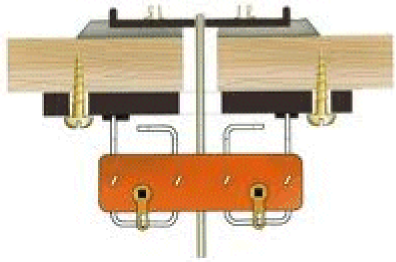
The high current is needed because the actuating mechanism is very inefficient, but it must be applied for a very short period of time to prevent the point motor getting too hot.

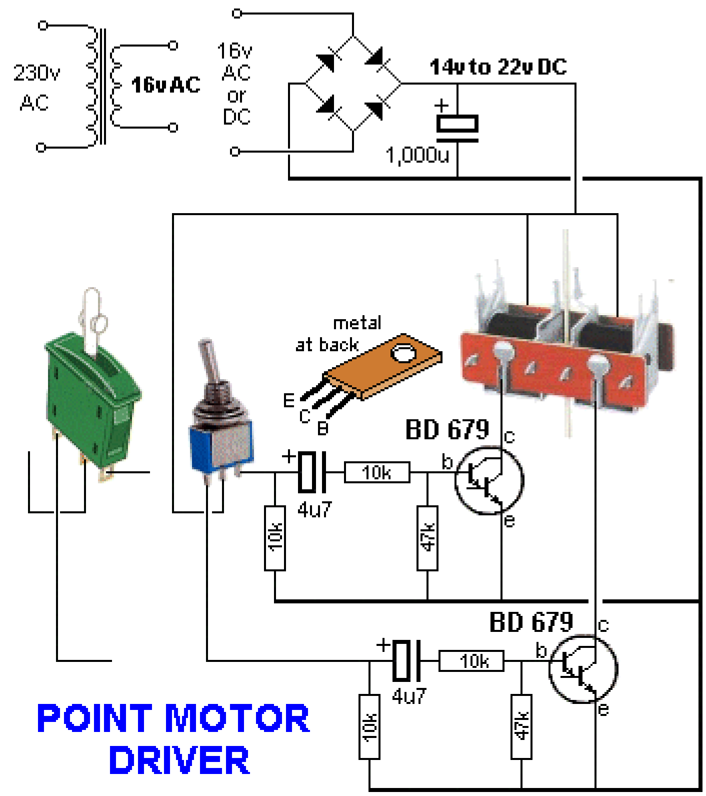
Sometimes a normal switch is used to change the points and if the operator forgets use it correctly, the Point Motor will "burn-out" after a few seconds.

To prevent this from happening we have designed the following circuit. It operates the Point Motor for 5mS to 10mS (a very short time) and prevents any damage.

You can use a Peco switch (PL23 - about $10.00!!) or an ordinary toggle switch (change-over switch).

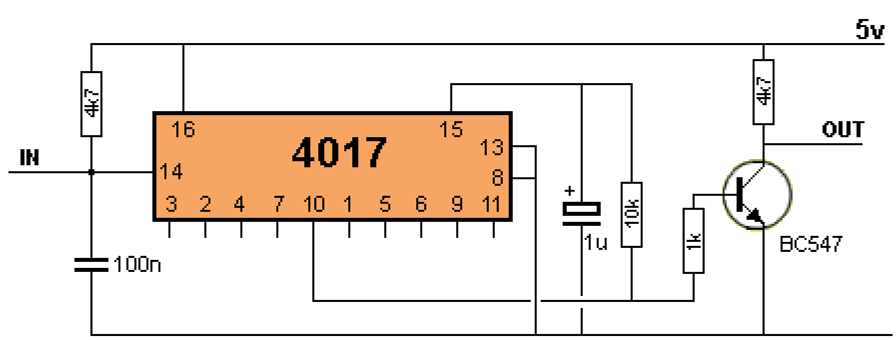
You can connect to either side of the Point Motor and both contacts of the other side go to 14v to 22v rail.





Point Motor mounted under the track. The Point-Motor shaft moves left-right to change the points.

COIN COUNTER

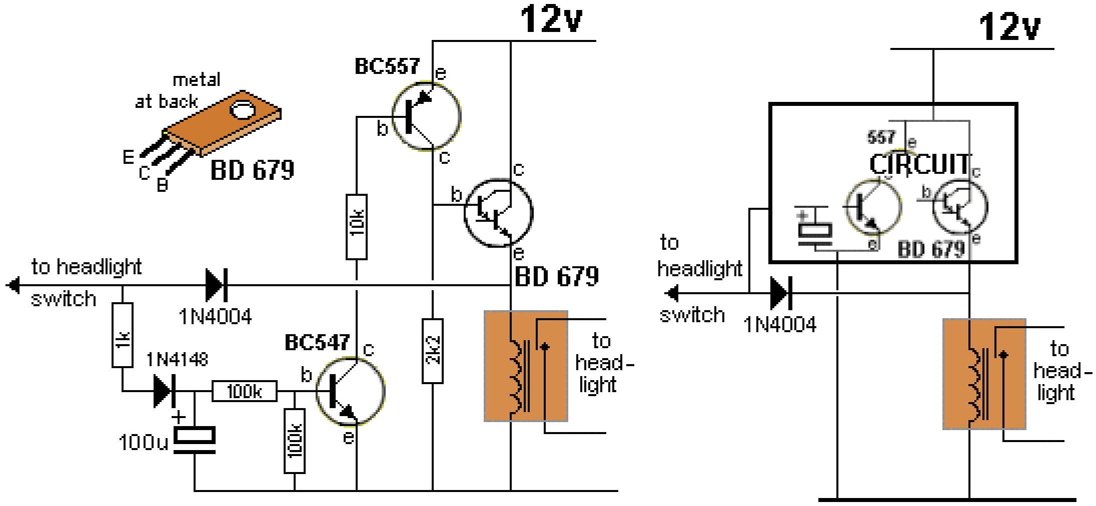


This circuit was designed for a reader who wanted to change his amusement machine from 3 coins to 4 coins.

The circuit can be modified to “divide-by” any value from 2 to 10:

HEADLIGHT EXTENDER

This circuit extends the “ON TIME” for headlights and the circuit does not take any current when the time has expired. When the headlights are switched OFF, the circuit keeps the lights ON for 30 seconds.



The electronics needs 3 connections. The diagram above shows these connections. The first connection is to the 12v side of the battery. The output of the circuit is the emitter of the BD679 transistor and this connects to the relay where the wire from the headlight switch is connected. Finally the circuit connects to the chassis of the car. The “delay-time” is determined by the 100u and 100k resistor. The resistor can be increased to 470k and the capacitor can be increased to 470u. For an adjustable time-delay, use a 500k mini trim pot for the 100k resistor.

TURN INDICATOR ALARM

Many turn indicators in cars, motor bikes and golf carts are not very loud.

That’s why they get left ON.

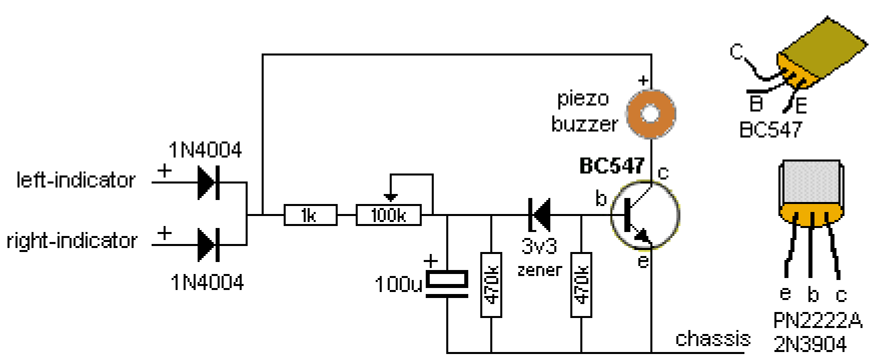
Here are 2 circuits for you to experiment with and work out which is the best for your application. They all use a piezo buzzer that has an oscillator circuit inside the case and produces a 3kHz annoying tone. We have listed two different types. TypeA produces a constant 3kHz tone that increases with loudness as the voltage increases.

TypeB is called a REVERSING BUZZER and produces a beep-beep-beep when a constant DC voltage is applied. The output increases in volume as the voltage increases.

Circuit A turns on after 15 seconds to let you know the turn indicator is active.

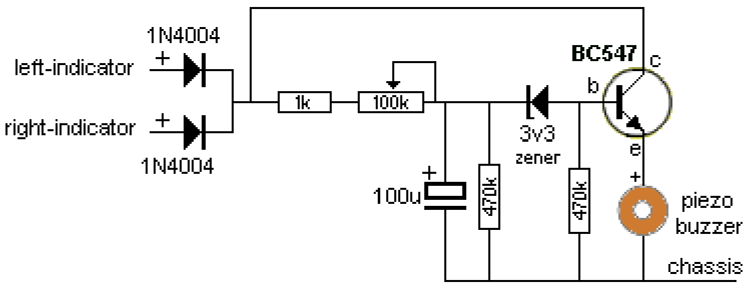
You can use Piezo TypeA to get a beep when the turn light is ON and silence when the light is OFF.

Piezo typeB will produce a beep-beep-beep when the light is ON and silence when it is OFF.



Beeps after 15 seconds.

Circuit B turns on after 15 seconds and the piezo will increase in loudness.

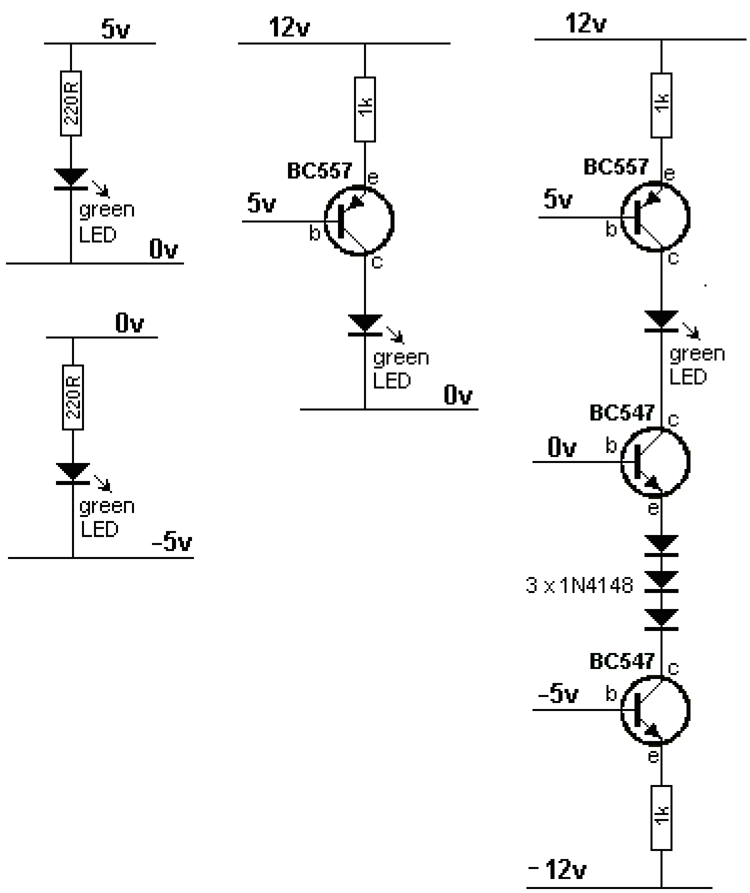


Beeps after 15 seconds with increasing volume

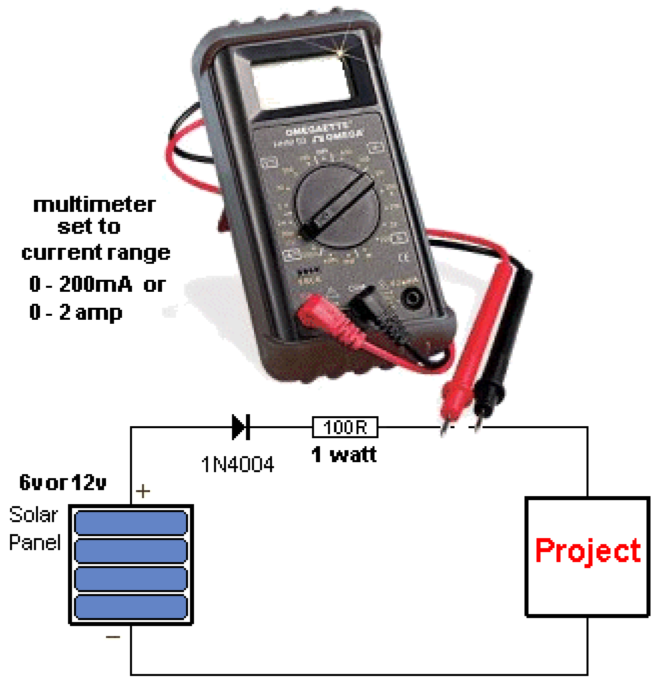
A piezo buzzer requires about 15mA and operates from 3v to 12v. Reversing buzzers are available from Talking Electronics for $4.50 each. They are also available on the web for $20.00

SUPPLY VOLTAGE MONITOR

These circuits will monitor supply voltages of ±5v and ±12v. They are not intended to indicate the level of the inputs. The LED will only illuminate when all the voltages are present.



SOLAR CHARGER



This is a simple circuit to keep a set of NiCads fully charged via a solar panel.

The mathematics and the circuit is the same for a 6v or 12v solar panel.

The mathematics revolves around CURRENT and not VOLTAGE. Remember: NiCad cells are 1.2v and you will need 5 cells to produce a 6v supply.

Ni-MH cells are 1.2v and come in 1,700mAHr and 3,000mAHr (and other capacities).

You can recharge ordinary alkaline cells (1.5v) about 50 times. It has about the same capacity as NiCad after the second re-charge.

1. MEASURE THE CURRENT TAKEN BY THE PROJECT Firstly measure the current taken by the project. If it is a constant 10mA, you will need to charge the batteries with 40mA from the solar panel, if we assume the sun shines for 8 hours per day.

If the circuit takes 1amp for 1 hour, we need to charge the batteries with 150mA for 8 hours of sunshine.

If the circuit takes 500mA for 15 minutes each hour, this is equivalent to a constant 125mA and the charging will have to be 500mA for 8 hours each day. (Even though this is equal to 3Ahr per day, the charging occupies 8 hours and thus the storage only needs to be 2Ahr and 2400mAHr cells can be used).

Our mathematics takes into account 80% efficiency in charging the cells.

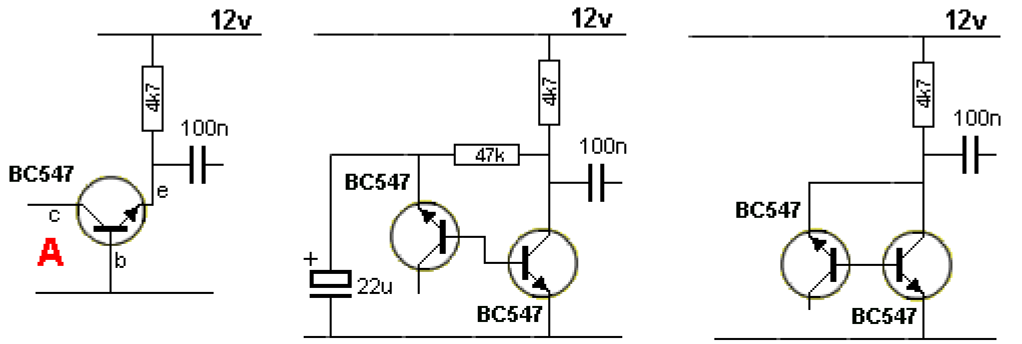
If the NiCad cells are 600mAHr, the maximum charging current is 100mA.

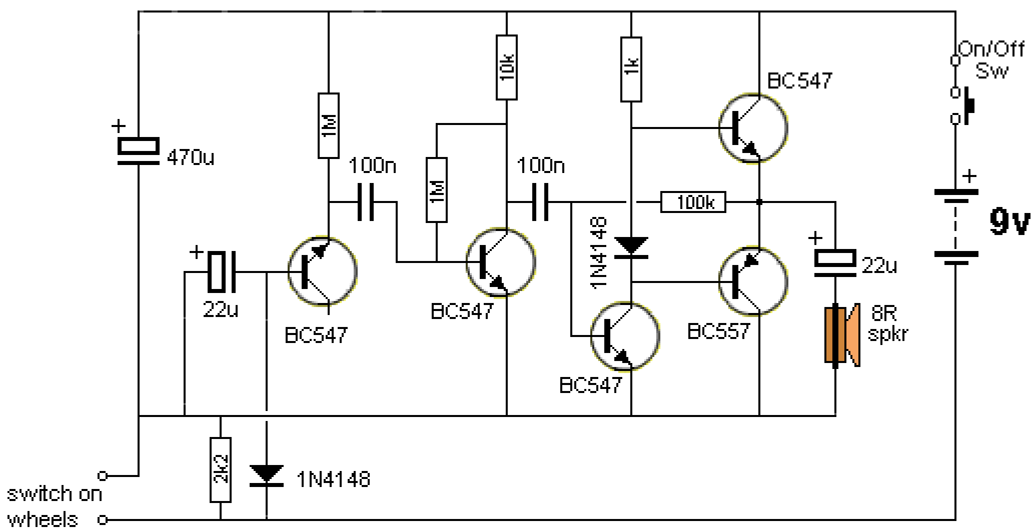
If the cells are 2,400mAHr, the maximum charging current is 500mA.

This charging current takes into account the fact that the cells will be fully charged towards the end of each day and that's why the current should not be too high.

2. MEASURE THE CHARGING CURRENT Build one of the circuits below and use a 100 ohm (1 watt) resistor for the current-limiting. Connect a multimeter (select 0 - 500mA or 0 - 2Amp range) as shown and measure the current during the day. Take a few readings and work out and average current and approx the length of each day. Every solar panel will deliver a different current and it is not possible to specify any values. That's why you have to take readings. If the current is too high, add another 100 ohm resistor in series. If the current is too low, place a 100 ohm resistor across the first 100 ohm resistor.

WHITE NOISE GENERATOR





STEAM ENGINE SIMULATOR

The basis of a white noise generator is the reverse connection of the base-emitter junction of a transistor as shown in fig A. When the junction sees a voltage above about 5v, it breaks down and this causes the voltage to reduce. The junction ceases to break down and the condition repeats. The result is a waveform of a few millivolts to over 2v, depending on the value of the resistor supplying current to the junction. This noise sounds like "ssssssssss" and can be added to an amplifier to produce all sorts of sound effects including Steam Sound for a model railway. The waveform contains all amplitudes and frequencies from audible up to AM broadcast band.

Try the following circuits and see how they work. The supply must be over 5v and preferably more than 8v. That's why many of the circuits specify 12v and higher.

INTERCOM or TELEPHONE HANDSET

You can make your own intercom or replace circuitry in old-style handsets with either of these circuits.

Telephone amplifier circuits are completely different to normal amplifier circuits. For a start, they have very high negative feedback to prevent "whistle" and in telephone-speak the circuit is designed so sounds from the earpiece (receiver) are not picked up by the mouthpiece (microphone) and amplified to crate a whistle.

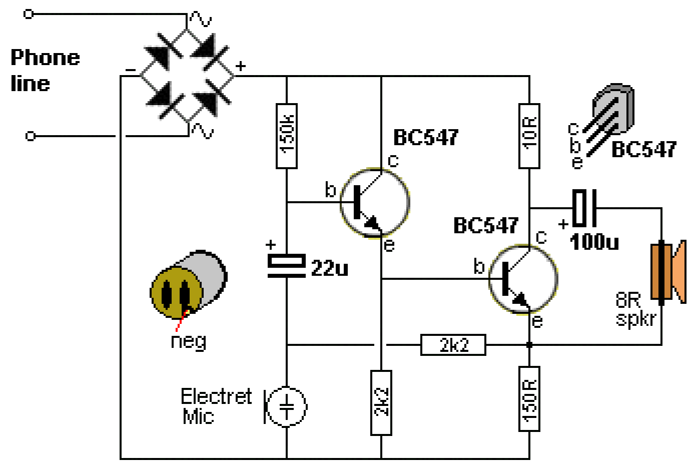
Secondly, the load for the amplifier is actually the relay at the exchange and the signal is picked off at the point where the amplifier connects to the relay and sent to the other telephone.

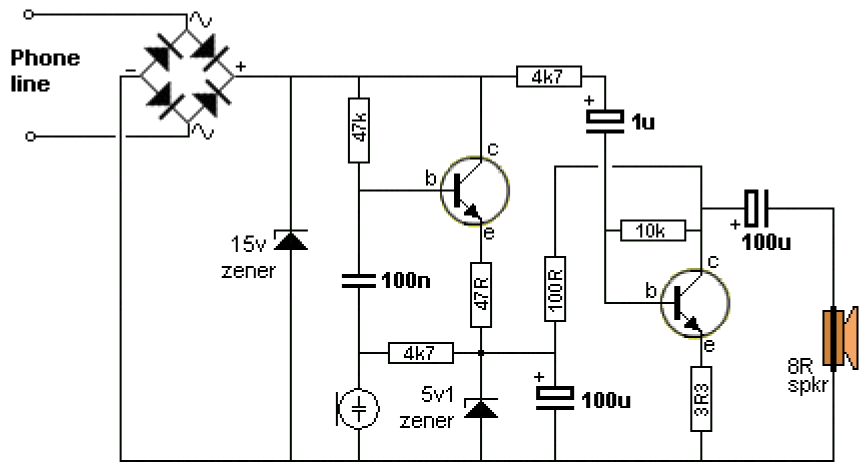
This means the supply for both the pre-amplifier and the output stage are on the same wire as the signal to the other phone.

The voltage across the first circuit is generated by the 150k turning ON the first BC547 transistor and it "pulls-up" the second transistor (a partial emitter follower).

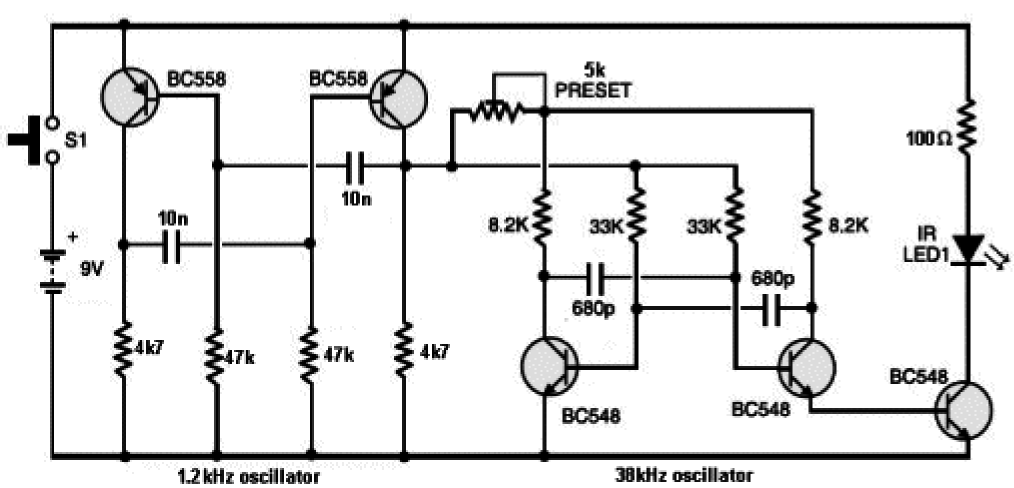
This creates current through the 150R and a voltage is developed across this resistor so that a voltage of approx 15v is developed across the whole circuit.

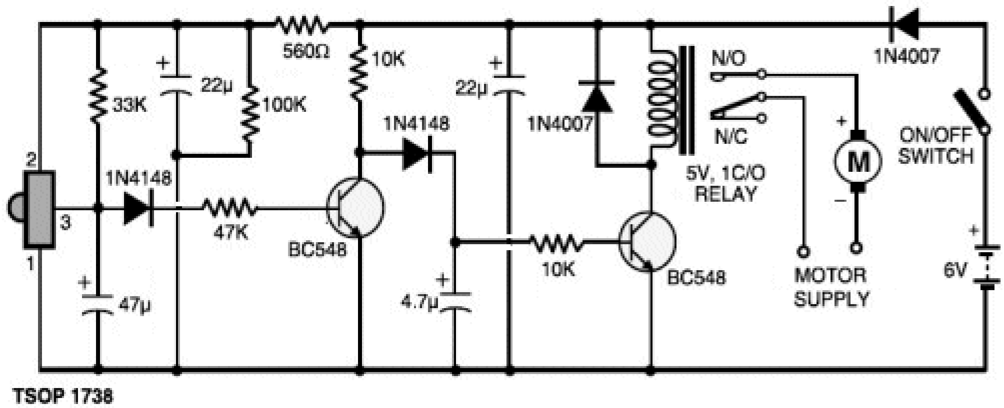
Here are two circuits for the handset:





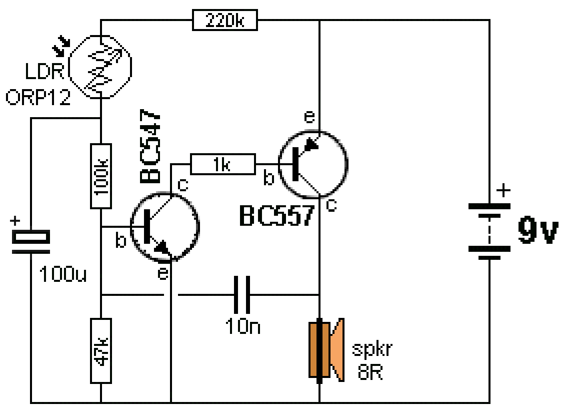
38KHz INFRARED LINK





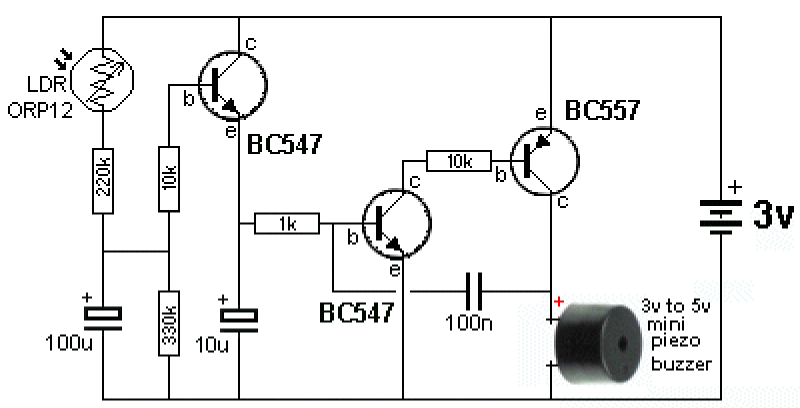
This circuit is an IR transmitter and IR receiver with a 38kHz detector TSOP 1738 in the receiver. This means the circuit will be immune to ambient light. The motor is activated when the transmitter is turned ON.

FRIDGE ALARM



This circuit will start to produce a sound about 15 seconds after the Light Dependent Resistor detects light:

FRIDGE ALARM MkII



This circuit drives an active piezo buzzer and the circuit takes no current when "sitting around."

It will start to produce a sound about 15 seconds after the Light Dependent Resistor detects light. The mini piezo buzzer contains a transistor and inductor to produce a high amplitude oscillator to drive the diaphragm and produce a loud squeal from a supply of 3v to 5v. It will not "turn on" from a slowly rising voltage so the circuit must be designed to rise rapidly when light is detected. That's the purpose of the 2nd and 3rd transistors. They form a high-gain amplifier where the output rises quickly due to the positive feedback provided by the 100n.

As soon as the second transistor starts to turn on, it turns on the 3rd transistor and the collector voltage rises. The right-plate of the 100n rises and since the 100n is uncharged, the left plate (lead) rises and increases the voltage and also the current into the base of the second transistor. This makes it turn on more and the action continues very quickly until both transistors are fully turned on. They stay turned on by the voltage (and current) provided by the first transistor.

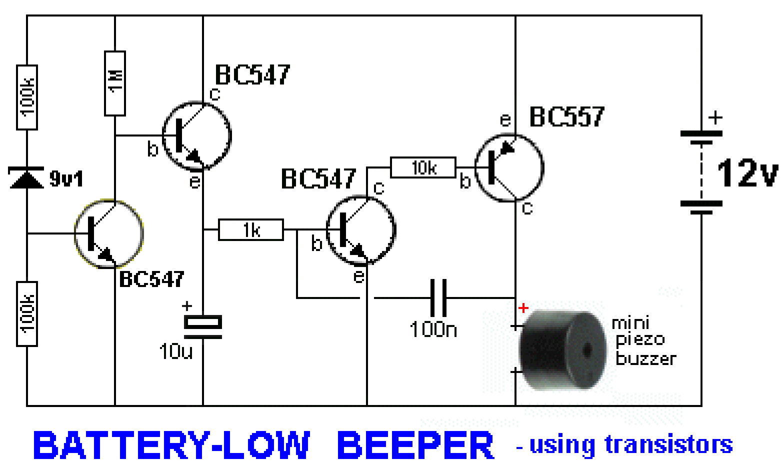
Even though we normally see the second two transistors used as an oscillator, we can use the “rapid turn-on” feature to “kick-start” the piezo and if the middle transistor is provided with too-much voltage (current) on the base, the oscillator feature will not occur because the current into the base is too high and the 100n cannot remove this current during the turn-off period of the cycle. The only unusual feature of this circuit is the oscillator section starts to oscillate at very low amplitude when the first transistor turns off (when the LDR ceases to be illuminated) and a 10u has been added to stop this oscillation so it takes no current when at rest.

All the other designs (using a chip), take a small current when at rest and the worst circuit comes from Future Kit, a Thailand based kit company. You can see the discussion in Spot The Mistake Page 17 under FRIDGE ALARM.

BATTERY-LOW BEEPER

If you want a simpler circuit using transistors, the following design will produce a constant beep when the battery voltage falls below 10v.

The actual voltage can be adjusted by using LEDs and diodes in place of the zener.

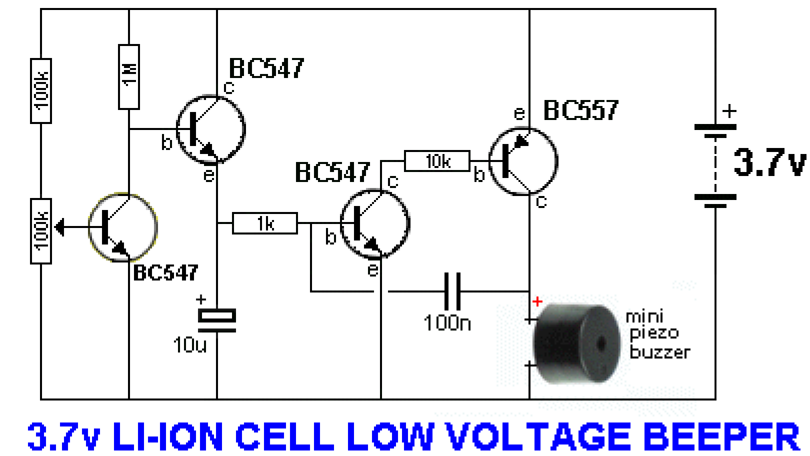


The mini piezo buzzer contains a transistor and inductor to produce a high amplitude oscillator to drive the diaphragm and produce a loud squeal from a supply of 5v to about 10v. It will not “turn on” from a slowly rising voltage so the circuit must be designed to rise rapidly when the voltage drop down to the “detection-point.”

That’s the purpose of the 3rd and 4th transistors. They form a high-gain amplifier where the output rises quickly due to the positive feedback provided by the 100n.

As soon as the third transistor starts to turn on, it turns on the 4th transistor and the collector voltage rises. The right-plate of the 100n rises and since the 100n is uncharged, the left plate (lead) rises and increases the voltage and also the current into the base of the third transistor. This makes it turn on more and the action continues very quickly until both transistors are fully turned on. They stay turned on by the voltage (and current) provided by the first transistor.

Even though we normally see these two transistors used as an oscillator, we can use the “rapid turn-on” feature to “kick-start” the piezo and if the third transistor is provided with too-much voltage (current) on the base, the oscillator feature will not occur because the current into the base is too high and the 100n cannot remove this current during the turn-off period of the cycle. The only unusual feature of this circuit is the oscillator section starts to oscillate at very low amplitude when the second transistor turns off (when the battery voltage rises) and a 10u has been added to stop this oscillation so it takes no current when the buzzer is not producing a tone. The only stages that take any quiescent current are the zener and the 1M collector load resistor.

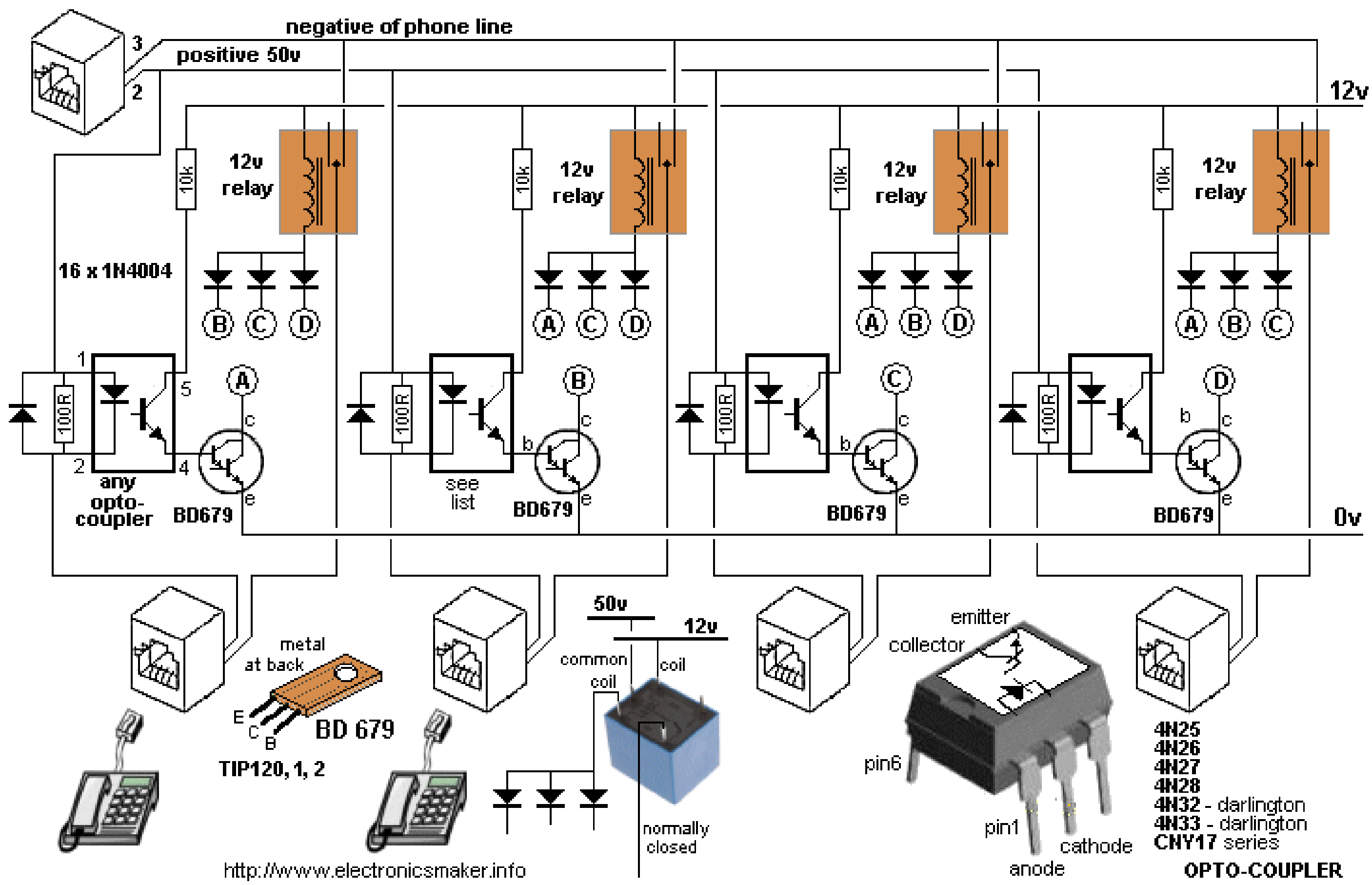


This circuit will buzz when the voltage drops to a pre-set level.

To adjust the circuit, get as many 10,000u electrolytics as possible and use them in place of the Li-ion cell.

Charge the electrolytics with the Li-Ion cell and remove it. The circuit takes a very amount of current and the voltage across the electrolytics will gradually drop. Monitor this with a digital meter and set the 100k pot to the required voltage.

4 PHONE SECURITY



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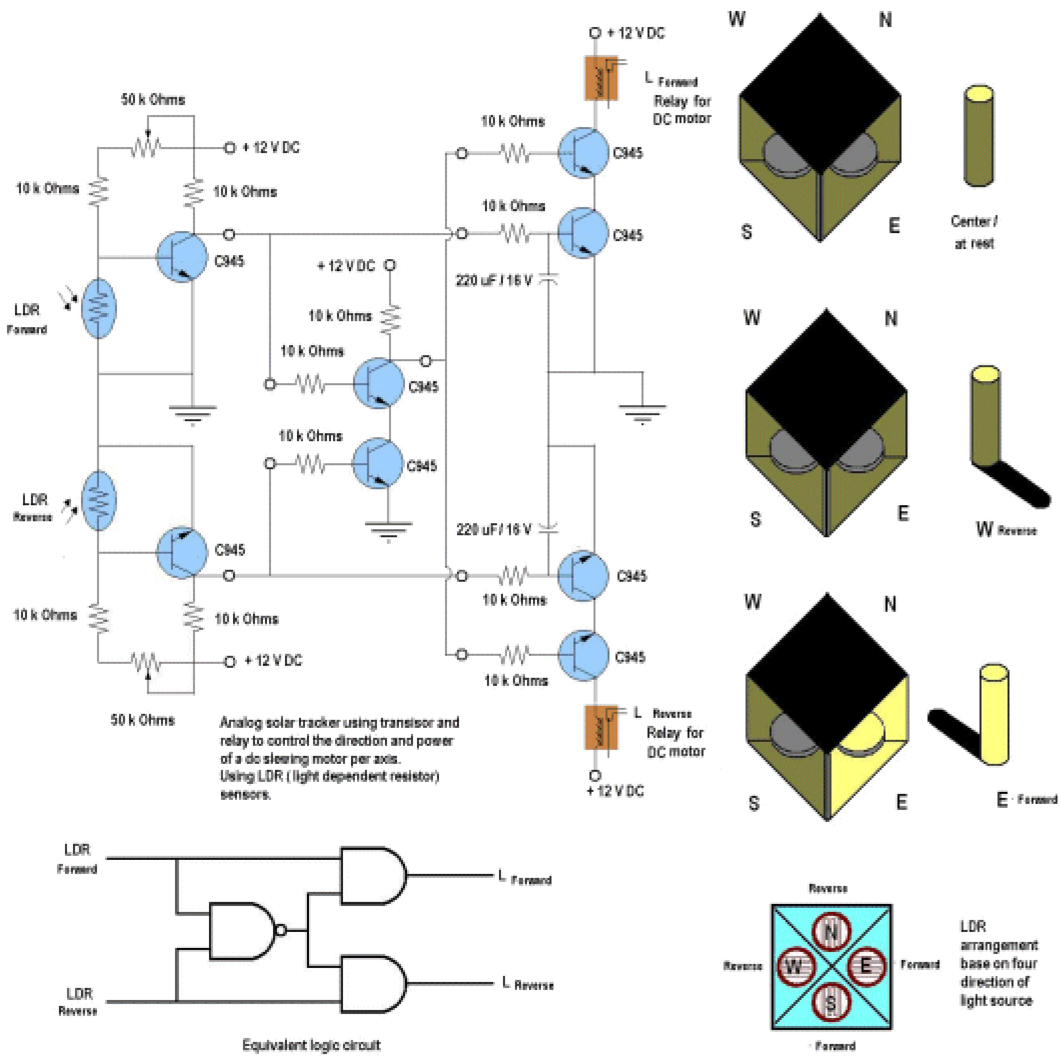
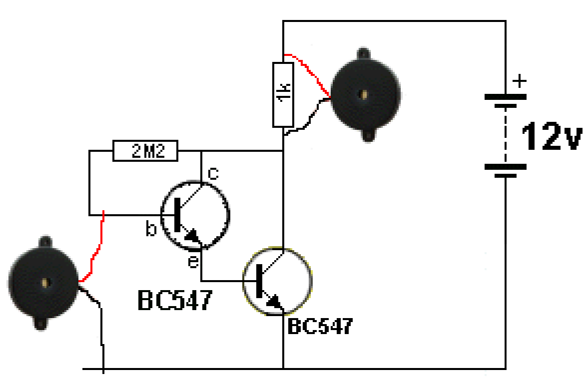
SOLAR TRACKER



SIMPLE SONIC DETECTOR

This is a simple feedback circuit that produces a whistle called a FEEDBACK WHISTLE.



This terrible sound was very common in old amplifiers when the microphone was placed too near the speaker.

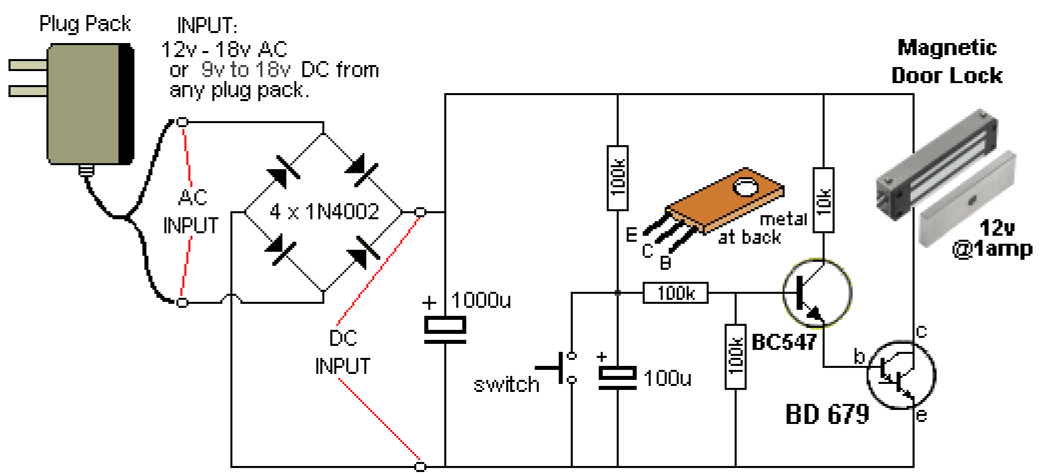
All you need is a high-gain amplifier and a microphone. We have used a piezo diaphragm for both the microphone and speaker.

The circuit works best on 12v but will produce good results on 6v or 9v.

Vary the distance between the two piezos and turn one over and lift it off the bench to see the different effects and range. Move your hand closer to the piezos and see how the frequency changes. This is due to the length of the wave and if you are located at a distance where the wave does not add to the vibration of the receiving diaphragm, you get silence.

The Circuit produces a FEEDBACK WHISTLE

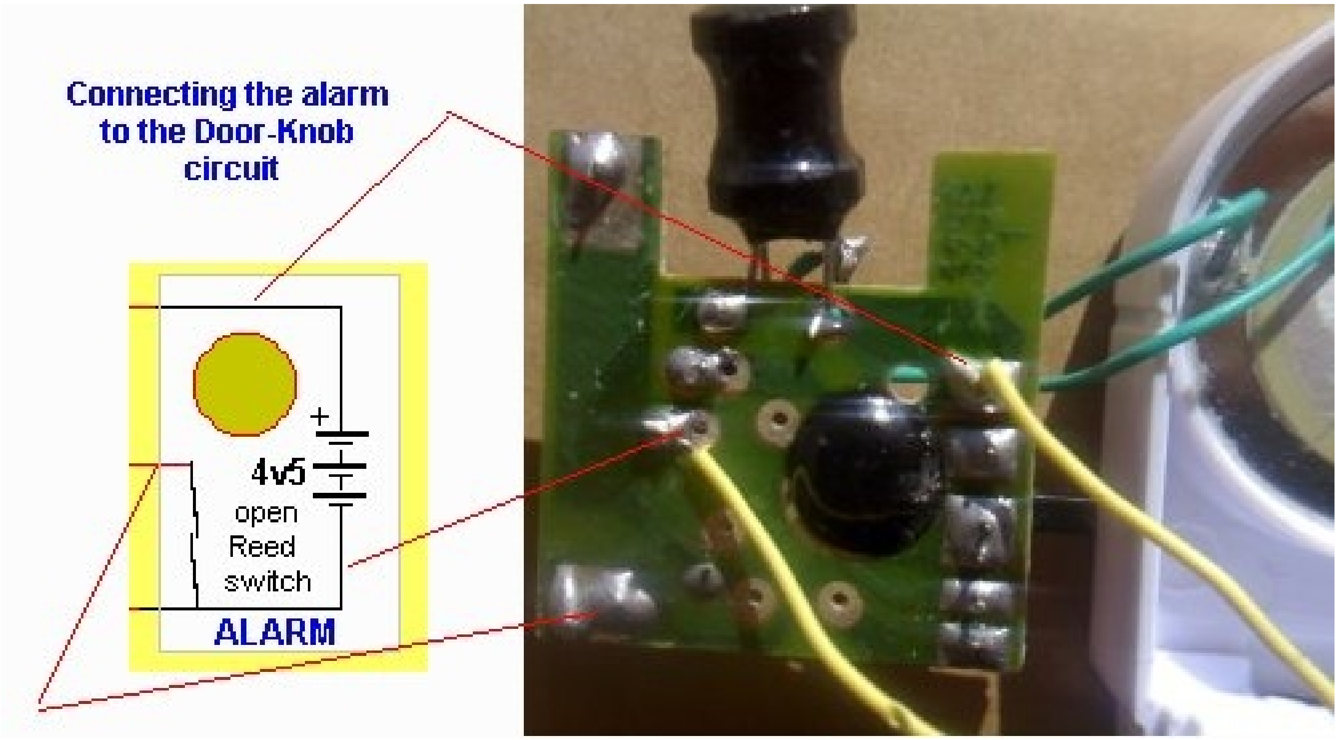
MAGNETIC DOOR LOCK DELAY

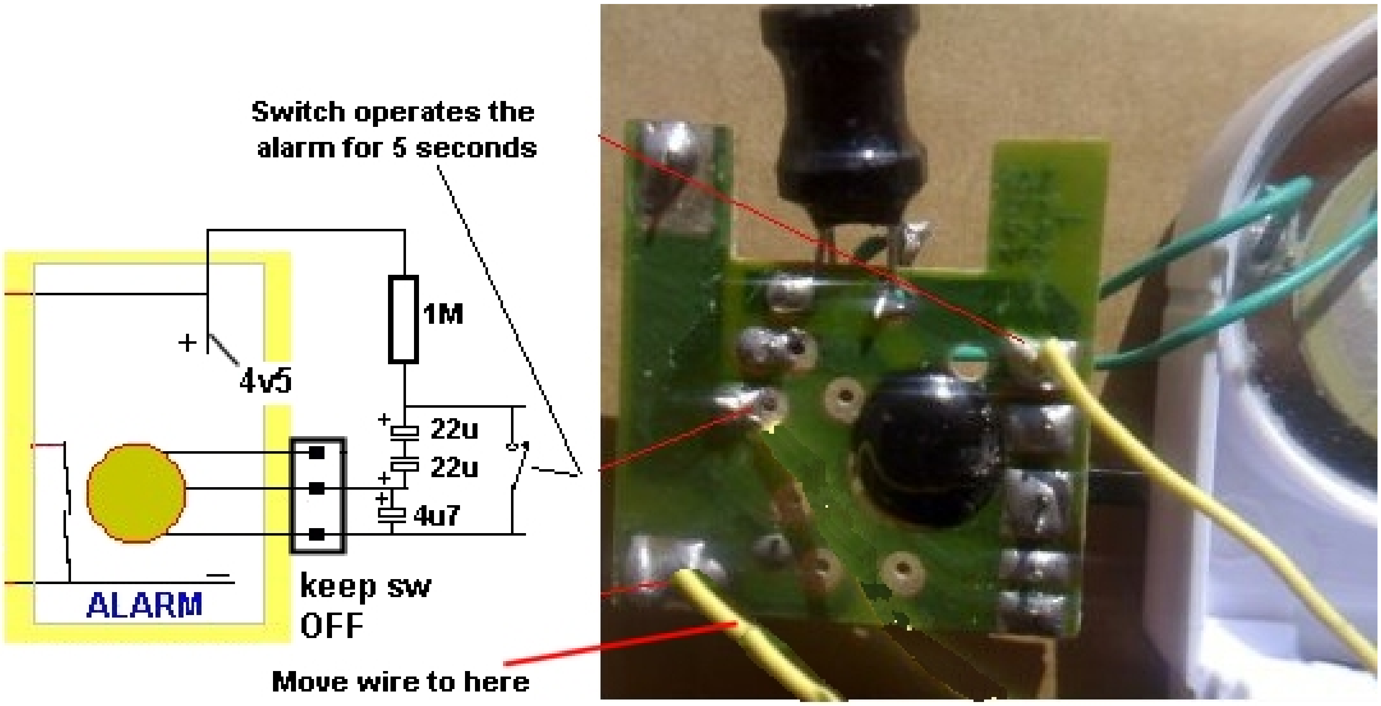


This circuit turns OFF the Magnetic Door Lock for 10 second to 30 seconds to allow you to enter. It turns ON after 10 seconds to 30 seconds.

5 SECOND ALARM

This circuit operates the alarm for 5 seconds, even if the switch is kept closed:





The original reed switch can be used but the bottom connection to the board must be isolated and re-wired. The reed switch cannot be de-soldered as it will fall apart. Change the value of the 4u7 electrolytic to increase the time. Closing the switch (in the circuit diagram above) operates the alarm.

When the voltage between the middle terminal of the slide switch and the lower terminal is reduced to 0v, the circuit operates. A very small current comes from the COB module via the middle pin of the slide switch and this current charges the 4u7 to 4.5v and the circuit turns OFF.

At the same time the two 22u are fully discharged. When the switch is closed, the 4u7 is discharged via the two 22u electrolytics and the alarm is activated. If the switch is immediately released, the 4u7 takes time to charge via the COB module.

If the switch is kept closed, the COB module charges the 4u7 and the 22u electrolytics and eventually turns OFF. If the switch is now opened, the 22u electrolytics discharge via the 1M. This takes a considerable time and the alarm cannot be re-activated for a few seconds.