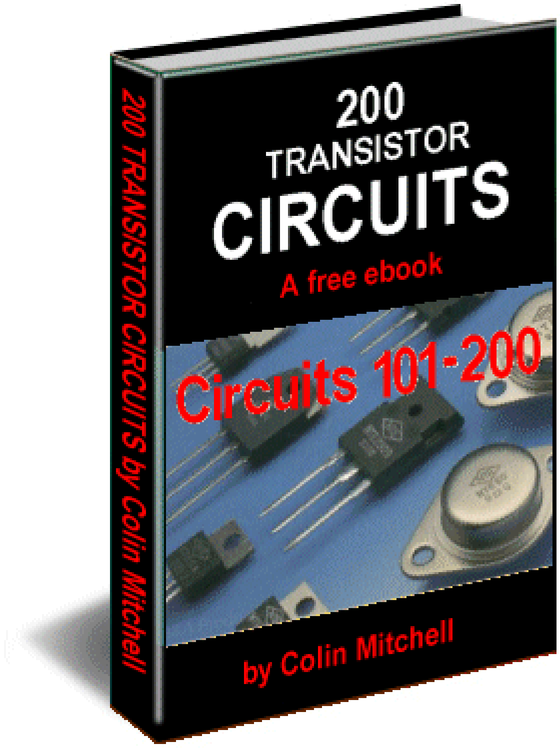


Go to: 1 - 100 Transistor Circuits
Go to: 100 IC Circuits

86 CIRCUITS as of 28-5-2011

Talking Electronics

See TALKING ELECTRONICS WEBSITE

email Colin Mitchell: talking@tpg.com.au

INTRODUCTION

This is the second half of our **Transistor Circuits** e-book. It contains a further 100 circuits, with many of them containing one or more Integrated Circuits (ICs).
It's amazing what you can do with transistors but when Integrated Circuits came along, the whole field of electronics exploded.
IC's can handle both analogue as well as digital signals but before their arrival, nearly all circuits were analogue or very simple "digital" switching circuits.
Let's explain what we mean.
The word analogue is a waveform or signal that is changing (increasing and decreasing) at a constant or non constant rate. Examples are voice, music, tones, sounds and frequencies. Equipment such as radios, TV's and amplifiers process analogue signals.
Then digital came along.
Digital is similar to a switch turning something on and off.
The advantage of digital is two-fold.
Firstly it is a very reliable and accurate way to send a signal. The signal is either HIGH or LOW (ON or OFF). It cannot be half-on or one quarter off.
And secondly, a circuit that is ON, consumes the least amount of energy in the controlling device. In other words, a transistor that is fully turned ON and driving a motor, dissipates the least amount of heat. If it is slightly turned ON or nearly fully turned ON, it gets very hot.
And obviously a transistor that is not turned on at all will consume no energy.
A transistor that turns ON fully and OFF fully is called a SWITCH.
When two transistors are cross-coupled in the form of a flip flop, any pulses entering the circuit cause it to flip and flop and the output goes HIGH on every second pulse.
This means the circuit halves the input pulses and is the basis of counting or dividing.
Digital circuits also introduce the concept of two inputs creating a HIGH output when both are HIGH and variations of this.
This is called "logic" and introduces terms such as "Boolean algebra" and "gates."
Integrated Circuits started with a few transistors in each "chip" and increased to whole mini or micro computers in a single chip. These chips are called Microcontrollers and a single chip with a few surrounding components can be programmed to play games, monitor heart-rate and do all sorts of amazing things. Because they can process information at high speed, the end result can appear to have intelligence and this is where we are heading: **AI** (Artificial Intelligence).

But let's crawl before we walk and come to understand how to interface some of these chips to external components.
In this Transistor Circuits ebook, we have presented about 100 interesting circuits using transistors and chips.
In most cases the IC will contain 10 - 100 transistors, cost less than the individual components and take up much less board-space. They also save a lot of circuit designing and quite often consume less current than discrete components.
In all, they are a fantastic way to get something working with the least componentry.
A list of of Integrated Circuits (Chips) is provided at the end of this book to help you identify the pins and show you what is inside the chip.
Some of the circuits are available from Talking Electronics as a kit, but others will have to be purchased as individual components from your local electronics store.
Electronics is such an enormous field that we cannot provide kits for everything. But if you have a query about one of the circuits, you can contact me.

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

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: http://www.talkingelectronics.com

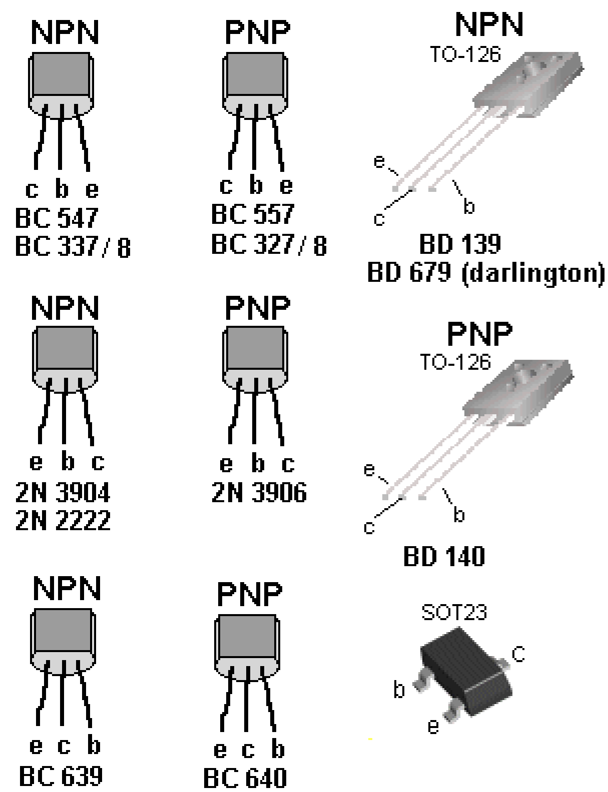
MORE INTRO

There are two ways to learn electronics.

One is to go to school and study theory for 4 years and come out with all the theoretical knowledge in the world but almost no practical experience.
We know this type of person. We employed them (for a few weeks!). They think everything they design WILL WORK because their university professor said so.
The other way is to build circuit after circuit and get things to work. You may not know the in-depth theory of how it works but trial and error gets you there.
We know. We employed this type of person for up to 12 years.
I am not saying one is better than the other but most electronics enthusiasts are not "book worms" and anyone can succeed in this field by constantly applying themselves with "constructing projects." You actually learn 10 times faster by applying yourself and we have had technicians repairing equipment after only a few weeks on the job.
It would be nothing for an enthusiast to build 30 - 40 circuits from our previous Transistor eBook and a similar number from this book. Many of the circuits are completely different to each other and all have a building block or two that you can learn from.
Electronics enthusiasts have an uncanny understanding of how a circuit works and if you have this ability, don't let it go to waste.
Electronics will provide you a comfortable living for the rest of your life and I mean this quite seriously. The market is very narrow but new designs are coming along all the time and new devices are constantly being invented and more are always needed.
Once you get past this eBook of "Chips and Transistors" you will want to investigate microcontrollers and this is when your options will explode.
You will be able to carry out tasks you never thought possible, with a chip as small as 8 pins and a few hundred lines of code.
As I say in my speeches. What is the difference between a "transistor man" and a "programmer?" TWO WEEKS!
In two weeks you can start to understand the programming code for a microcontroller and perform simple tasks such as flashing a LED and produce sounds and outputs via the press of a button.
All these things are covered on Talking Electronics website and you don't have to buy any books or publications. Everything is available on the web and it is instantly accessible. That's the beauty of the web.
Don't think things are greener on the other side of the fence, by buying a text book. They aren't. Everything you need is on the web AT NO COST.
The only thing you have to do is build things. If you have any technical problem at all, simply email Colin Mitchell and any question will be answered. Nothing could be simpler and this way we guarantee you SUCCESS. Hundreds of readers have already emailed and after 5 or more emails, their circuit works. That's the way we work. One thing at a time and eventually the fault is found.
If you think a circuit will work the first time it is turned on, you are fooling yourself. All circuits need corrections and improvements and that's what makes a good electronics person. Don't give up. How do you think all the circuits in these eBooks were designed? Some were copied and some were designed from scratch but all had to be built and adjusted slightly to make sure they worked perfectly.
I don't care if you use bread-board, copper strips, matrix board or solder the components in the air as a "bird's nest." You only learn when the circuit gets turned on and WORKS!
In fact the rougher you build something, the more you will guarantee it will work when built on a printed circuit board.
However, high-frequency circuits (such as 100MHz FM Bugs) do not like open layouts and you have to keep the construction as tight as possible to get them to operate reliably.
In most other cases, the layout is not critical.

TRANSISTORS

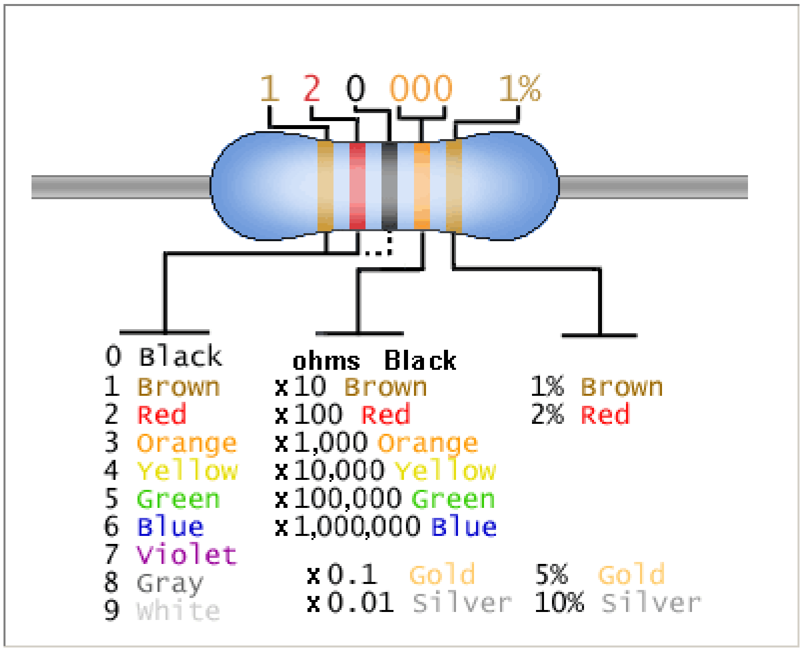
Most of the transistors used in our circuits are BC 547 and BC 557. These are classified as "universal" or "common" NPN and PNP types with a voltage rating of about 25v, 100mA collector current and a gain of about 100. Some magazines use the term "**TUP**" (for Transistor Universal PNP) or "**TUN**" (for Transistor Universal NPN). We simply use Philips types that everyone recognises. You can use almost any type of transistor to replace them and here is a list of the equivalents and pinouts:



CONTENTS

red indicates 1-100 Transistor Circuits

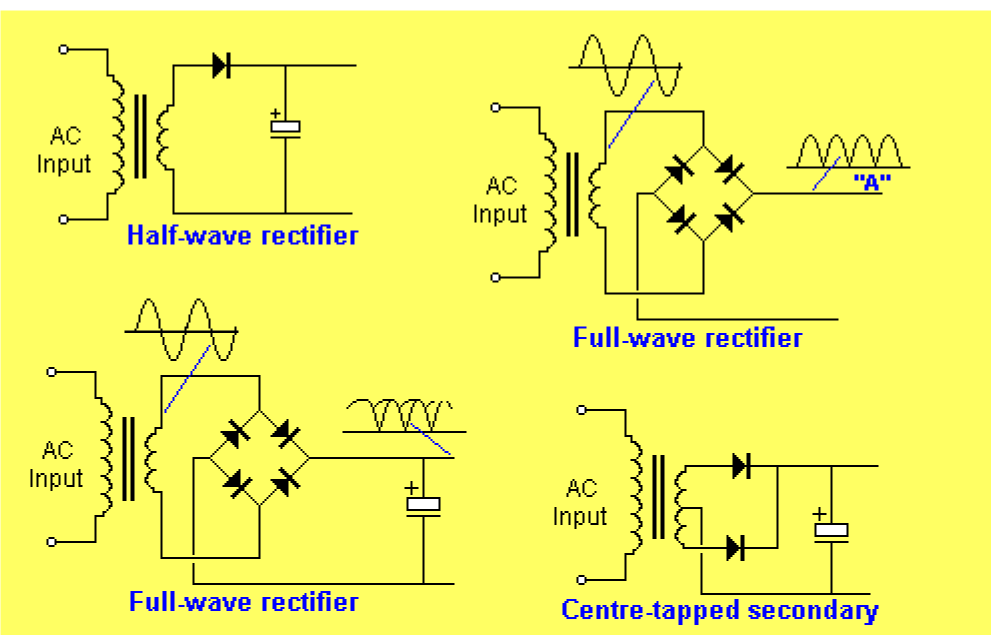
RESISTOR COLOUR CODE

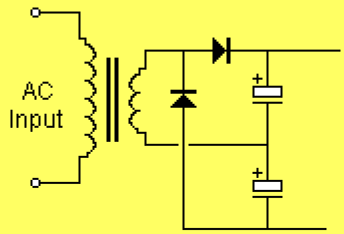


See resistors from 0.22ohm to 22M in full colour at end of book and another resistor table

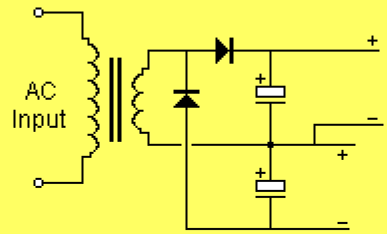
RECTIFYING a Voltage

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.

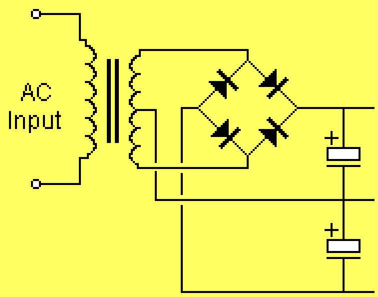




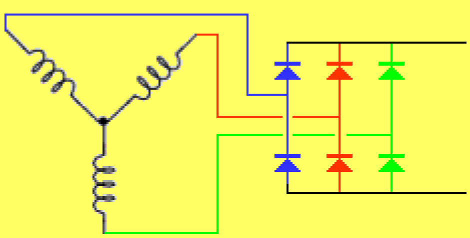
Full-wave voltage doubler
Each section is half-wave supplied. The circuit uses both positive and negative parts of the waveform



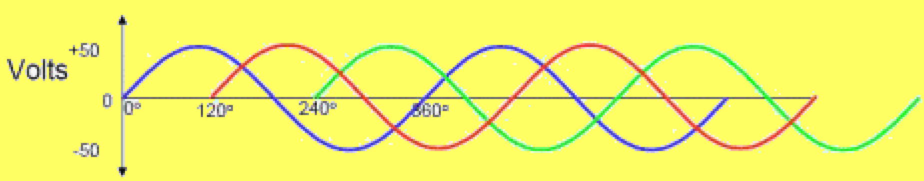
Dual Power Supply
using a single secondary

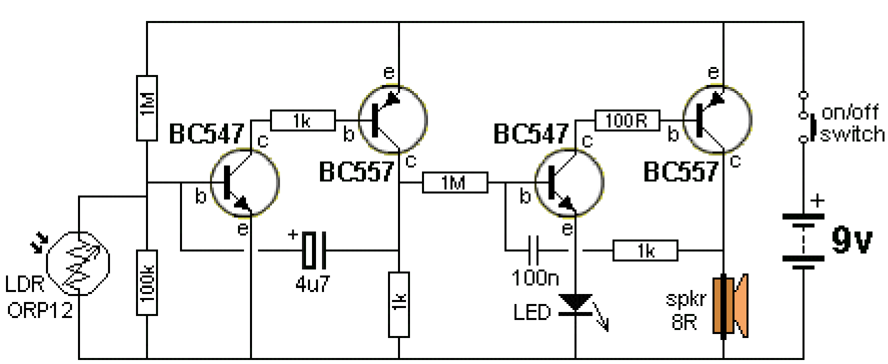


Dual Power Supply using a Centre-tapped secondary



3-phase alternator such as car alternator or windmill





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.

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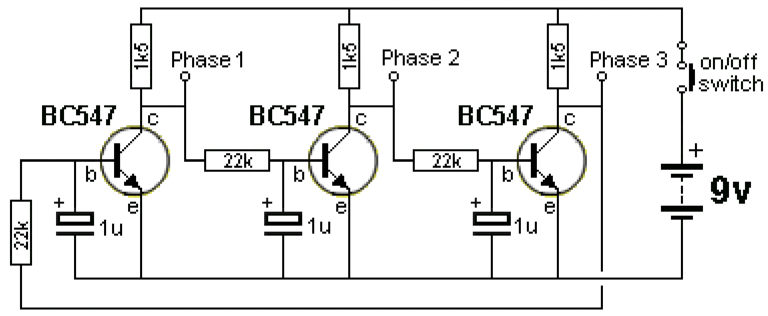

3-PHASE SINEWAVE GENERATOR

This circuit produces a sinewave and each phase can be tapped at the point shown.

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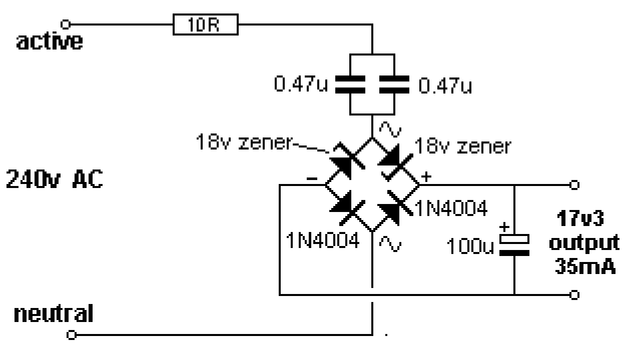

TRANSFORMERLESS POWER SUPPLY

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.

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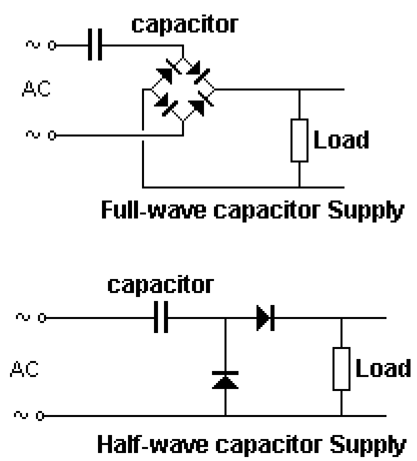

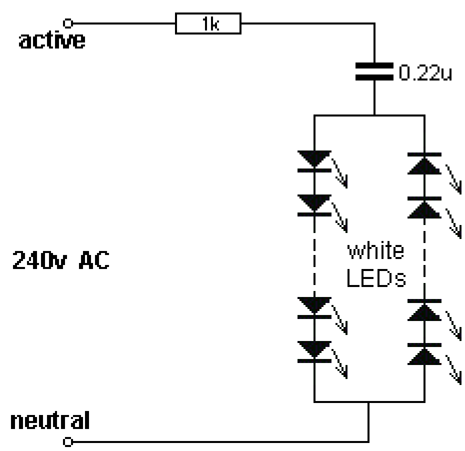

LEDs on 240v

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)**.**

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.

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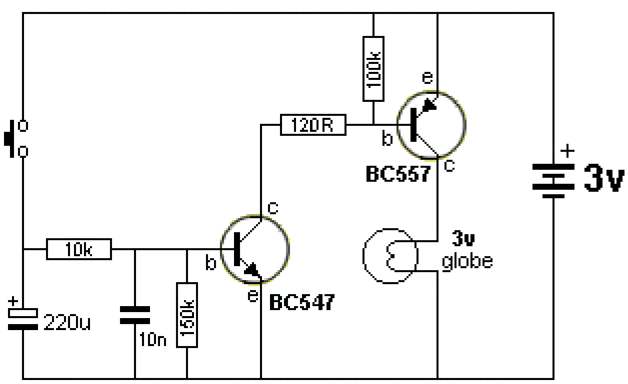

BOOK LIGHT

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.
The photo shows the circuit built with surface-mount components:

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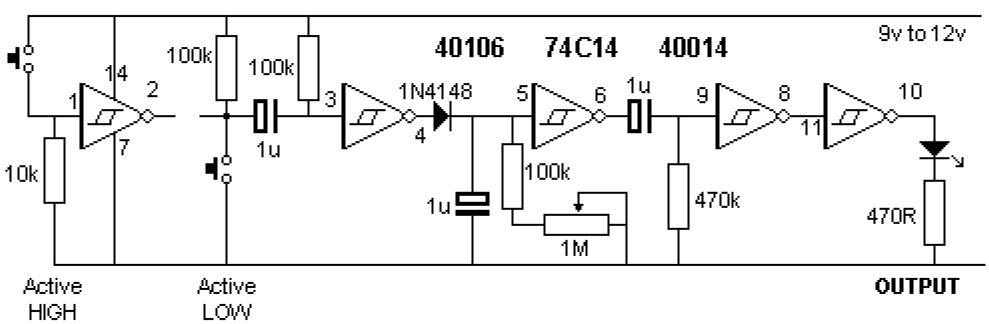

CAMERA ACTIVATOR

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.

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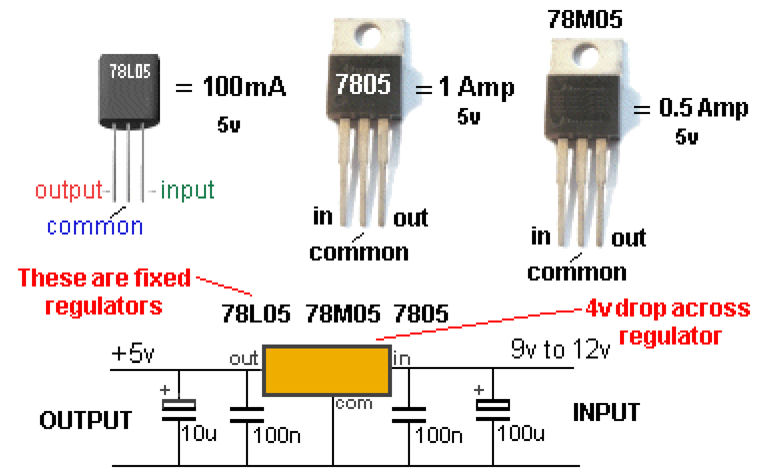
POWER SUPPLIES - FIXED:



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.

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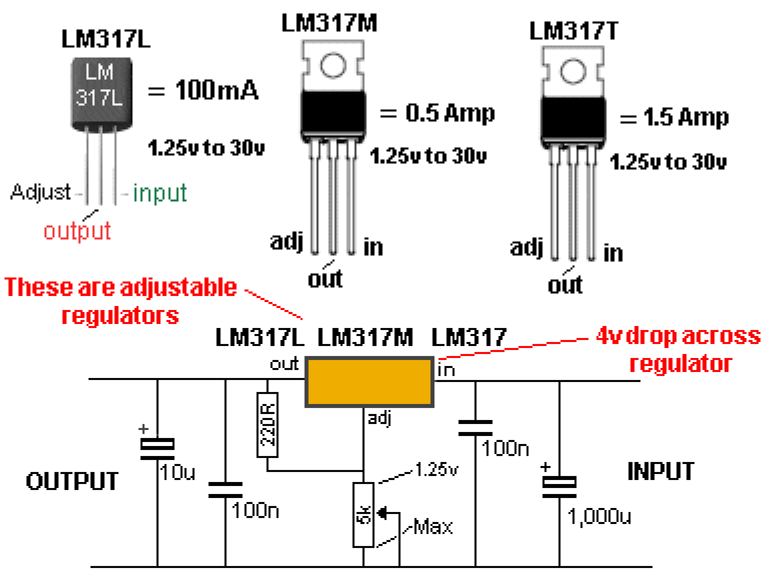
POWER SUPPLIES - ADJUSTABLE:



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

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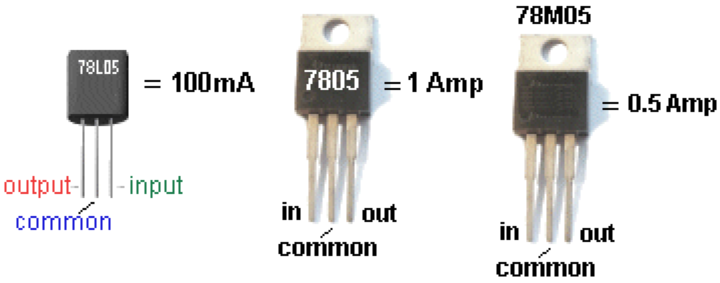
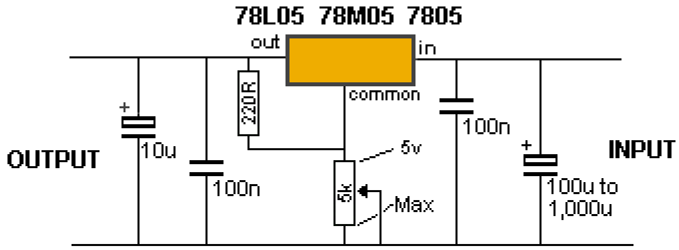
POWER SUPPLIES - ADJUSTABLE using 7805:





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.

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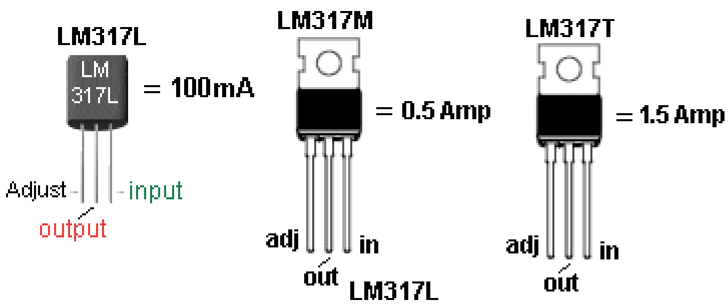
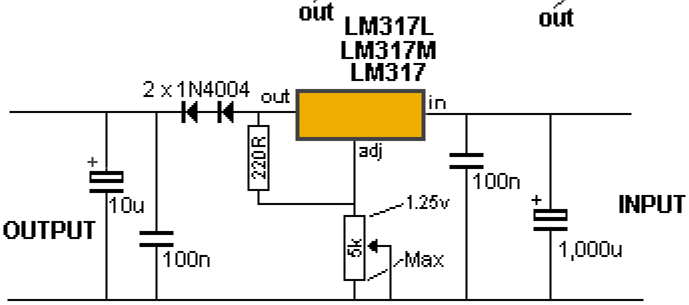
POWER SUPPLIES - ADJUSTABLE from 0v:





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."

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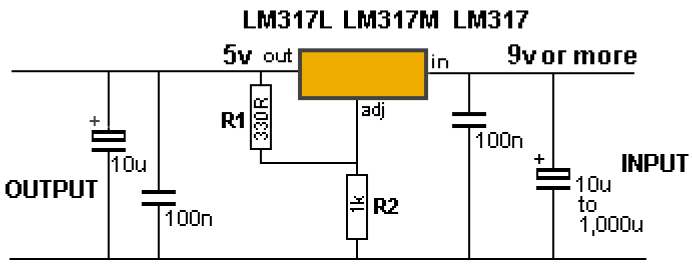
5v POWER SUPPLY

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



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

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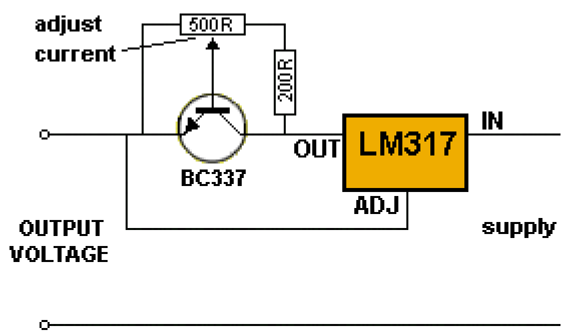

CONSTANT CURRENT

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.

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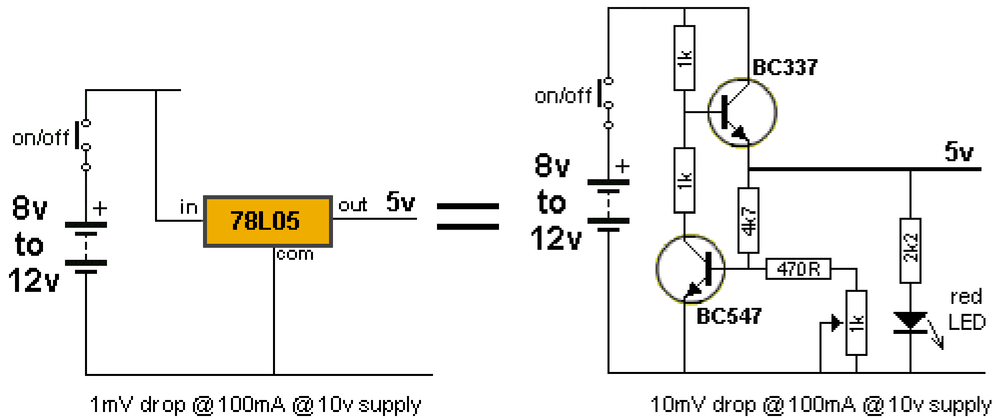
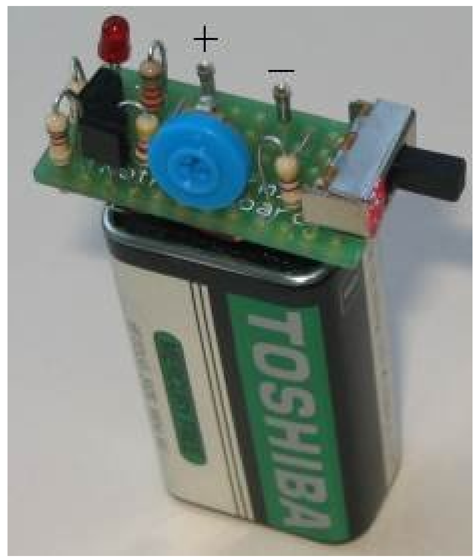
5v FROM OLD CELLS - circuit 1

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).

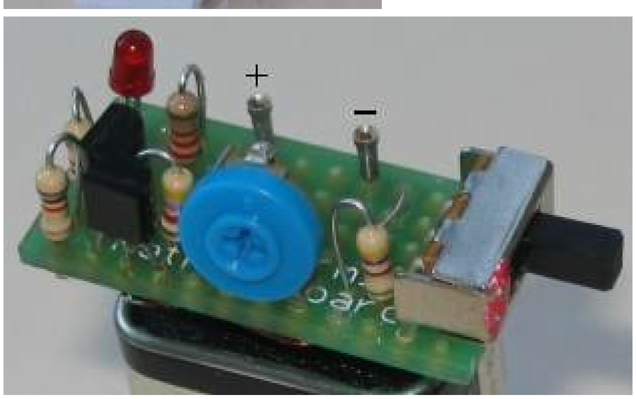


The regulator connected to a 12v battery pack



The regulator connected to a 9v battery

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.



A close-up of the regulator module

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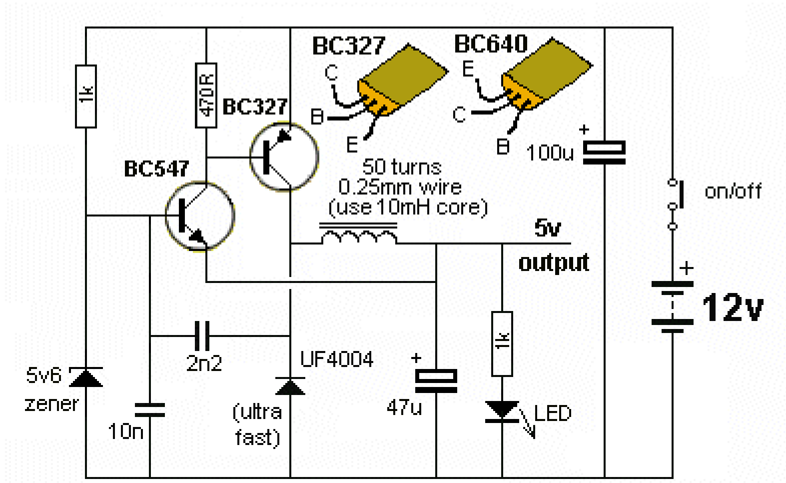
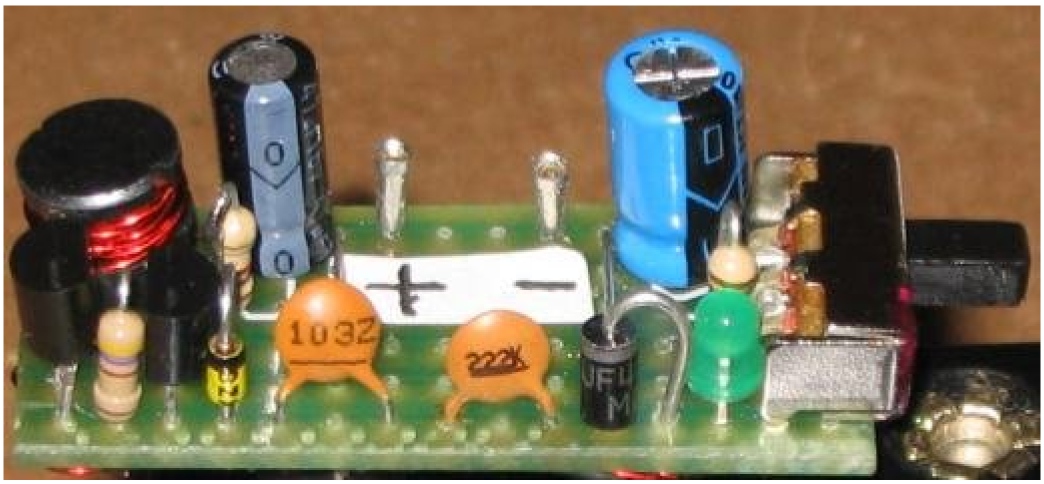
5v FROM OLD CELLS - circuit 2

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.





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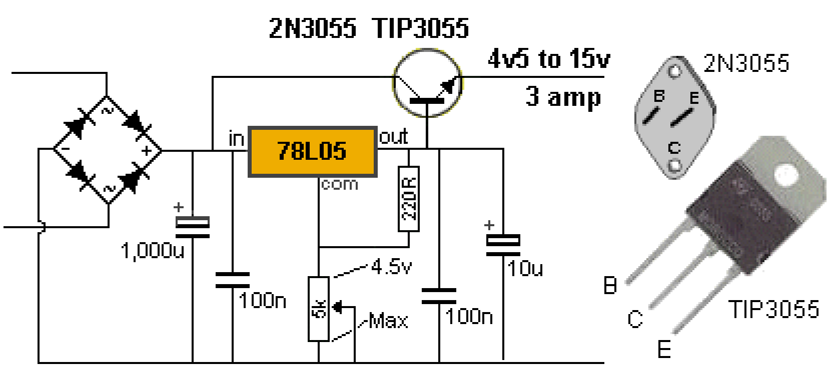

INCREASING THE OUTPUT CURRENT

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.

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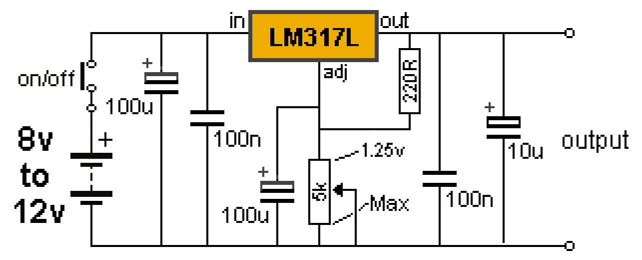

SOFT START

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.

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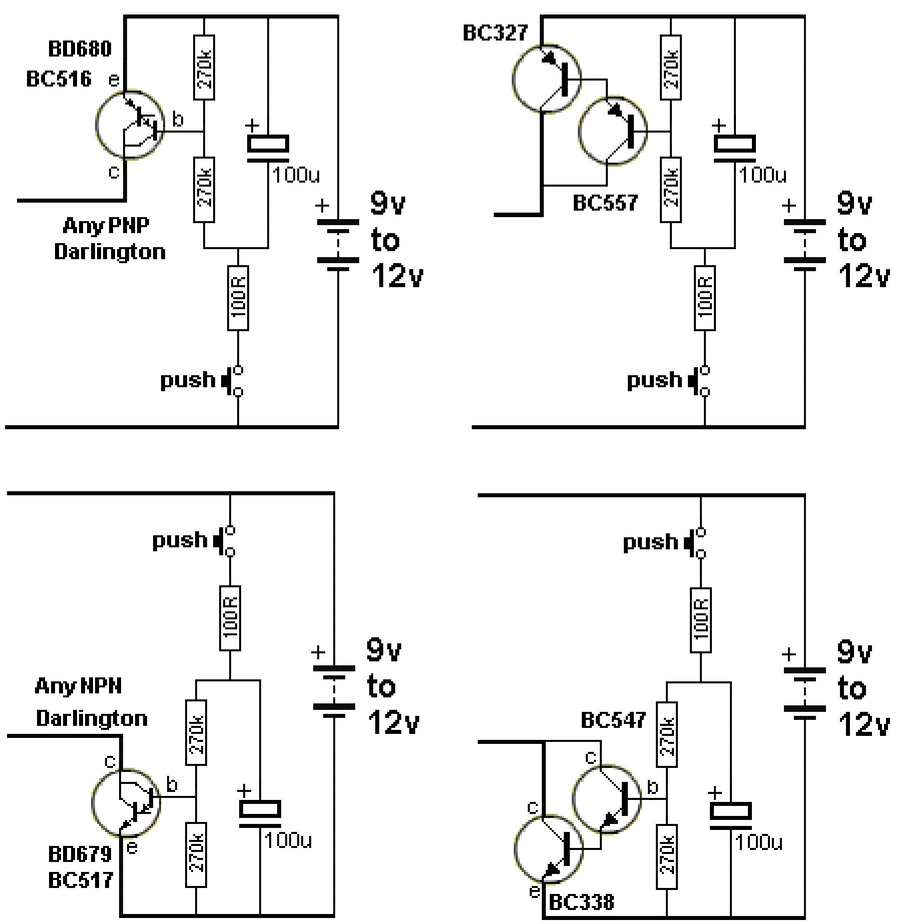
TURN-OFF DELAY

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.



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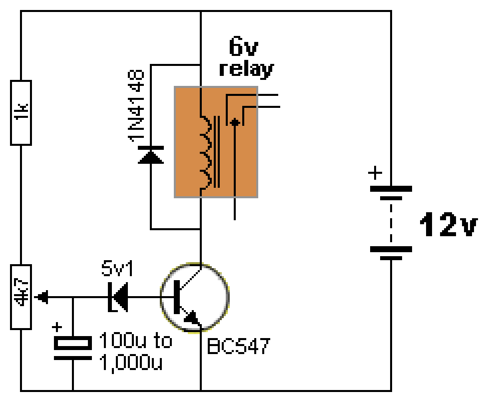
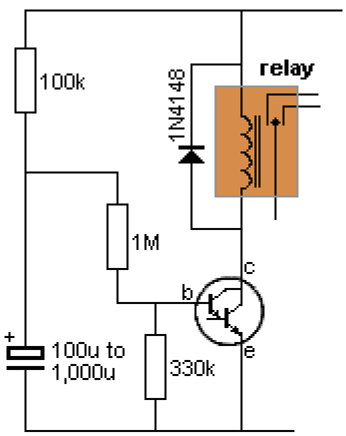
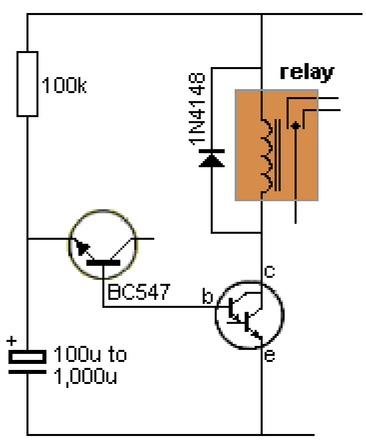
TIME DELAY CIRCUITS

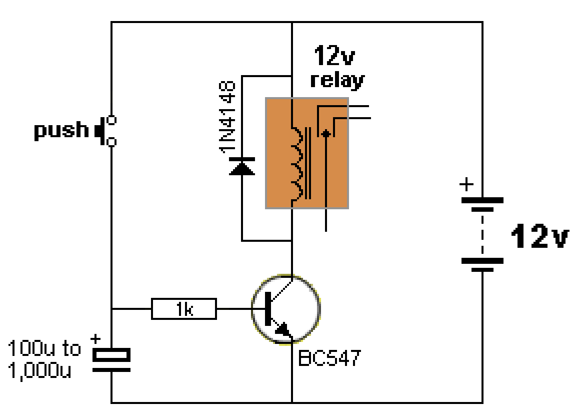
These 3 circuits are all the same. They turn on a relay after a period of time.

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.

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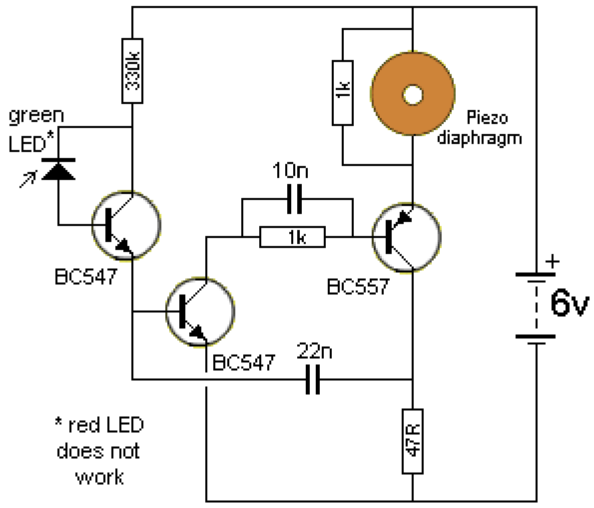

LED DETECTS LIGHT

The LED in this circuit will detect light to turn on the oscillator. Ordinary red LEDs do not work. But green LEDs, yellow LEDs and high-bright white LEDs and high-bright red LEDs work very well.
The output voltage of the LED is up to 600mV when detecting very bright illumination.
When light is detected by the LED, its resistance decreases and a very small current flows into the base of the first transistor. The transistor amplifies this current about 200 times and the resistance between collector and emitter decreases. The 330k resistor on the collector is a current limiting resistor as the middle transistor only needs a very small current for the circuit to oscillate. If the current is too high, the circuit will "freeze."
The piezo diaphragm does not contain any active components and relies on the circuit to drive it to produce the tone. A different **LED Detects Light** circuit in eBook 1:
1 - 100 Transistor Circuits

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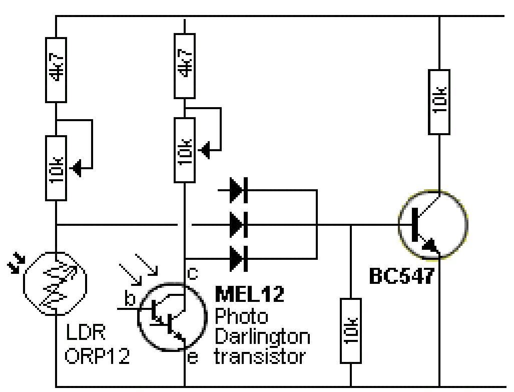

TRAIN DETECTORS

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.

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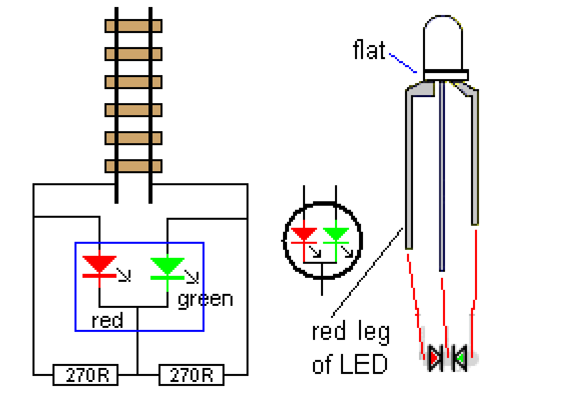

TRACK POLARITY

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).

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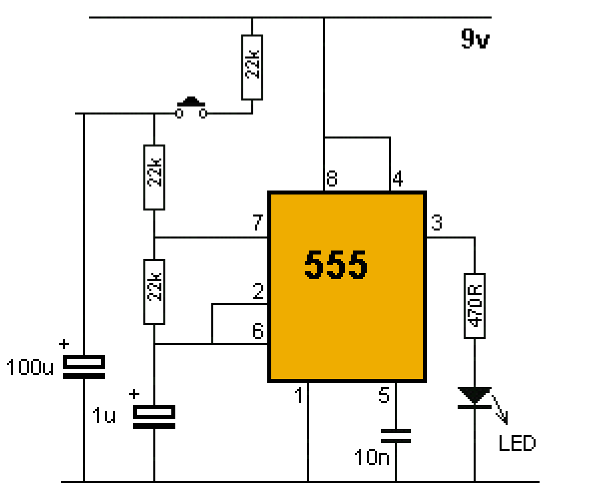

DECAYING FLASHER

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.

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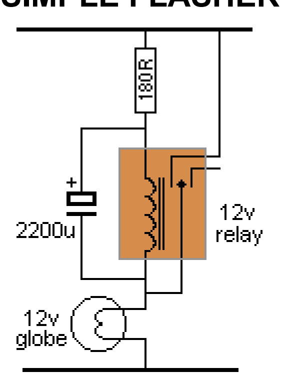
SIMPLE FLASHER



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

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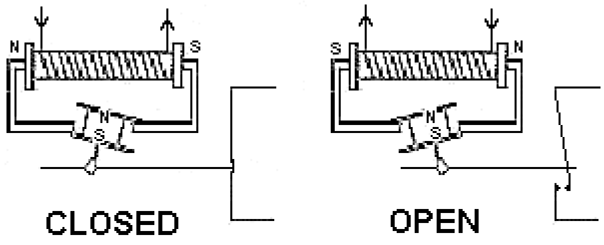
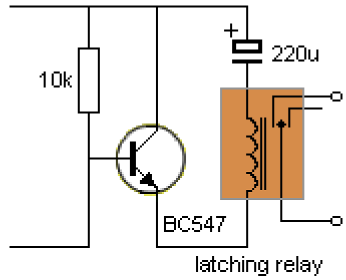
LATCHING RELAY

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.

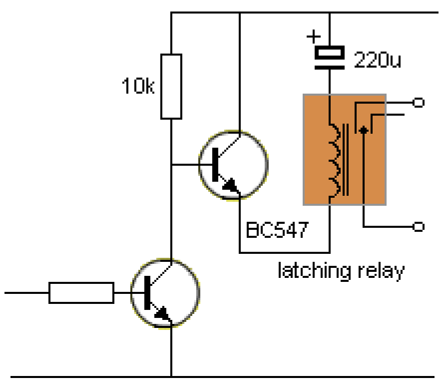
The following diagram shows how the coil makes the magnet click in the two directions.





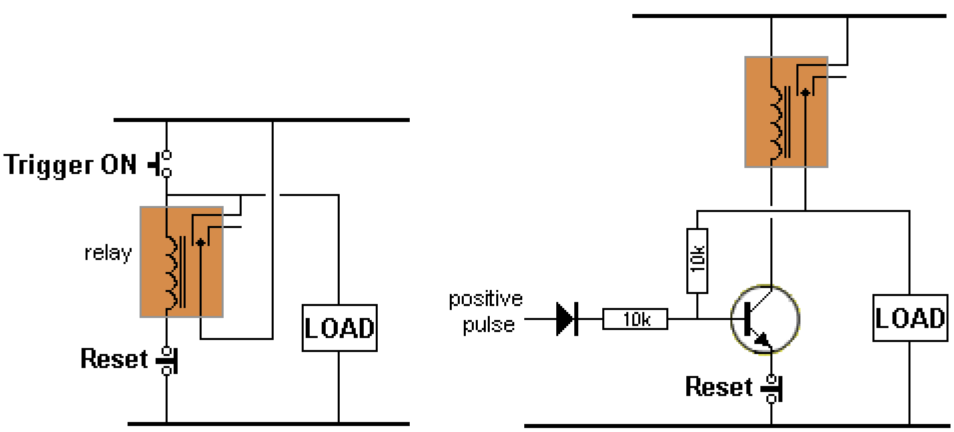
PULSE LATCHING RELAY ON/OFF

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.



PULSE LATCHING RELAY ON/OFF via a MICROCONTROLLER

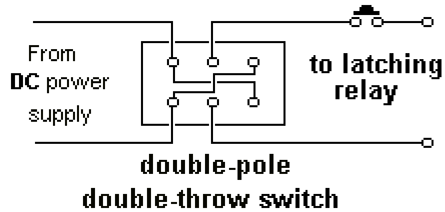
The pulse-latching circuit above can be connected to a microcontroller via the circuit at the left. The electrolytic can be increased to 1,000u to cater for relays with a low resistance.



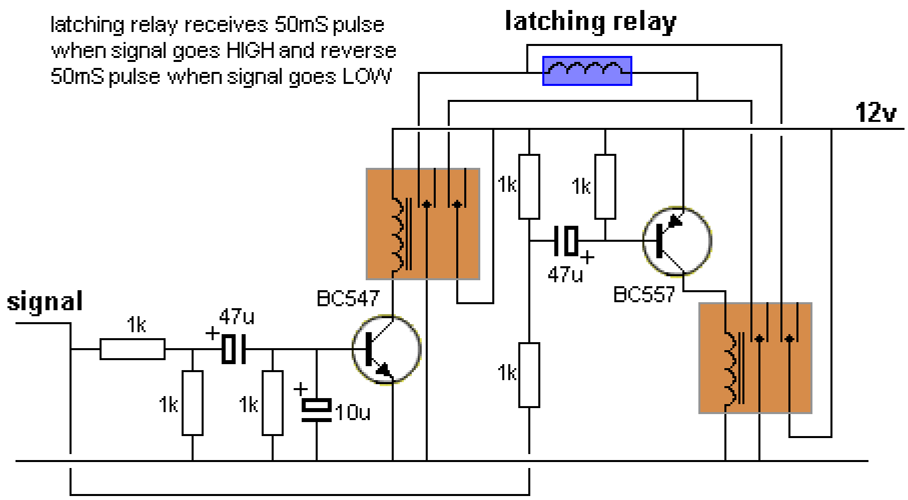
Latching an ordinary relay

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

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:

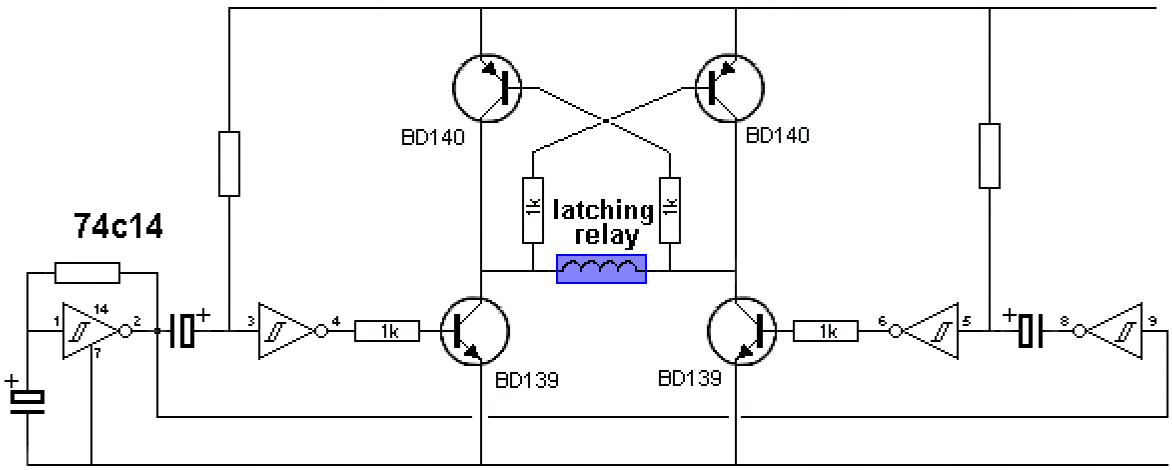


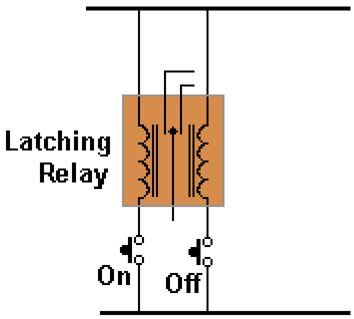
To use this circuit you have to understand some of the technical requirements.

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

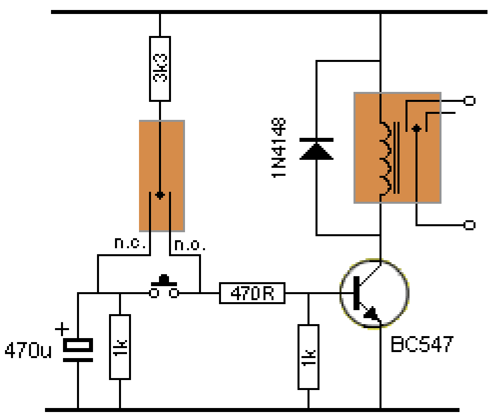
The following circuit pulses a latching relay every 30 seconds. The circuit only consumes current during the 50mS latching period.
The values for the timing components have not been provided. These can be worked out by experimentation.



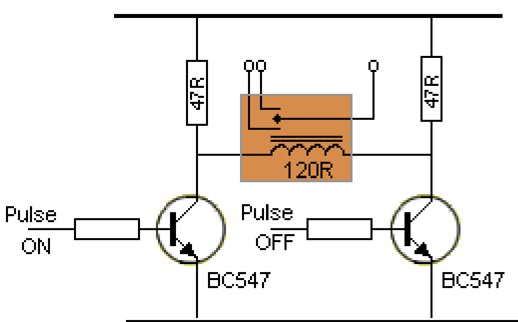


A 2-coil Latching Relay

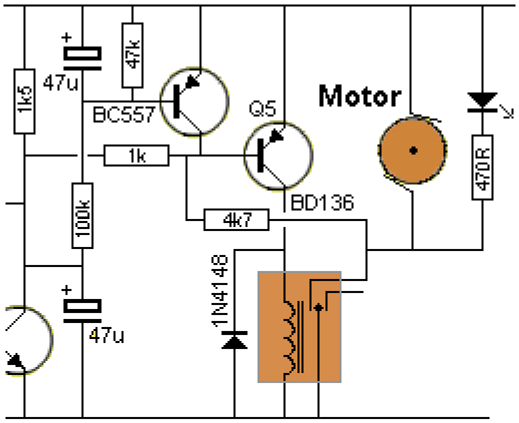
Latching Relays are expensive but a 5v Latching Relay is available from: Excess Electronics for $1.00 as a surplus item. It has 2 coils and requires the circuit at the left. A 5v Latching Relay can be use on 12v as it is activated for a very short period of time.



A 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 circuit at the left 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.

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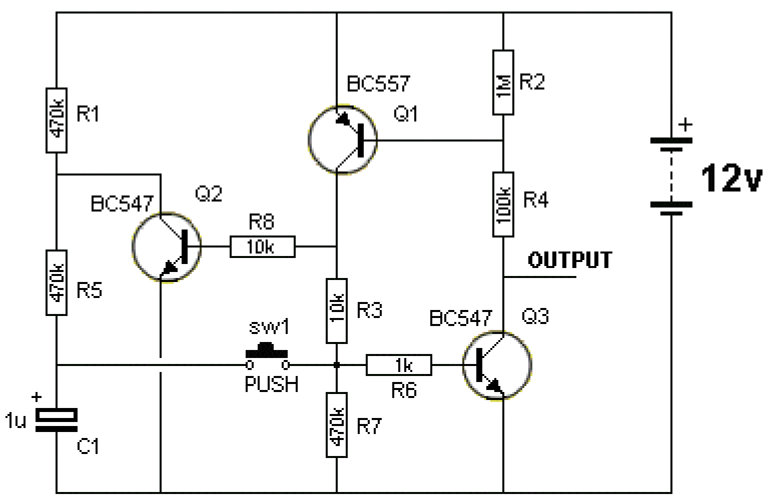
LATCHING A PUSH BUTTON - also called: PUSH-ON PUSH-OFF

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.



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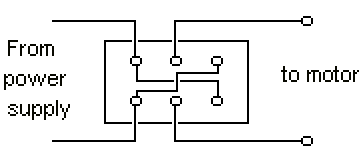
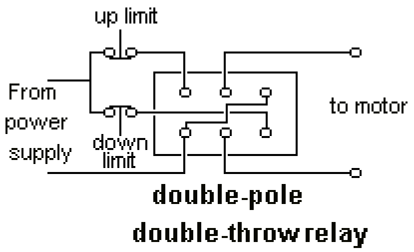
REVERSING A MOTOR-1

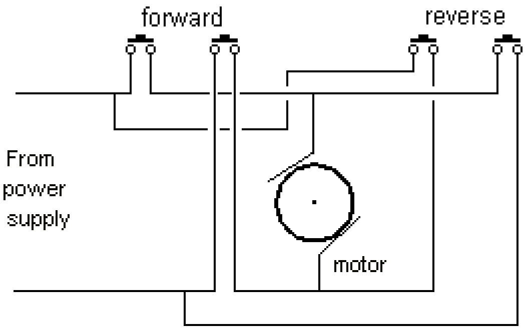
There are a number of ways to reverse a motor. The following diagrams show how to connect a double-pole double throw relay or switch and a set of 4 push buttons. The two buttons must be pushed at the same time or two double pole push-switches can be used.
See H-Bridge below for more ways to reverse a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



double-pole double-throw relay

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.

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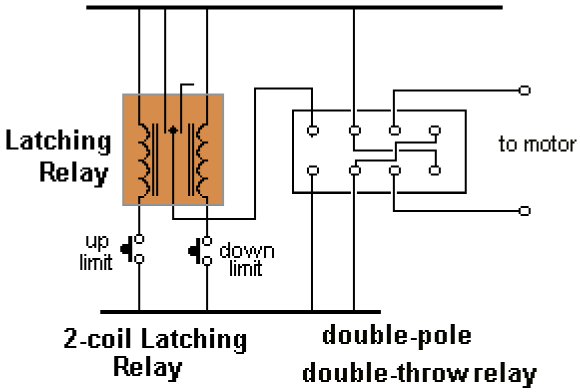
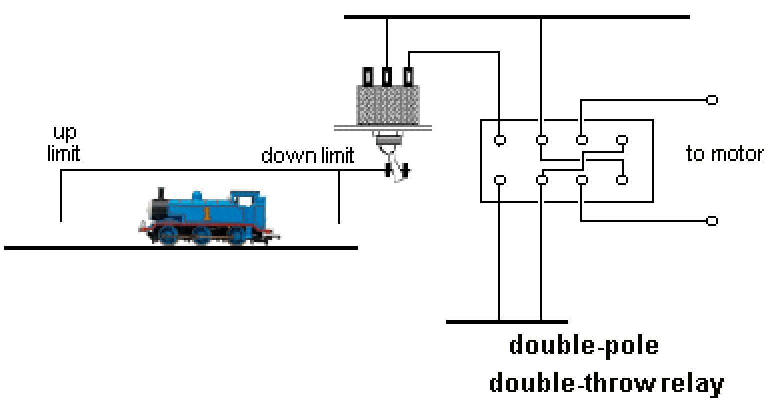
REVERSING A MOTOR-2

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:



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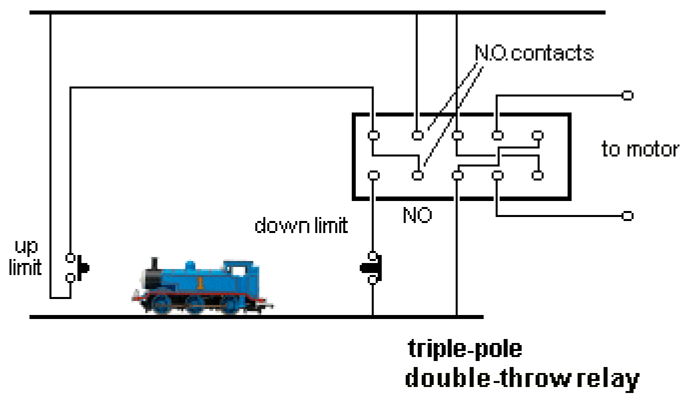
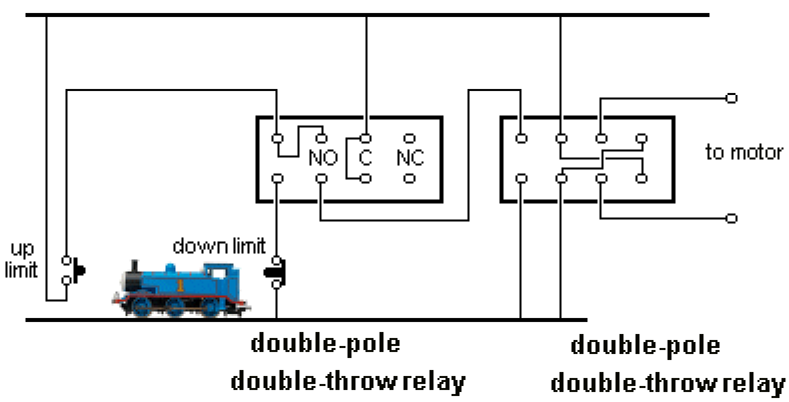
REVERSING A MOTOR-3

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:



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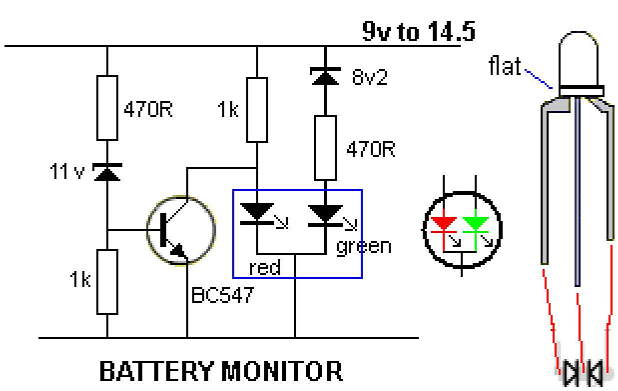
BATTERY MONITOR MkI

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



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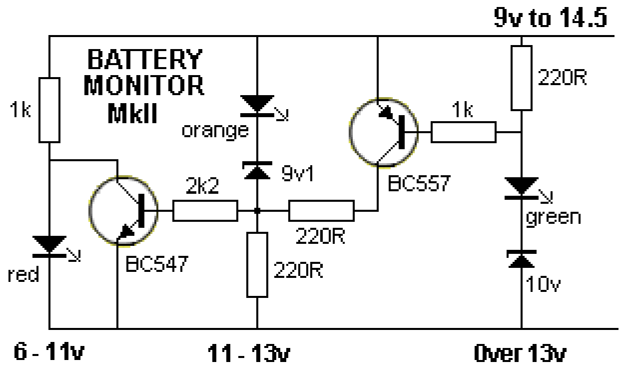
BATTERY MONITOR MkII

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

It turns off above 13v and
The green LED illuminates above 13v



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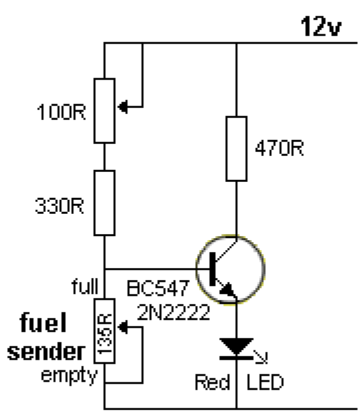
LOW FUEL INDICATOR

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



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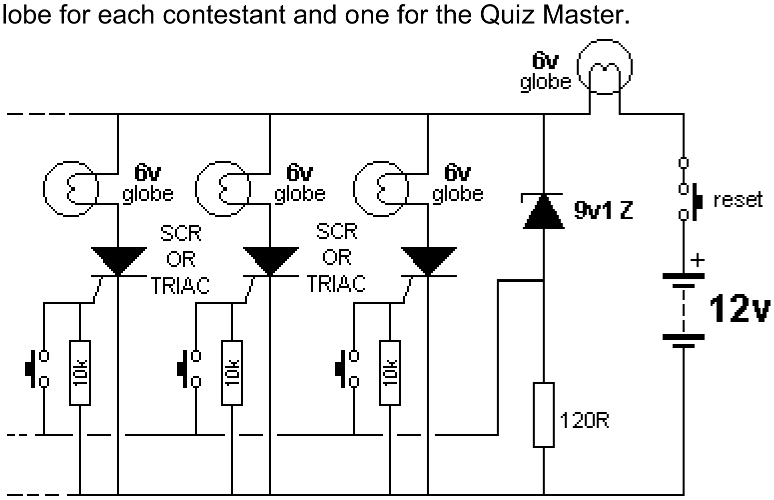
QUIZ TIMER

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.

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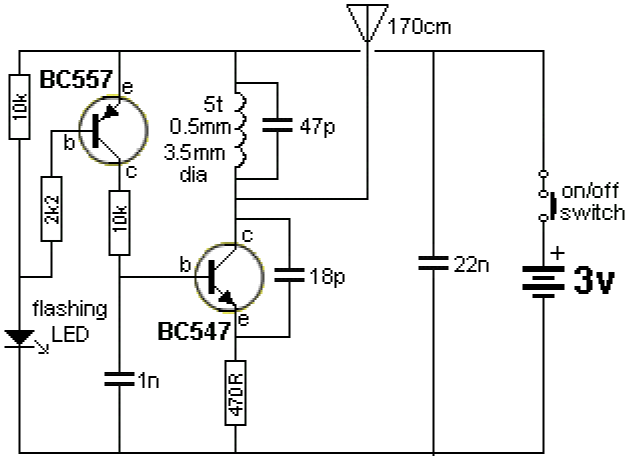
TRACKING TRANSMITTER

This circuit can be used to track lots of items.



TRACKING TRANSMITTER MKI

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).

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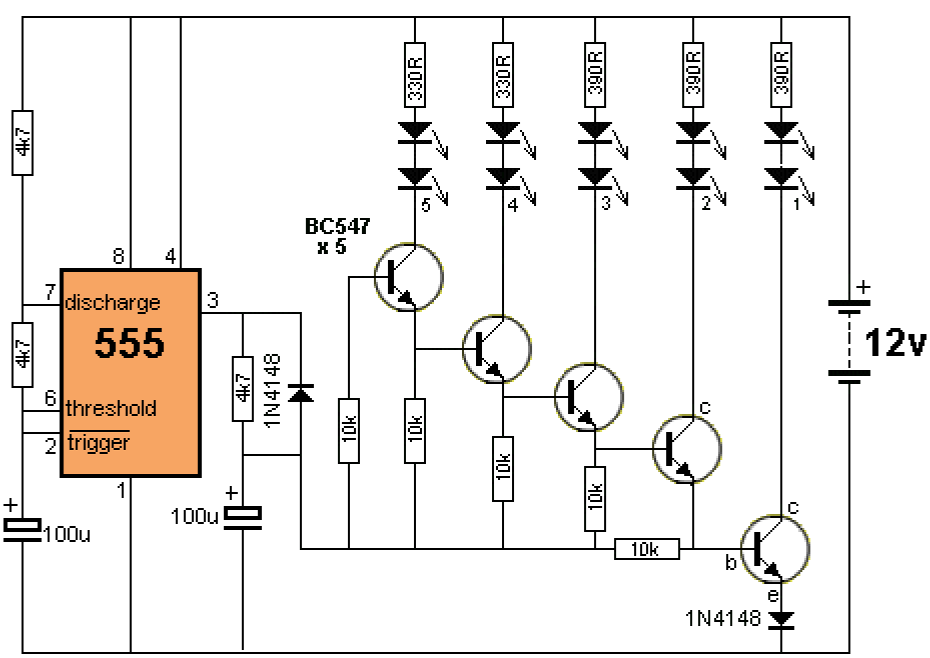
BIKE TURNING SIGNAL

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.



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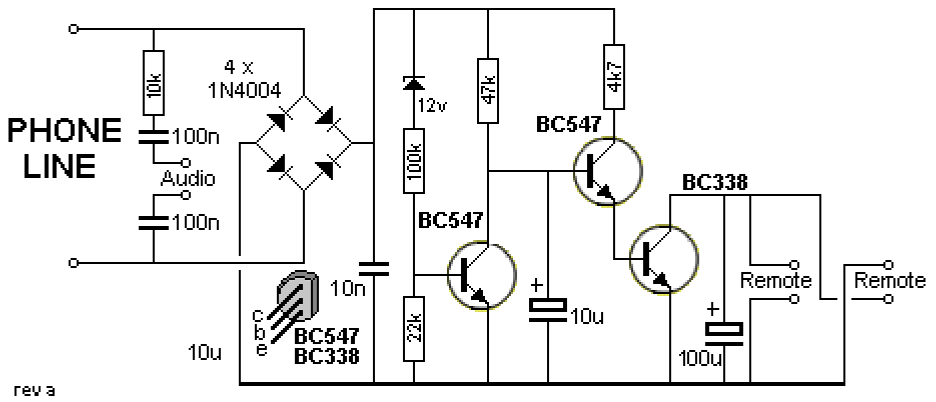
PHONE TAPE-3

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.



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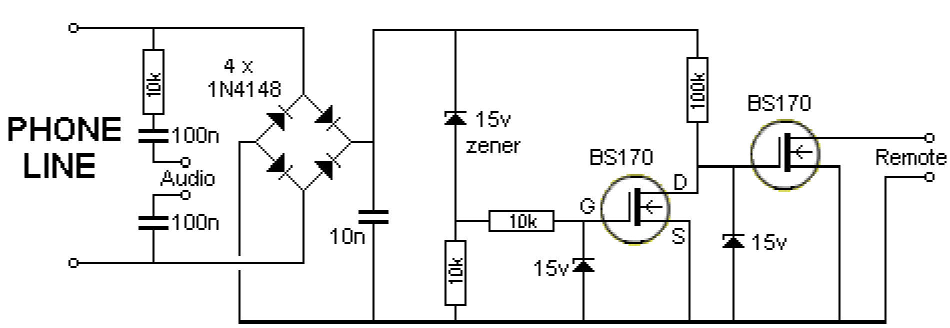
PHONE TAPE-4

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.



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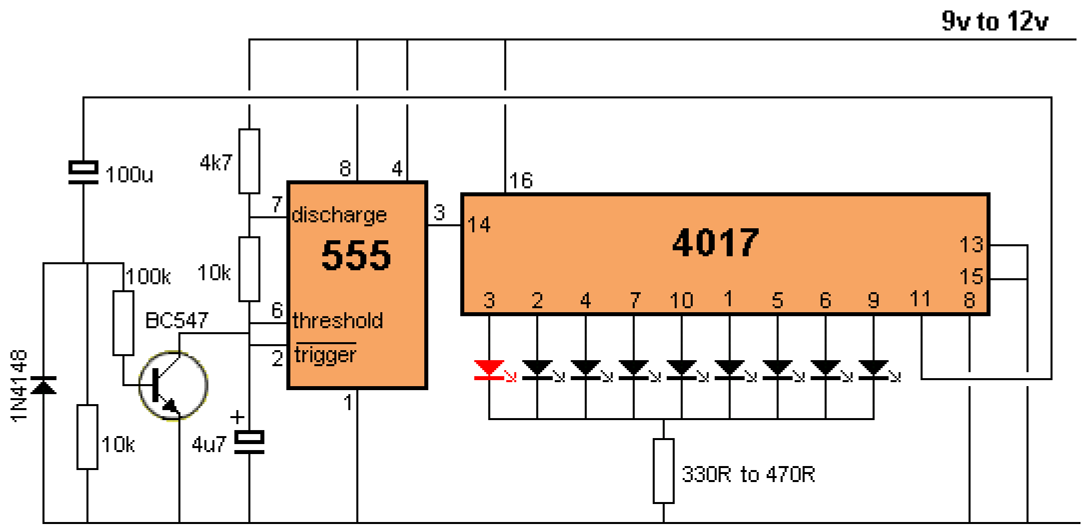
SEQUENCER

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.
The animated circuit shows this sequence:



SEQUENCER WITH 3 SECOND INTERVAL

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.

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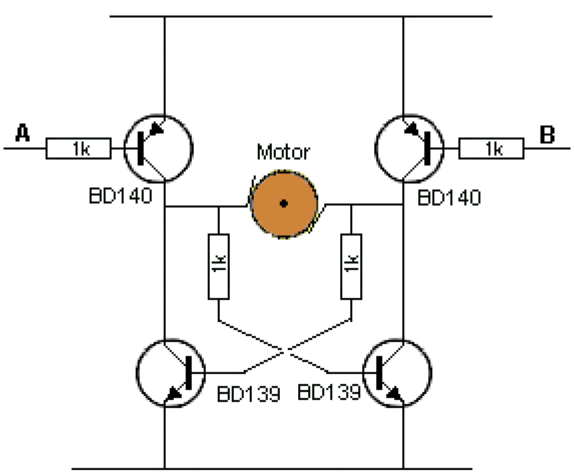
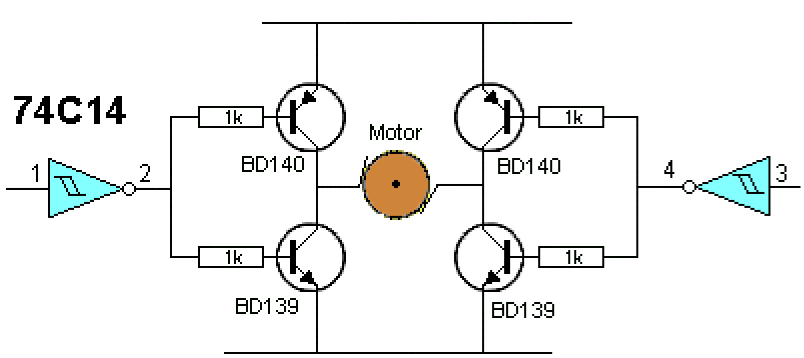
H-BRIDGE

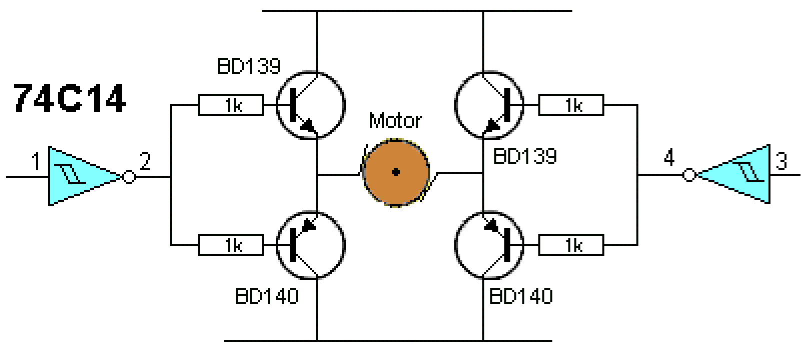
These circuits reverse a motor via two input lines. Both inputs must not be LOW with the first H-bridge circuit. If both inputs go LOW at the same time, the transistors will "short-out" the supply. This means you need to control the timing of the inputs. In addition, the current capability of some H-bridges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



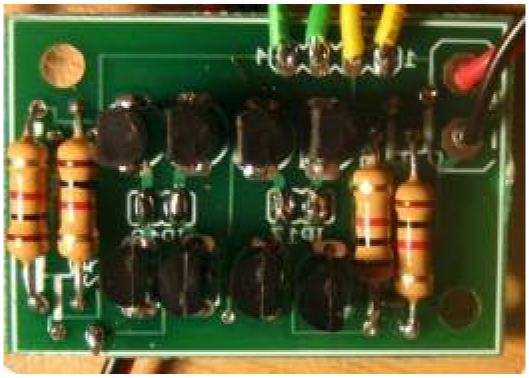
A and B must NEVER both be low



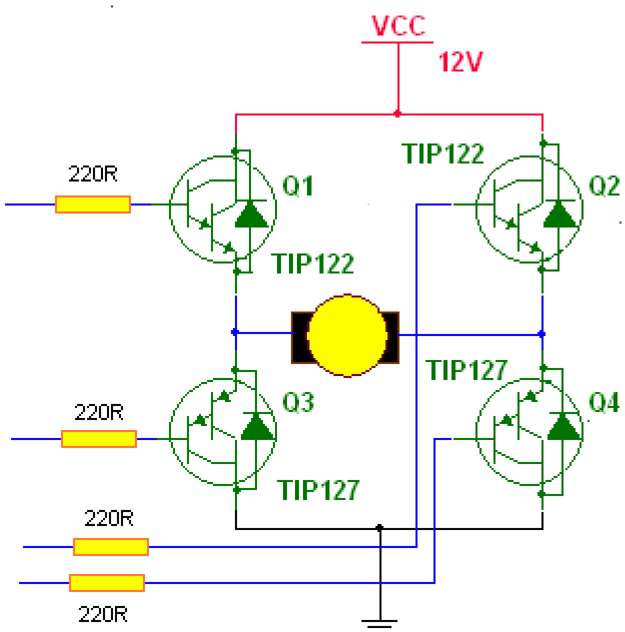
When A and B are equal, motor does not run



The driver transistors are in "emitter follower" mode in this circuit.



Two H-Bridges on a PC board



H-Bridge using Darlington transistors

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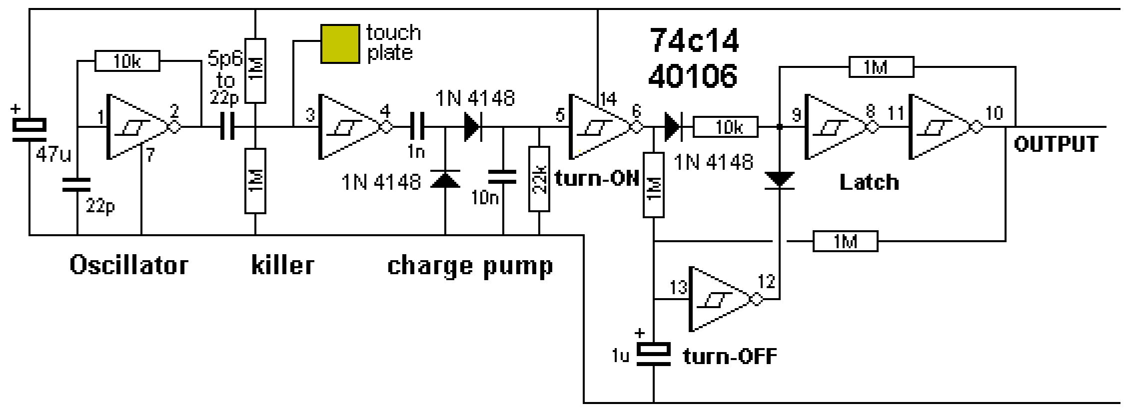
TOUCH-ON TOUCH-OFF SWITCH

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."



TOUCH-ON TOUCH-OFF SWITCH

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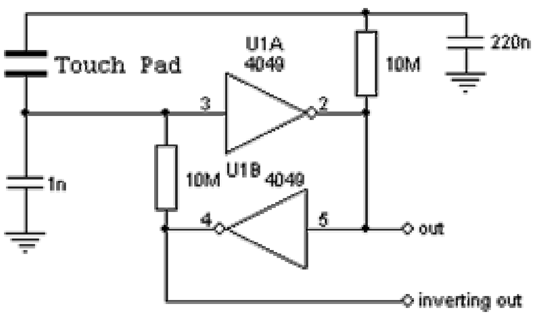
SIMPLE TOUCH-ON TOUCH-OFF SWITCH

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.



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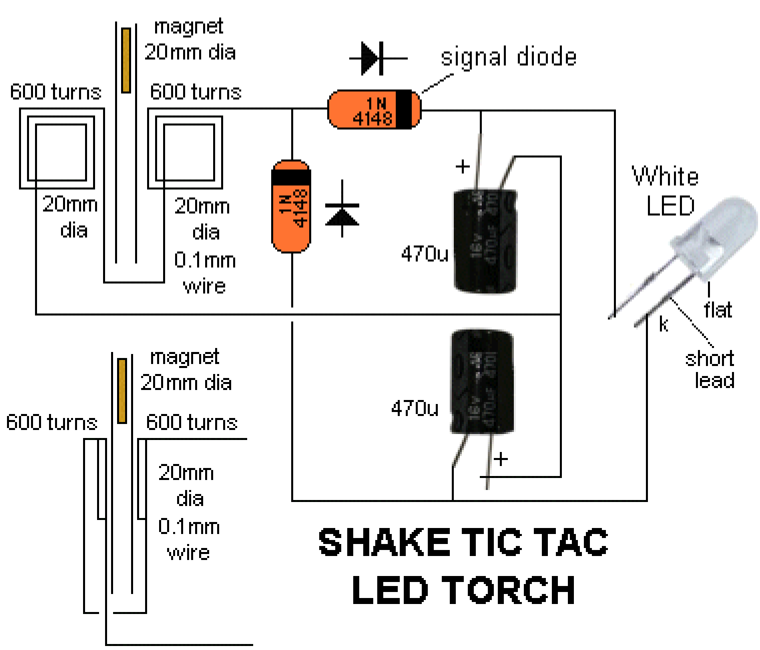

SHAKE TIC TAC LED TORCH

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.

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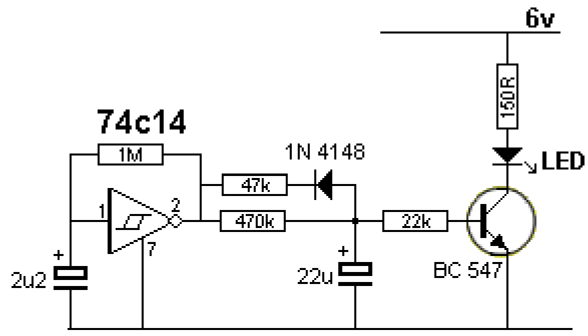
FADING LED

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.



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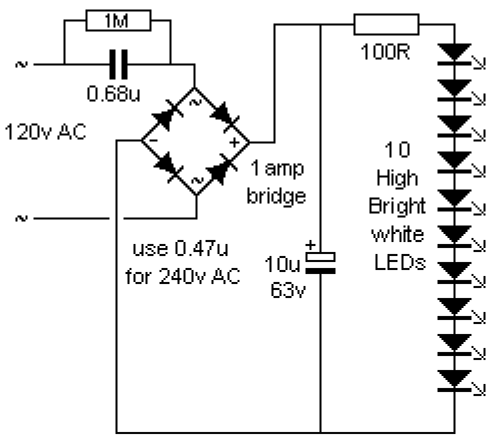
MAINS NIGHT LIGHT

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



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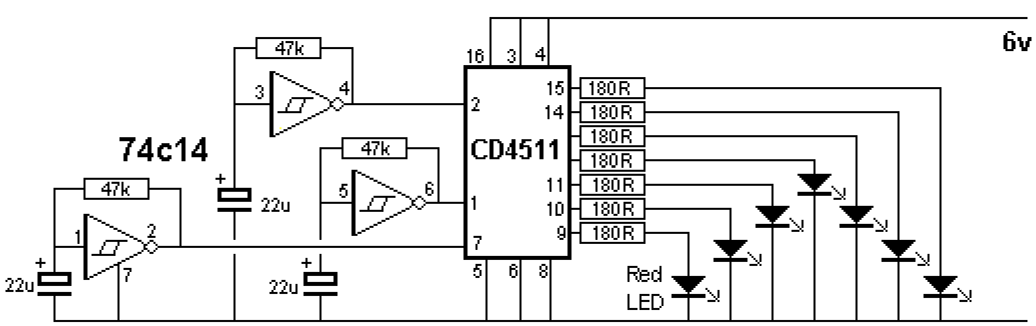
RANDOM BLINKING LEDS

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



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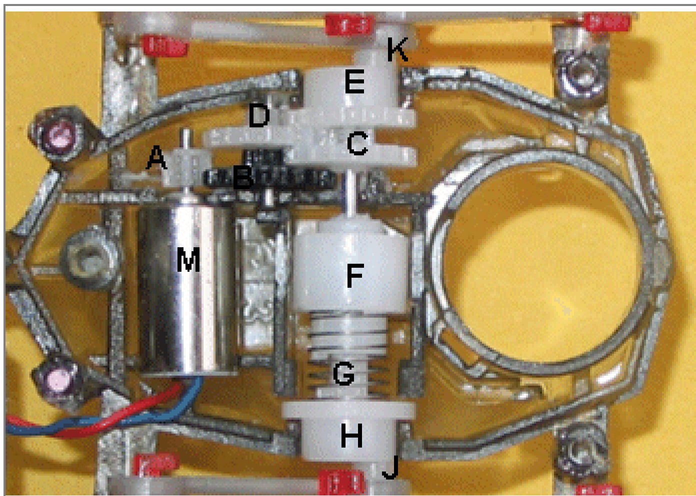
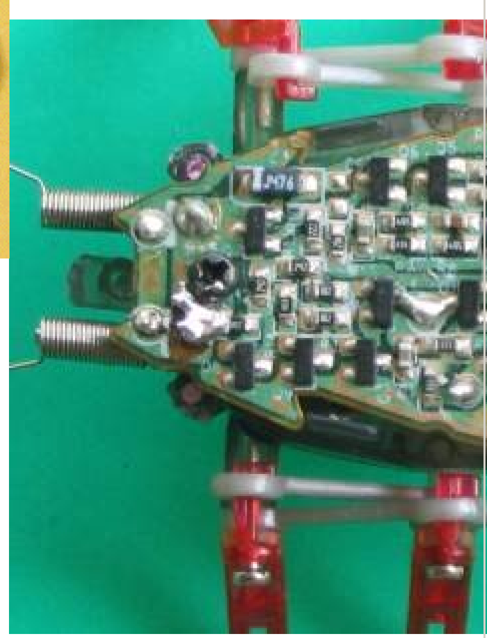
HEX BUG

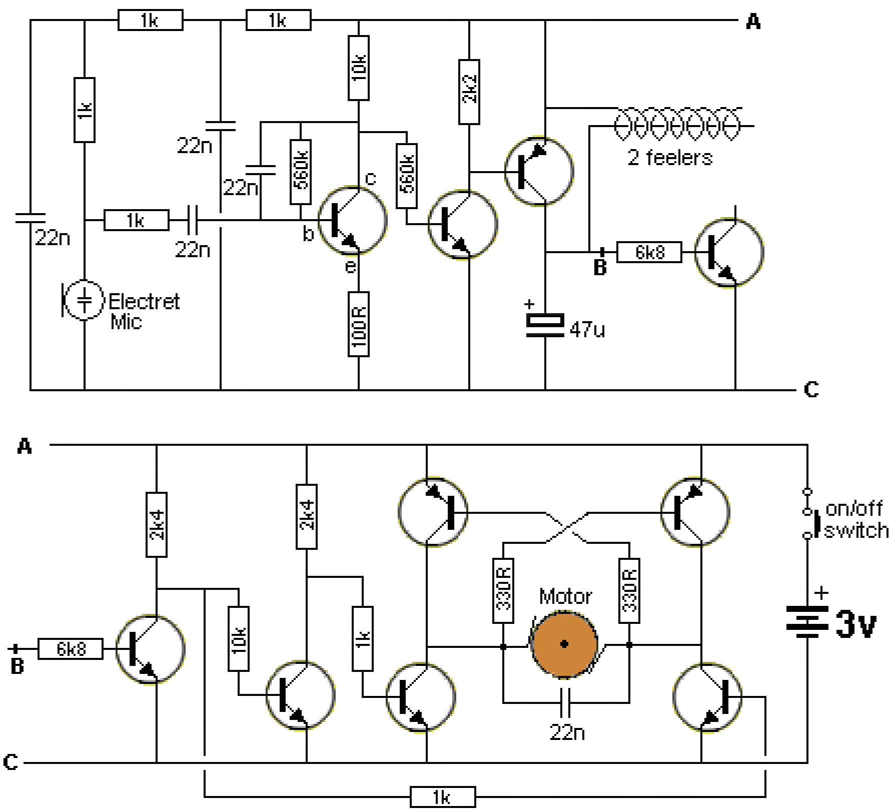
This is the circuit from a HEX BUG. It is a surface-mount bug with 6 legs. The pager motor is driven by an H-Bridge and "walks" to a wall where a feeler (consisting of a spring with a stiff wire down the middle) causes the motor to reverse.

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

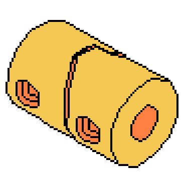


spring-loaded inclined plane that does not operate in reverse.
This causes the bug to turn around slightly.
The circuit also responds to a loud clap. The photo shows the 9 transistors and accompanying components:





HEX BUG CIRCUIT



Inclined Dog Clutch

HEX BUG 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.

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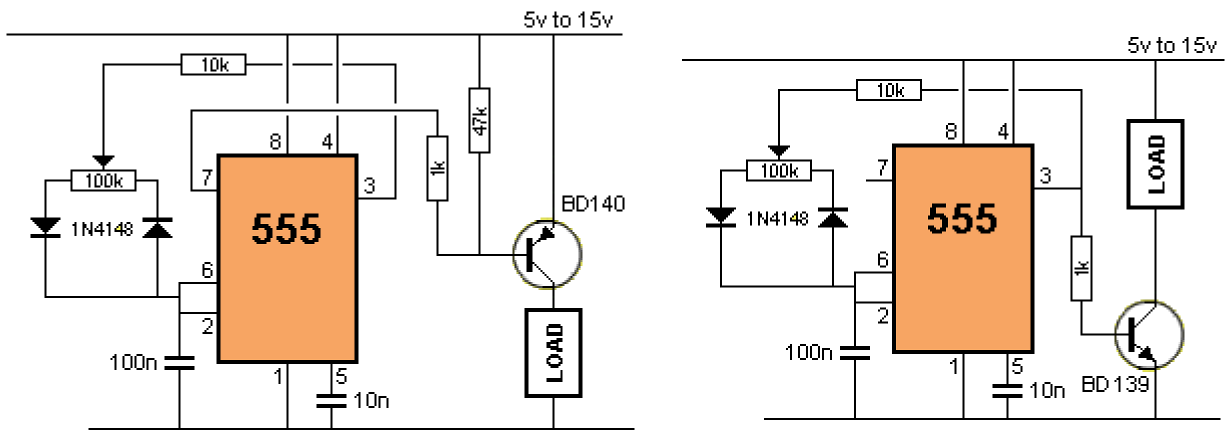
PWM CONTROLLER

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.



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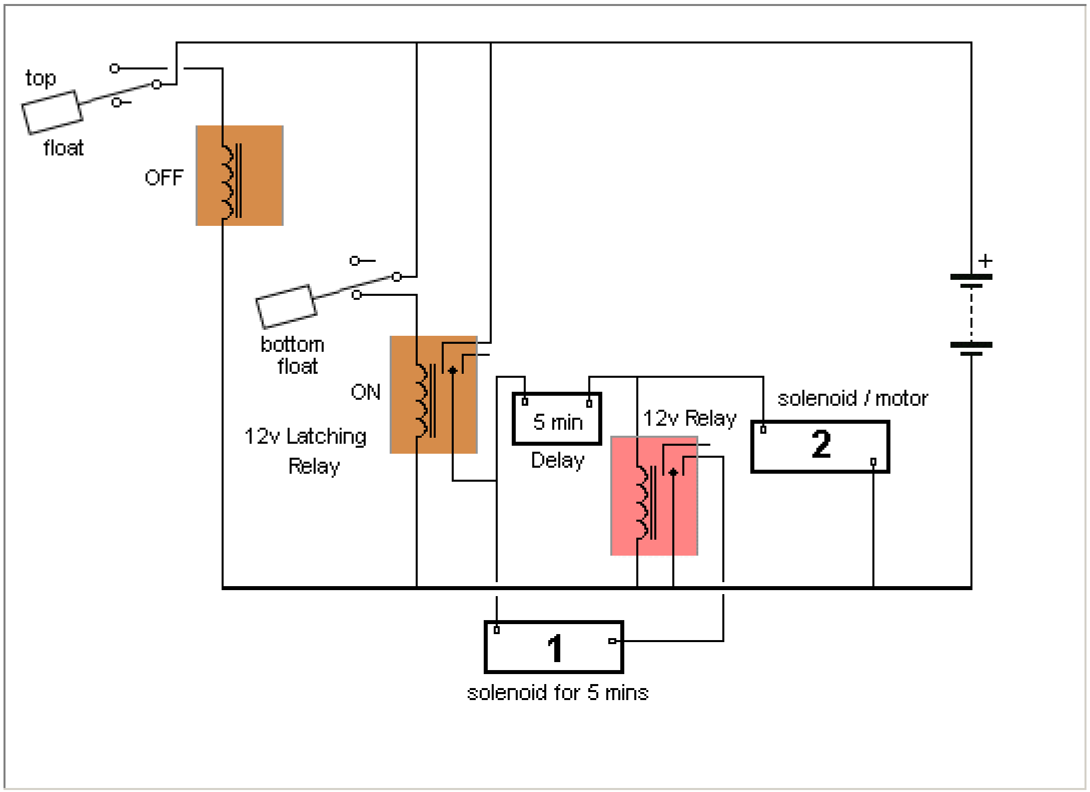
LIMIT SWITCHES

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.



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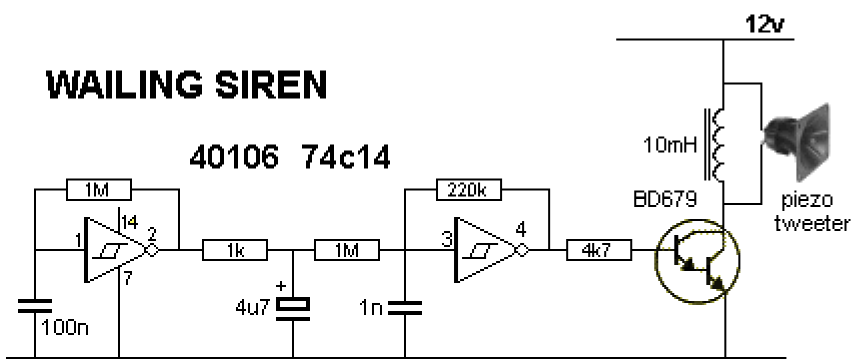
WAILING SIREN

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



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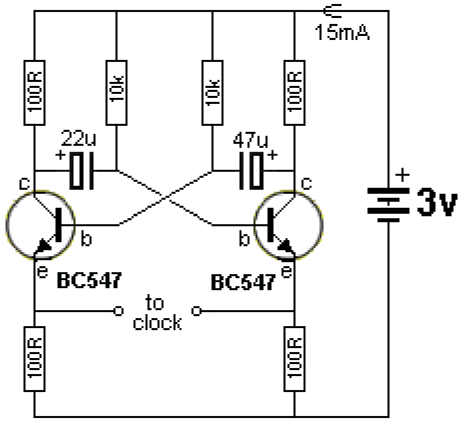
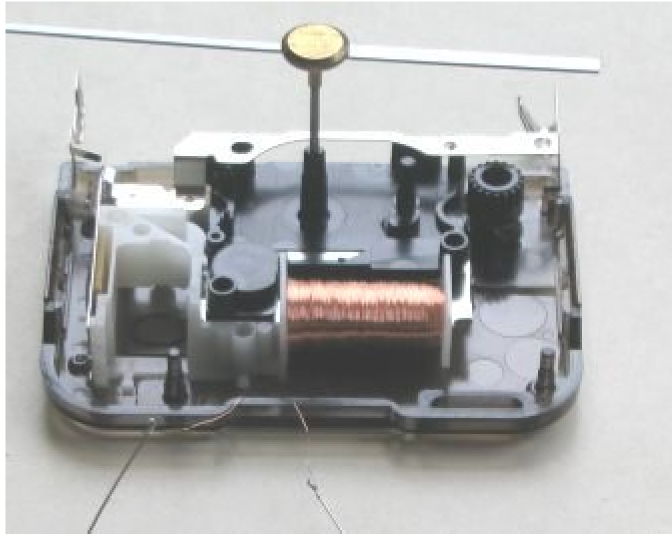
MODEL RAILWAY TIME

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.

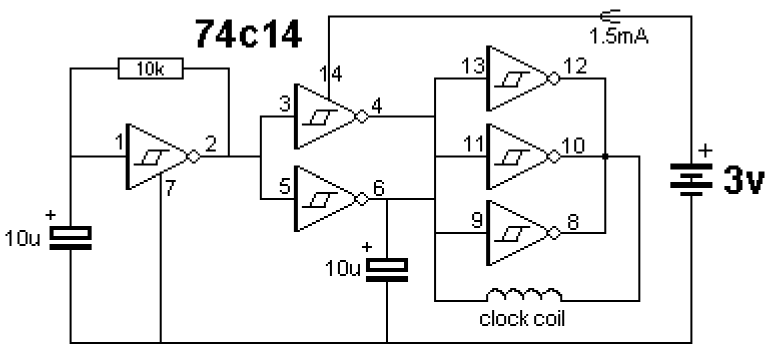


Model Railway Time Circuit



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 chip:



Model Railway Time Circuit using a 74c14 Hex Schmitt Chip

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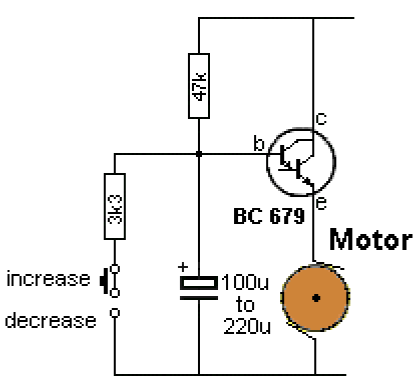
SLOW START-STOP

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.



Slow Start-Stop Circuit

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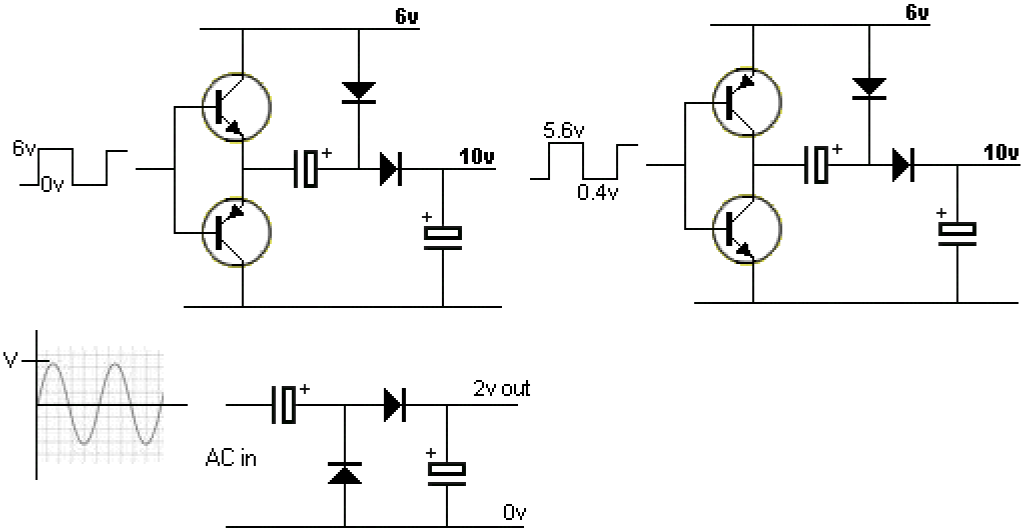
VOLTAGE MULTIPLIERS

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 CIRCUITS

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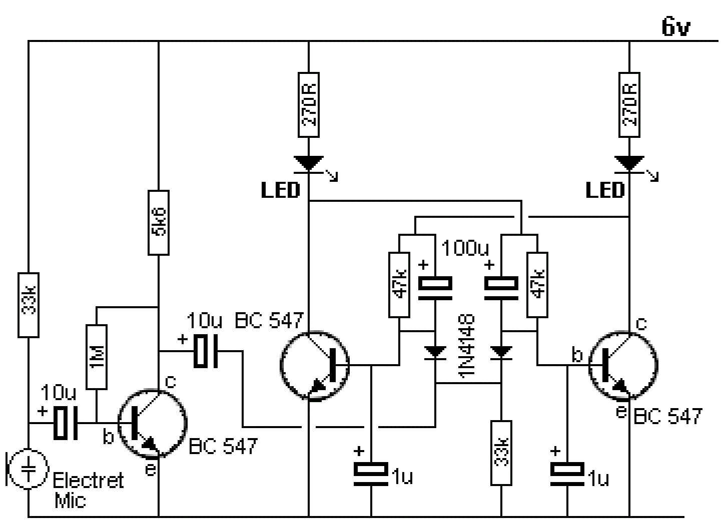
CLAP SWITCH

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.



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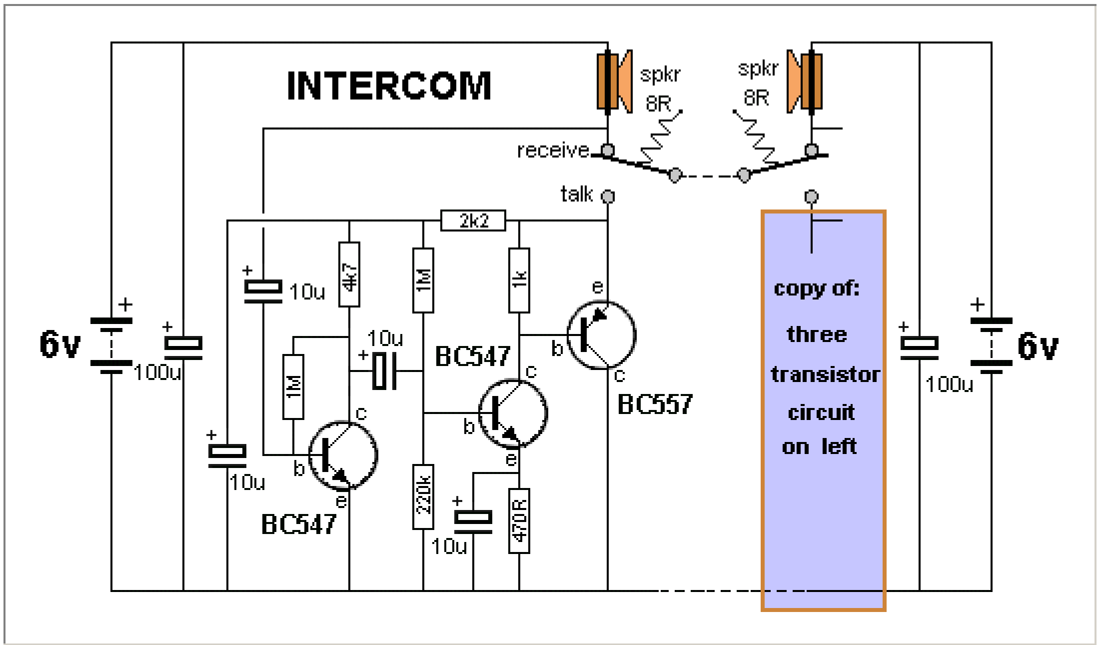
INTERCOM

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.



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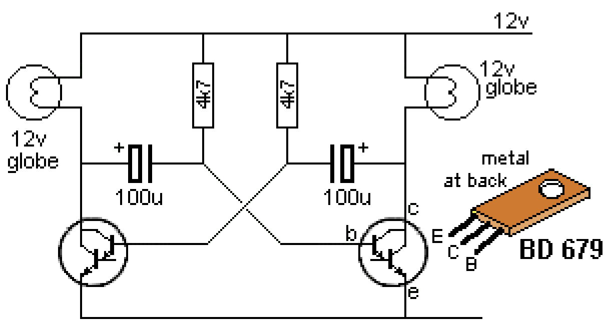
WARNING BEACON



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.

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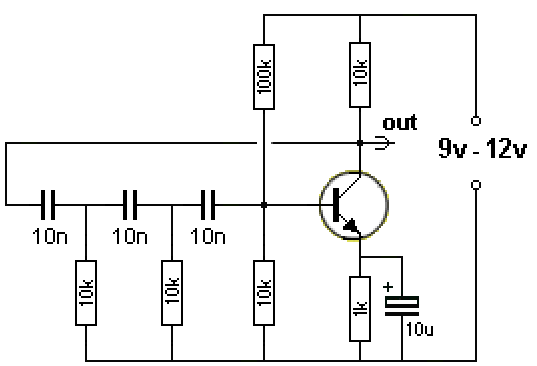
PHASE-SHIFT OSCILLATOR also called SINEWAVE OSCILLATOR



This circuit produces a sinewave very nearly equal to rail voltage.
The important feature is the need for the emitter resistor and 10u 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.

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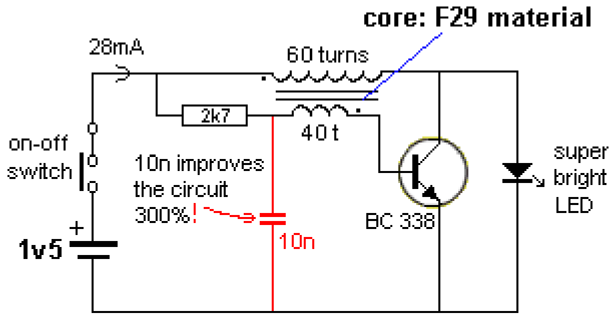
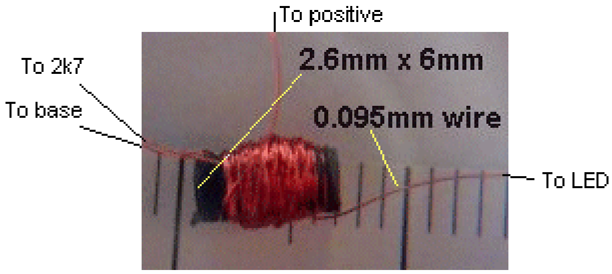
BLOCKING OSCILLATOR also called FLYBACK OSCILLATOR



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.

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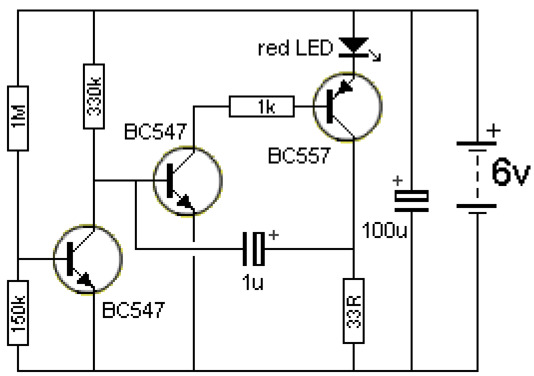
LOW VOLTAGE FLASHER



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.

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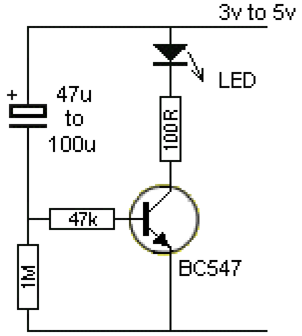
POWER ON



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.

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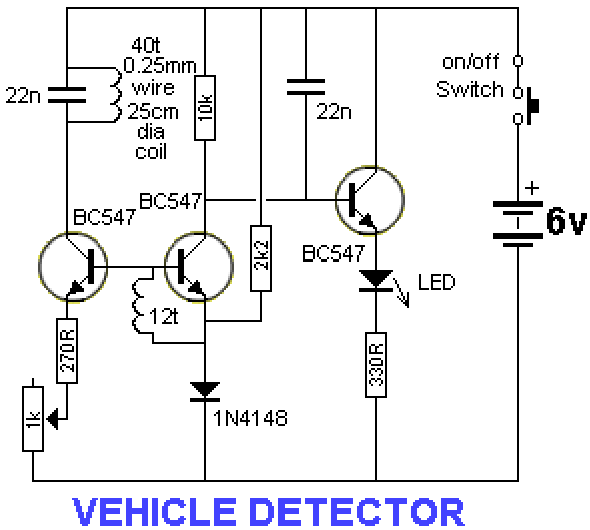
CAR LOOP DETECTOR



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.

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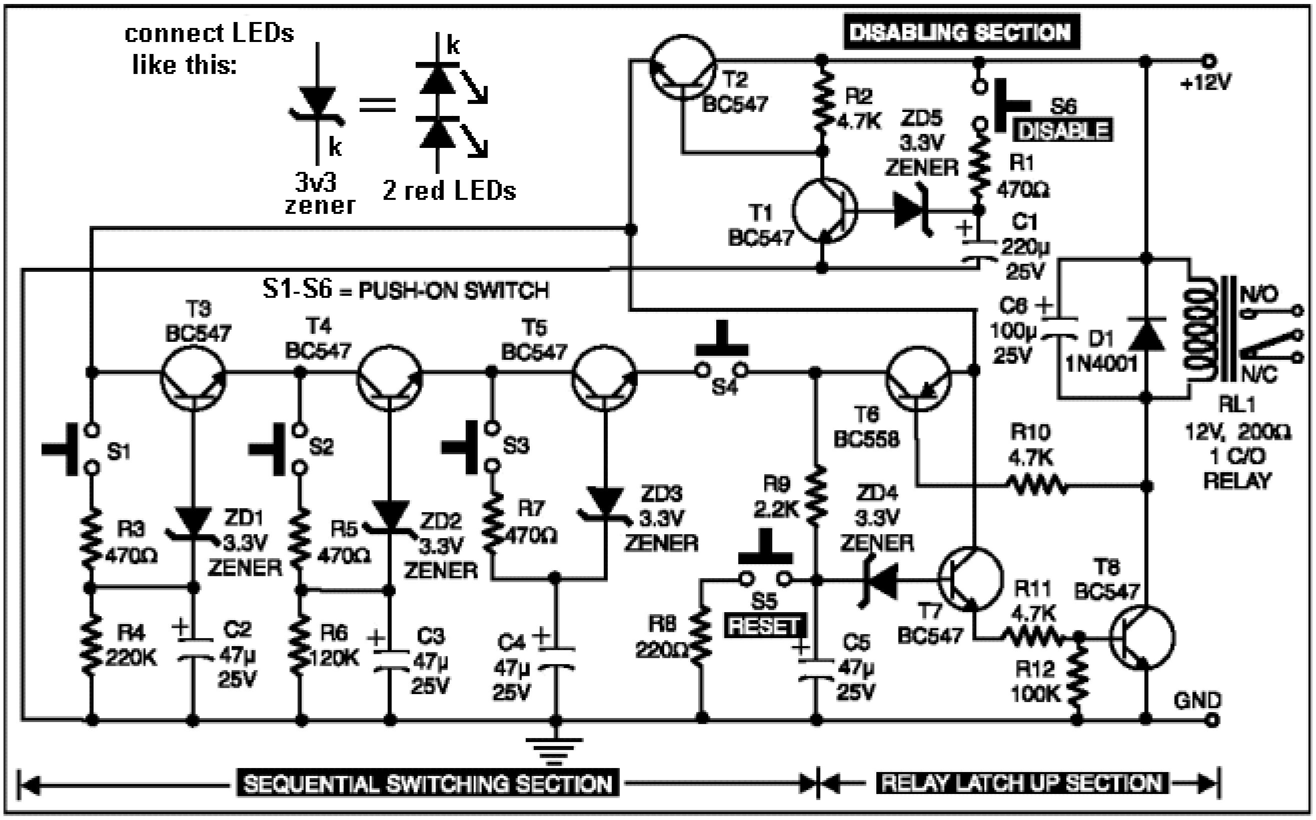
ALARM USING 4-BUTTONS



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.

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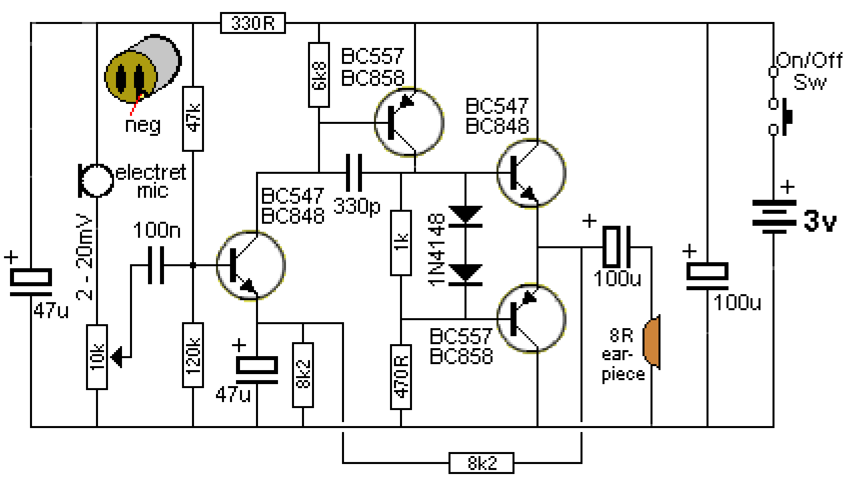
AUDIO AMPLIFIER (mini)



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.

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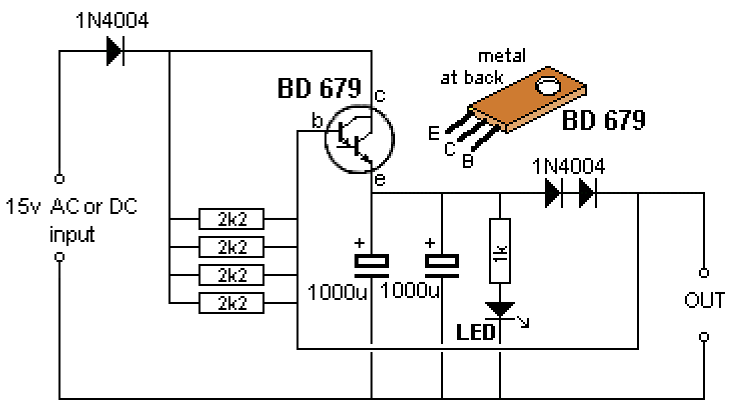
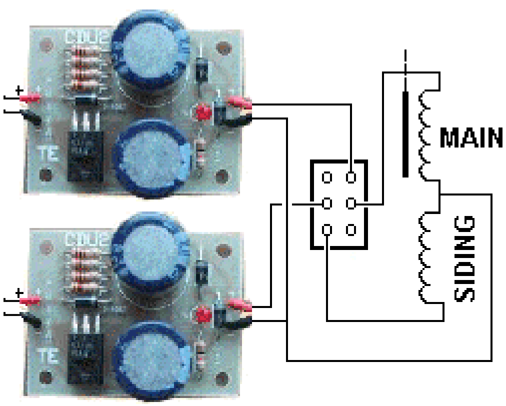
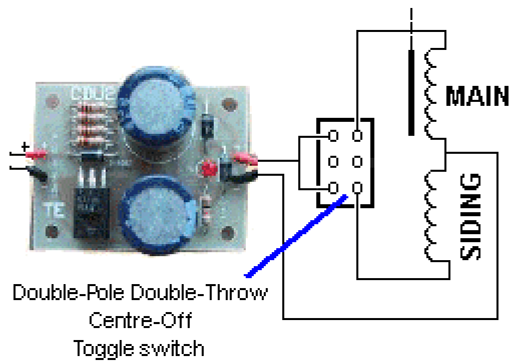


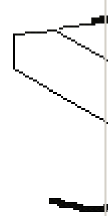
CAPACITOR DISCHARGE UNIT MkII (CDU2)

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

CAPACITOR DISCHARGE UNIT MkII







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.

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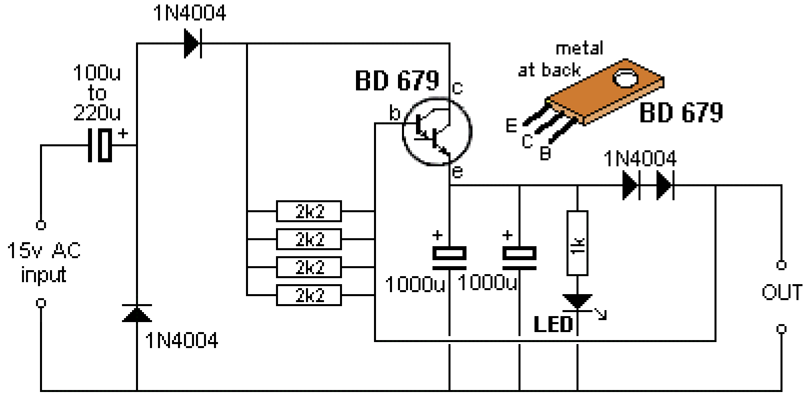
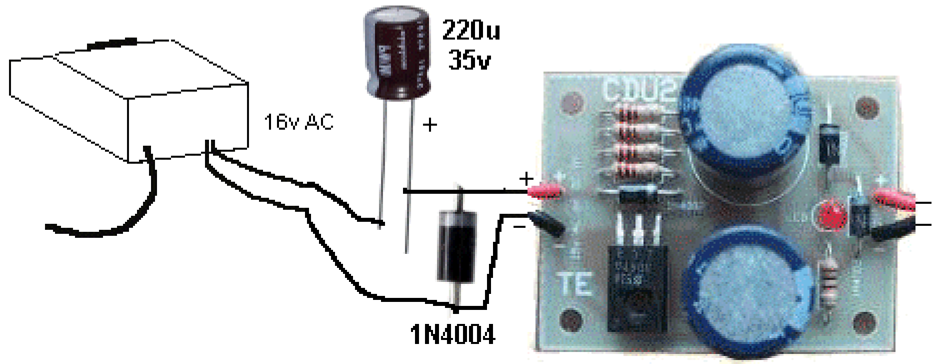
CAPACITOR DISCHARGE UNIT MkII (CDU2) - modification

If your transformer 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.



CAPACITOR DISCHARGE UNIT MkII
MODIFICATION



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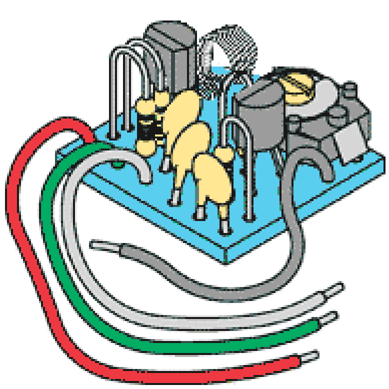
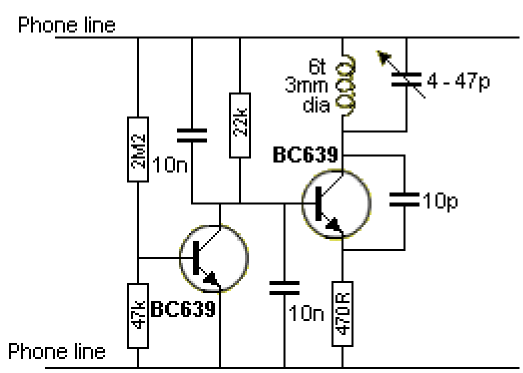
PHONE BUG **see also Phone Transmitter 1 and 2 (1-100 circuits)**

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.





TELEPHONE BUG

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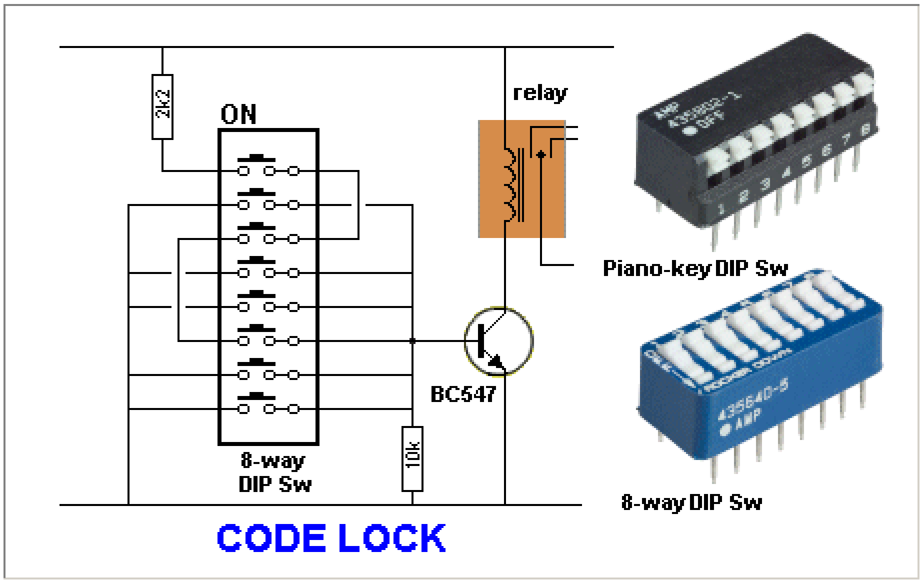
CODE LOCK

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.



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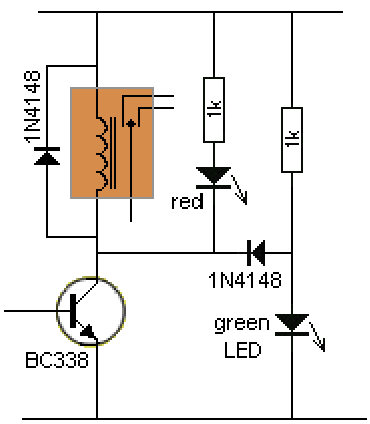
LEDS SHOW RELAY STATE

The green LED indicates the relay is not energised and the red LED shows the relay is energised.



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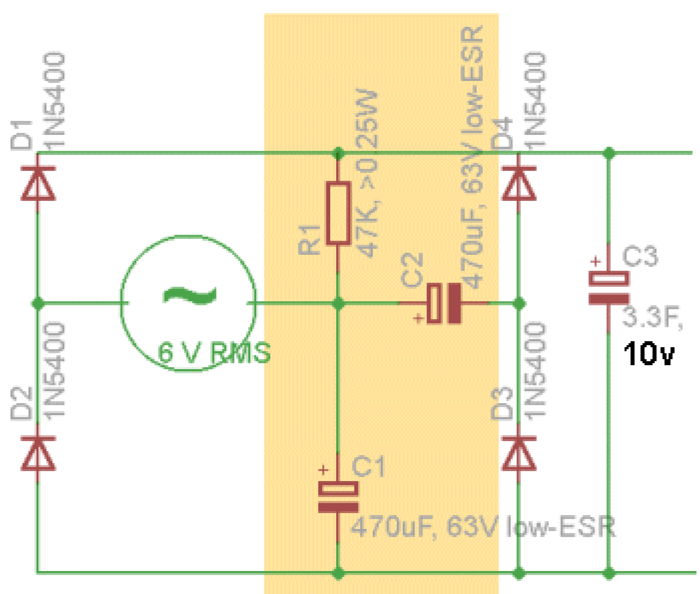
VOLTAGE DOUBLER



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.

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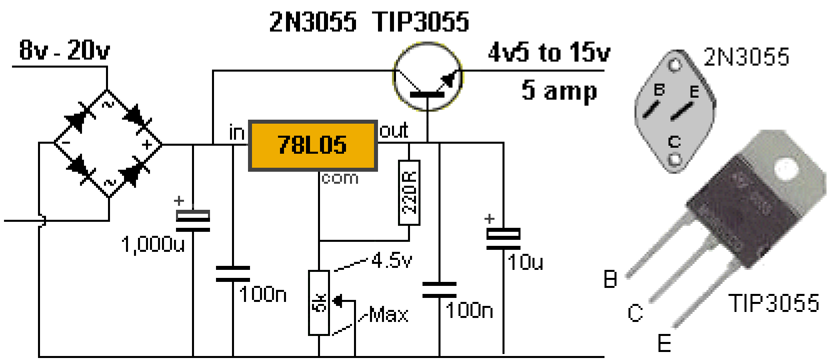
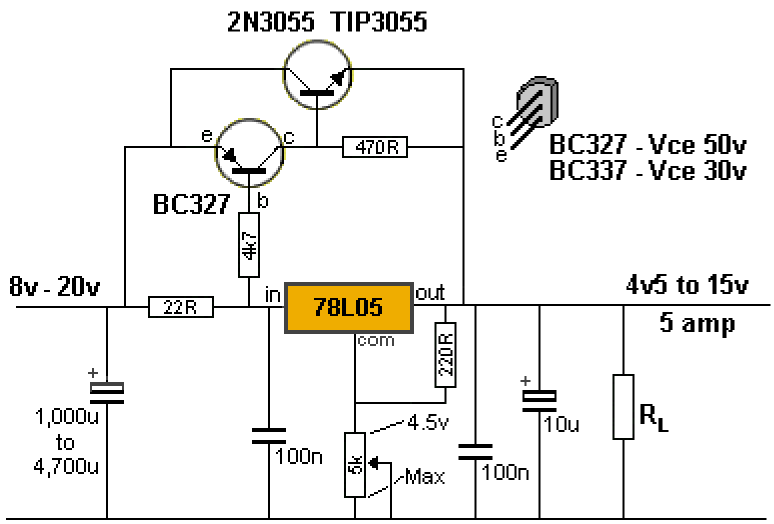
Adjustable High Current Regulated Power Supply

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.

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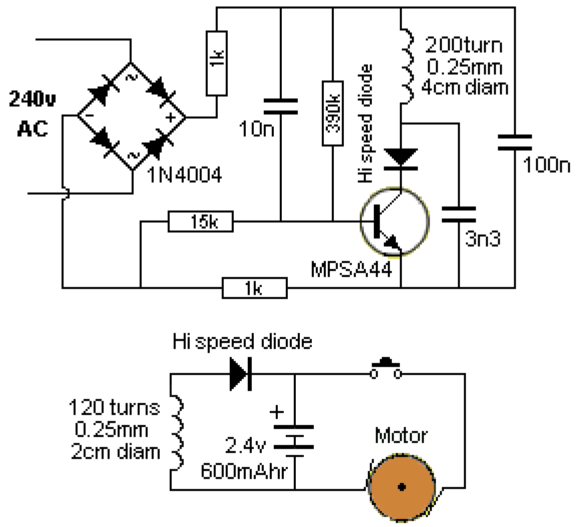
INDUCTIVELY COUPLED POWER SUPPLY

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.

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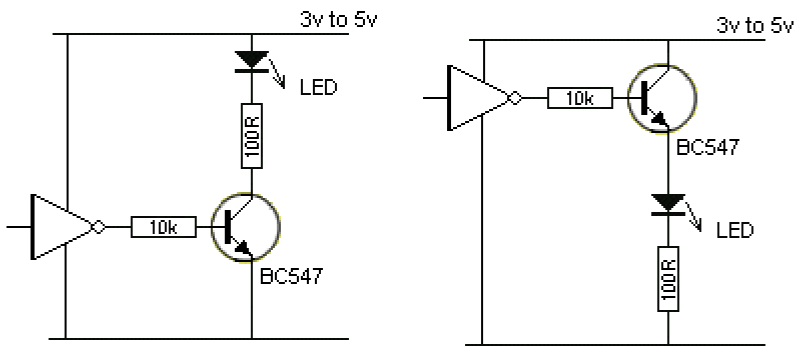
POWERING A LED

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.



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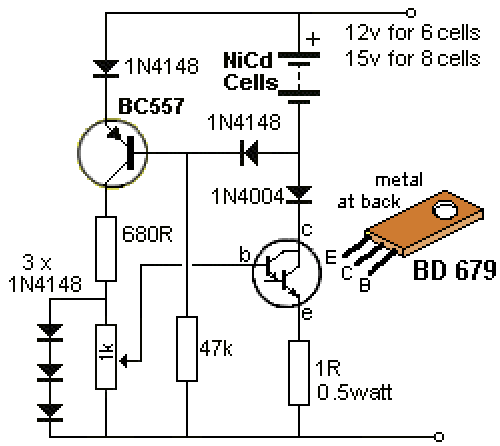
NiCd BATTERY CHARGER

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.



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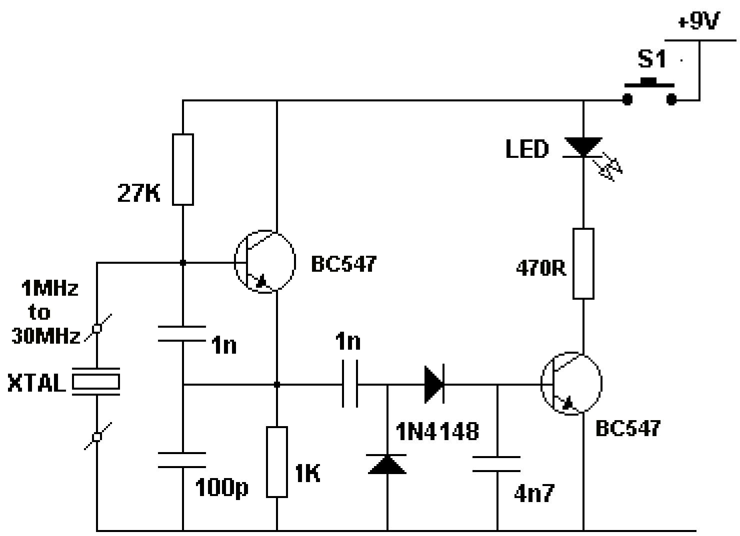
CRYSTAL TESTER

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.



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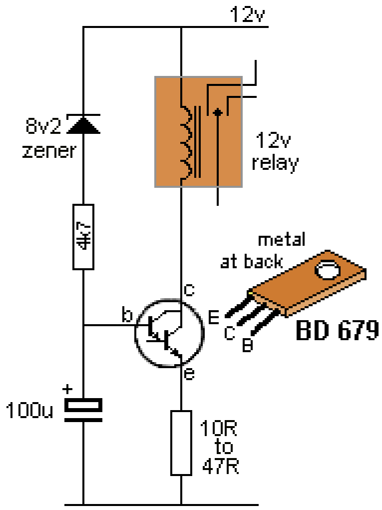
LOW VOLTAGE CUT-OUT

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.



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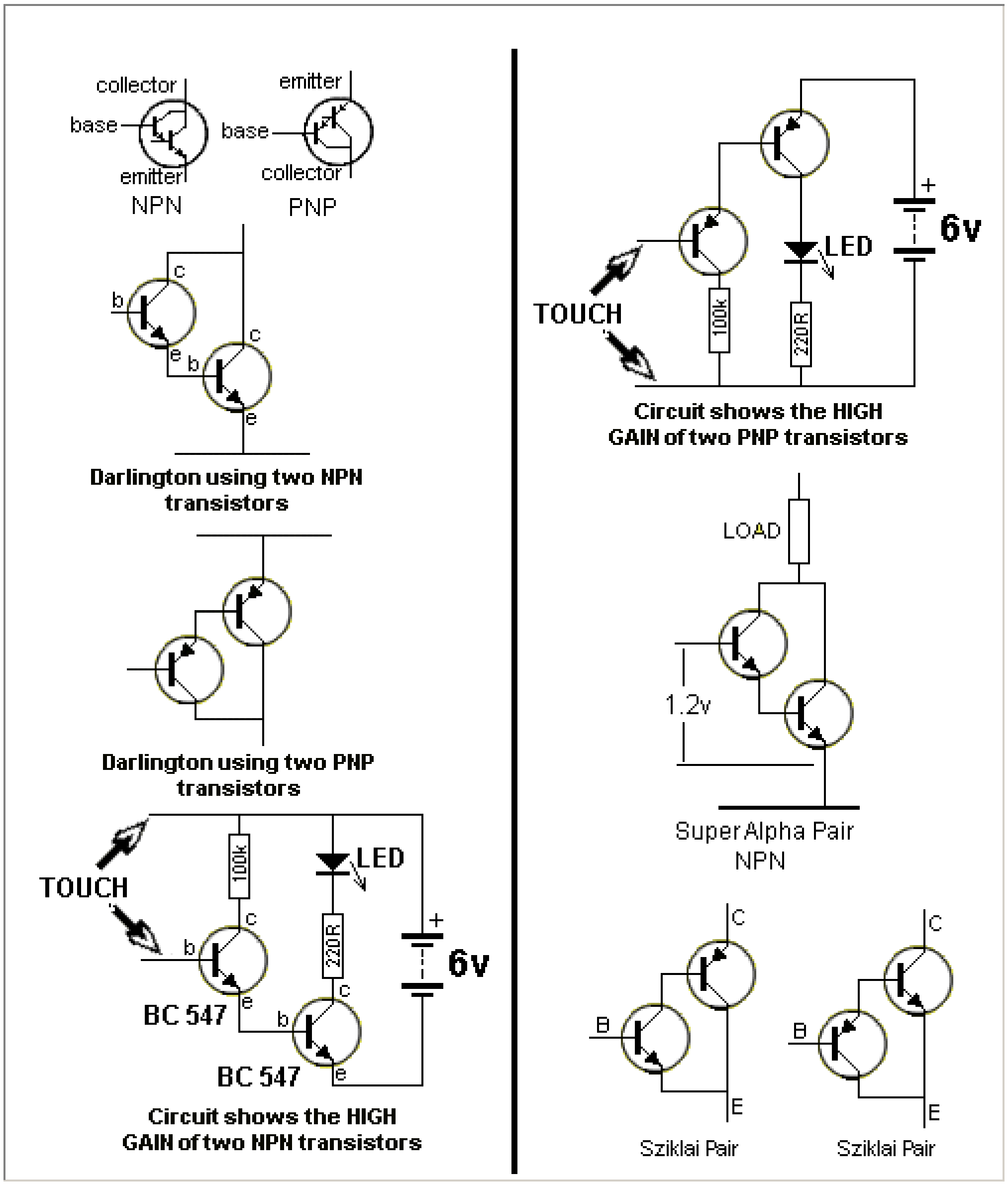
THE DARLINGTON TRANSISTOR

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.



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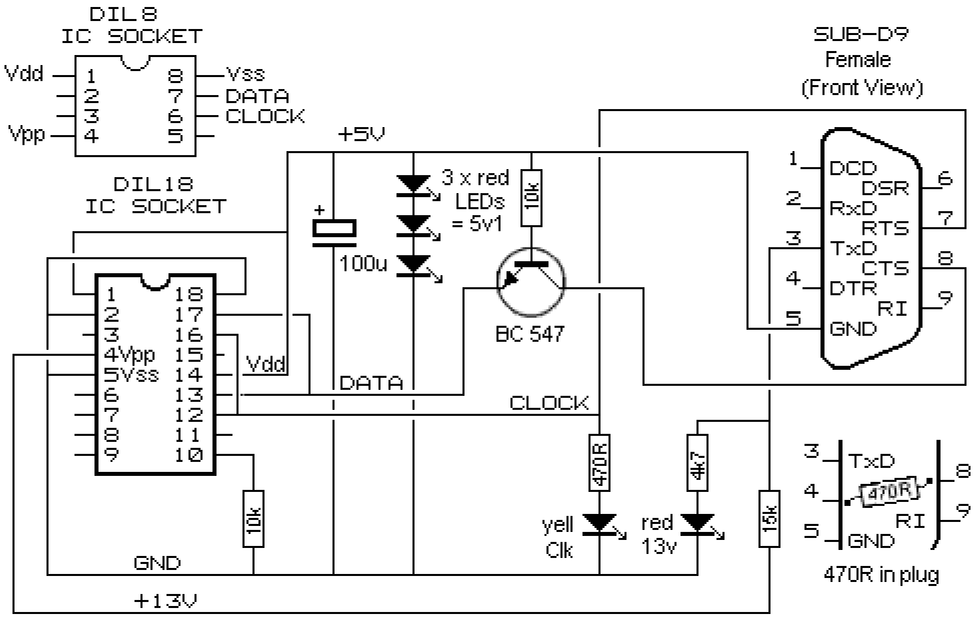
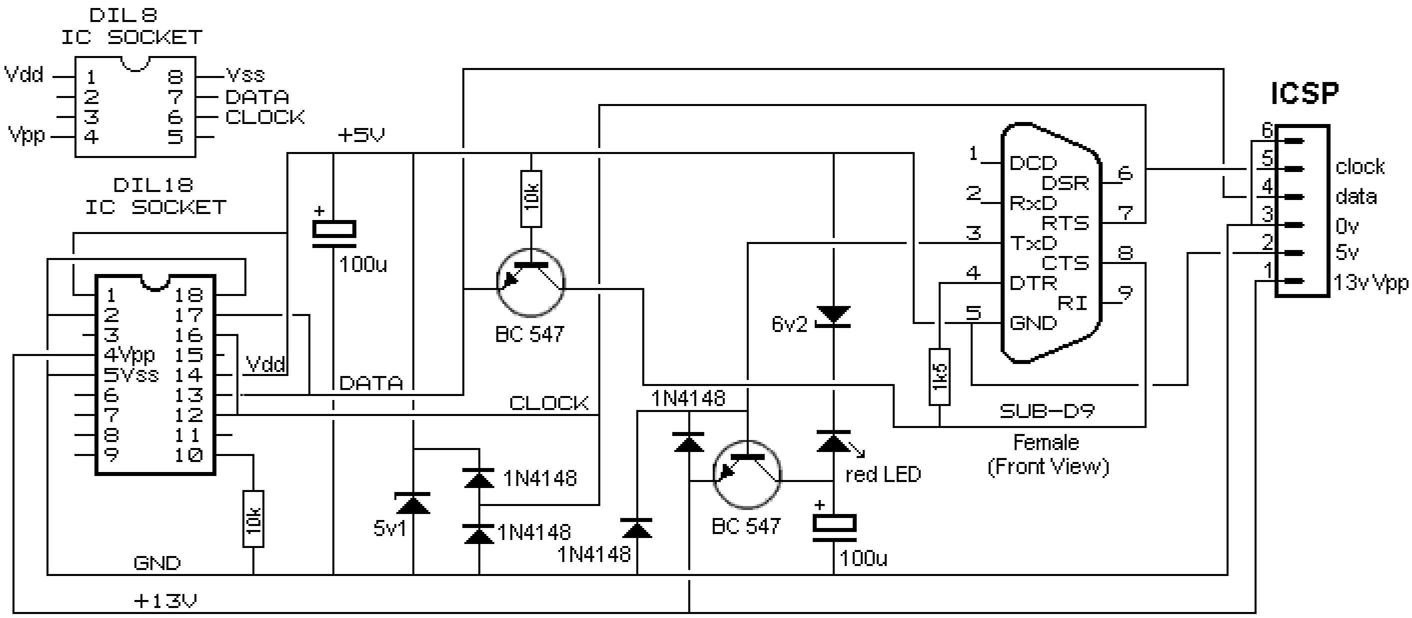
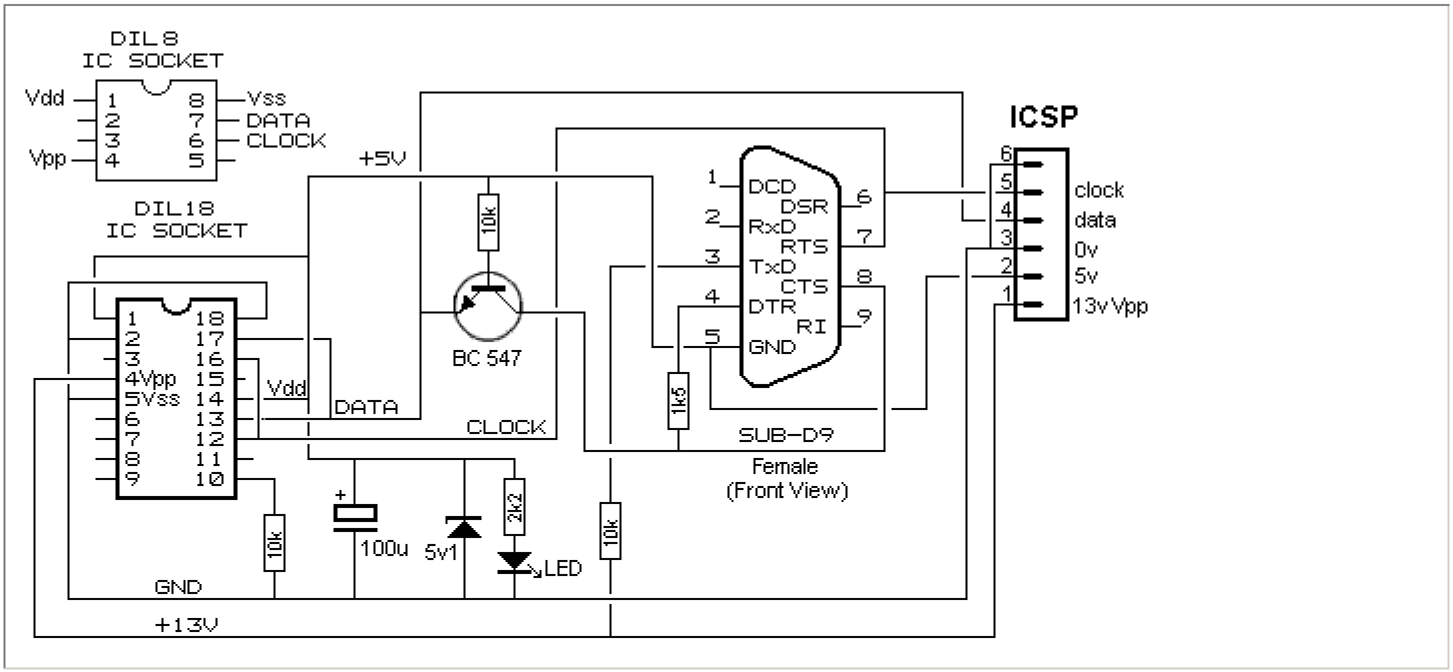
PIC PROGRAMMER

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.


DIL 8
IC SOCKET
Vdd
Vpp
Vss
DATA
CLOCK
DIL18
IC SOCKET
+5V
3 x red
LEDs
= 5v1
10k
100u
BC 547
SUB-D9
Female
(Front View)
DCD
DSR
RxD
RTS
TxD
CTS
DTR
RI
GND
4Vpp
5Vss
Vdd
DATA
CLOCK
470R
4k7
15k
10k
yell
Clk
red
13v
GND
+13V
470R in plug


DIL 8
IC SOCKET
Vdd
Vpp
Vss
DATA
CLOCK
DIL18
IC SOCKET
+5V
100u
10k
BC 547
4Vpp
5Vss
Vdd
DATA
CLOCK
6v2
1N4148
5v1
1N4148
1N4148
1N4148
BC 547
red LED
100u
1k5
10k
GND
+13V
DCD
DSR
RxD
RTS
TxD
CTS
DTR
RI
GND
SUB-D9
Female
(Front View)
ICSP
clock
data
0v
5v
13v Vpp



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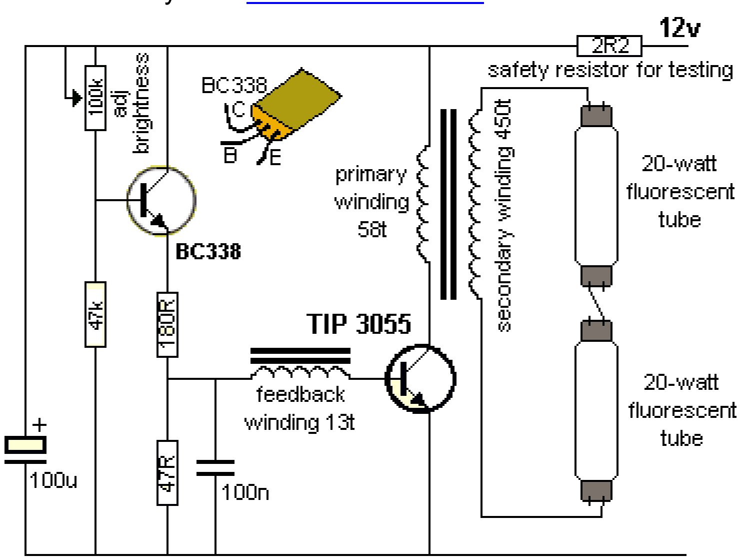
FLUORESCENT INVERTER

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.



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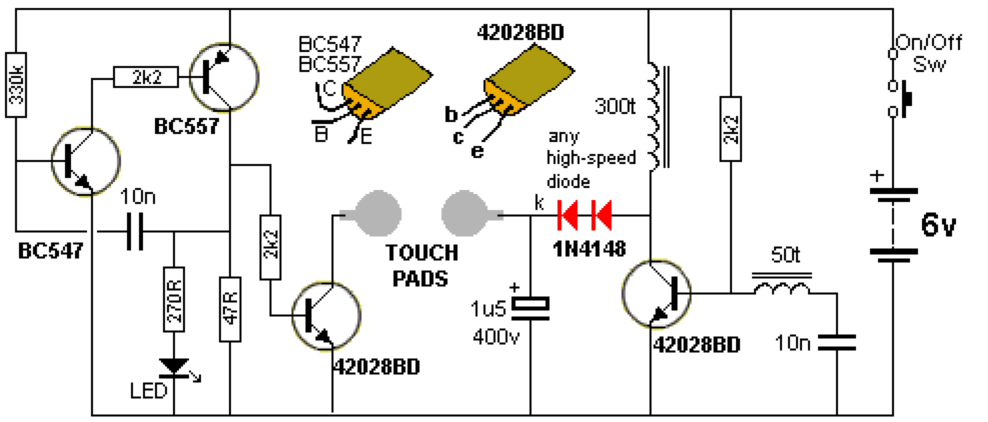
ZAPPER - 160v

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.



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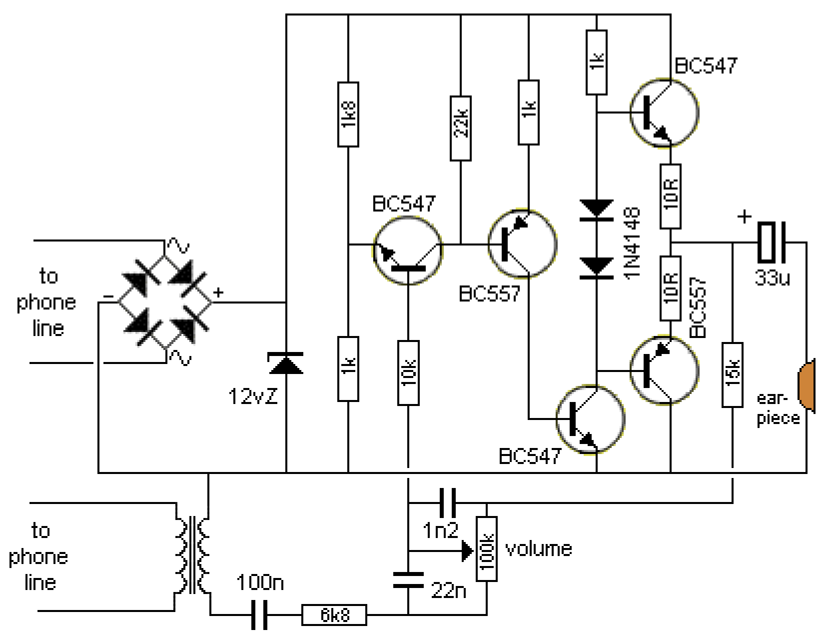
TELEPHONE AMPLIFIER

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.



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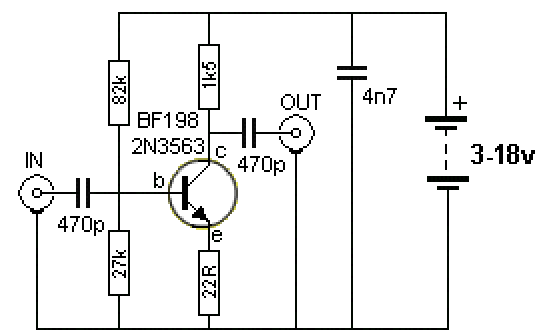
VHF AERIAL AMPLIFIER

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.



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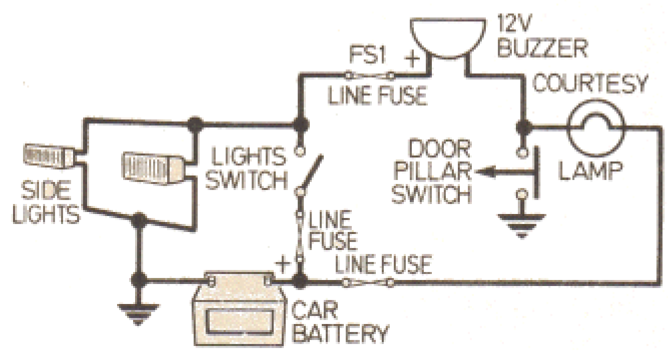
CAR LIGHTS ALERT

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.



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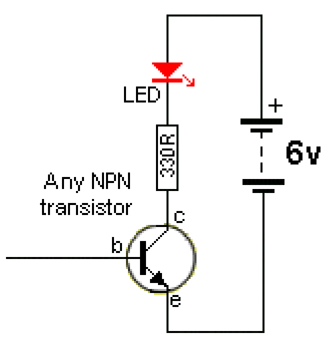

MAINS DETECTOR

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.

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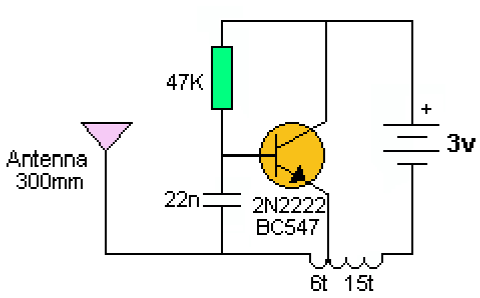
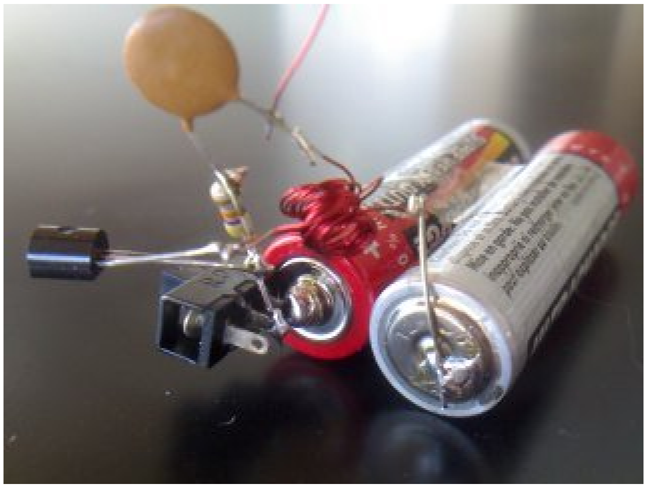
SIMPLEST FM BUG





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.

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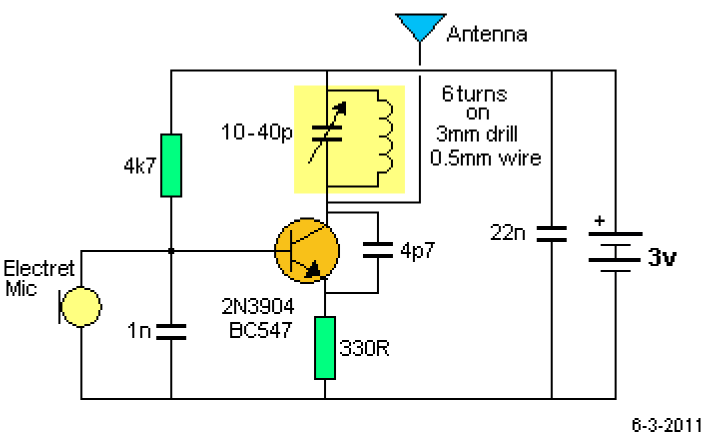
A GOOD ONE-TRANSISTOR CIRCUIT



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. The photo below shows the components on a PC board:

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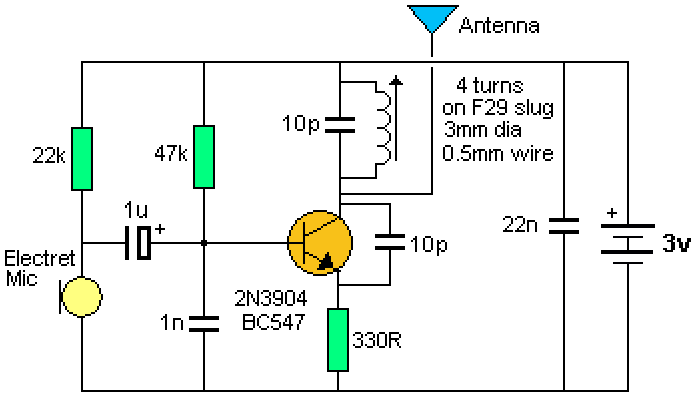
AN IMPROVED DESIGN



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.

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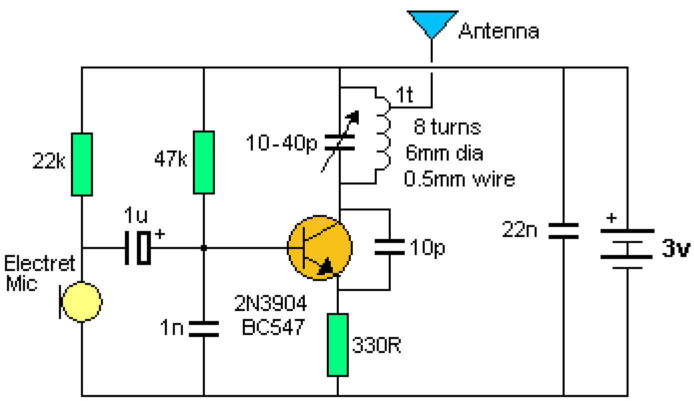
MORE STABILITY



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.

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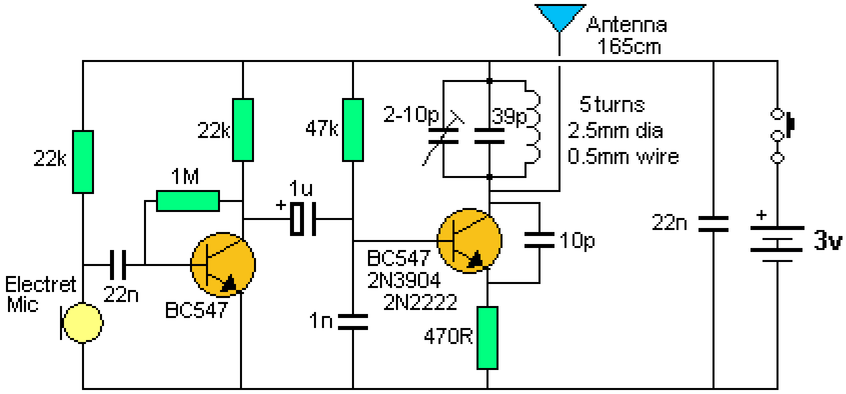
2-TRANSISTOR CIRCUIT

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.

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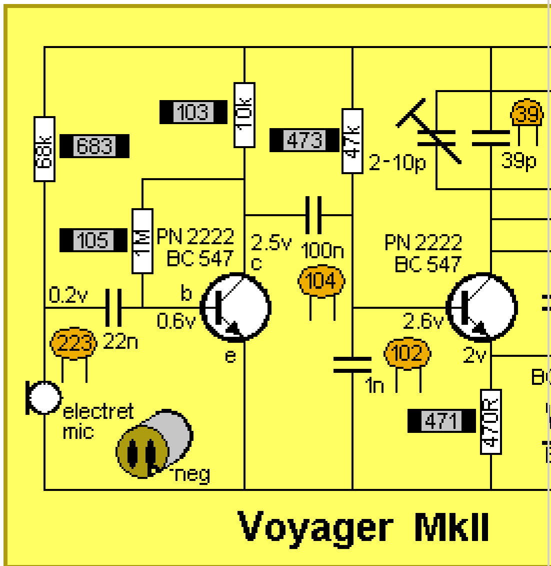
THE VOYAGER

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.

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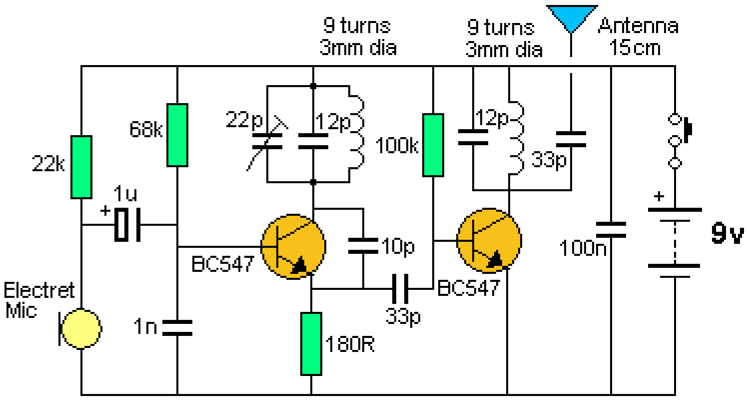
HAND-HELD MICROPHONE



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.

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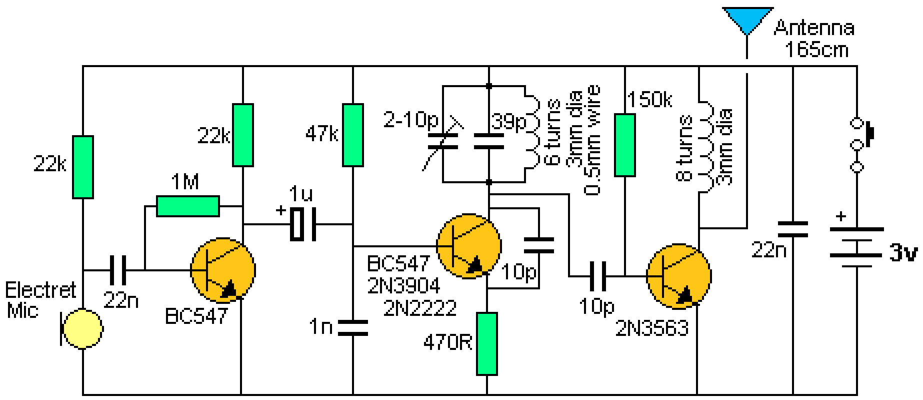
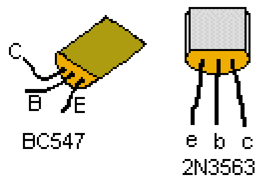
INCREASING THE RANGE





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.

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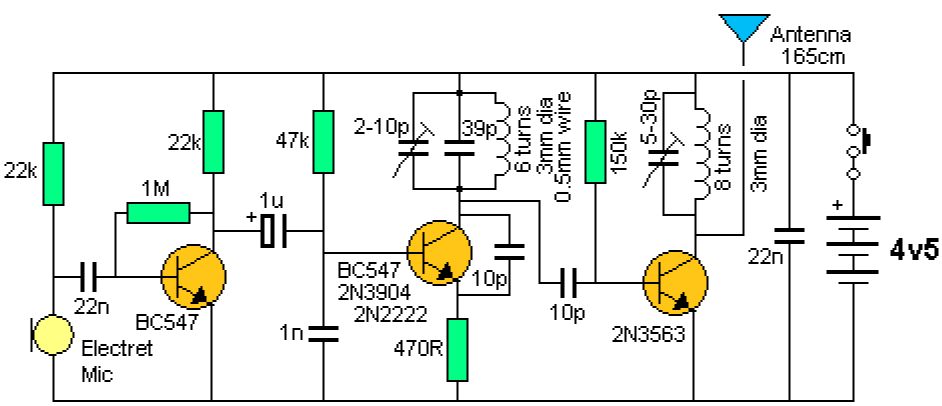
MORE RANGE

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.
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.



A tuned output stage delivers more output

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.

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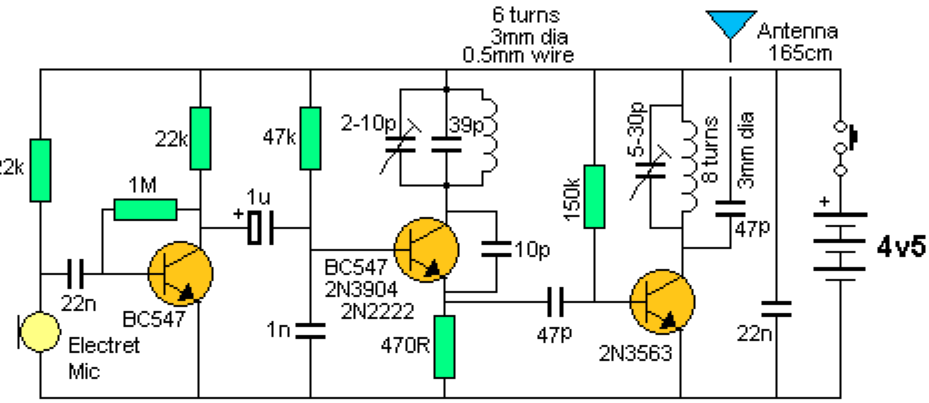
EMITTER TAP

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

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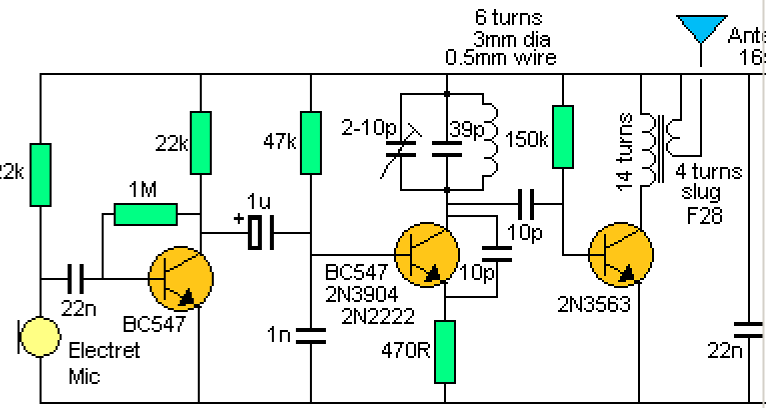
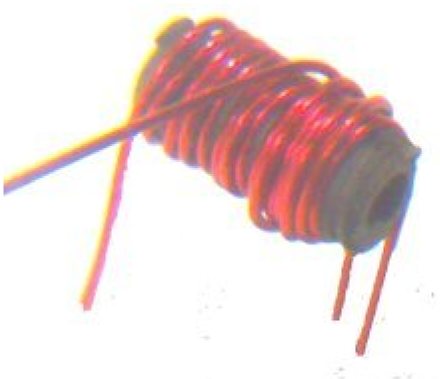
GOING FURTHER





THE RF TRANSFORMER

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 prevent harmonics passing to the antenna. The transformer approximately doubles the output power of the transmitter.

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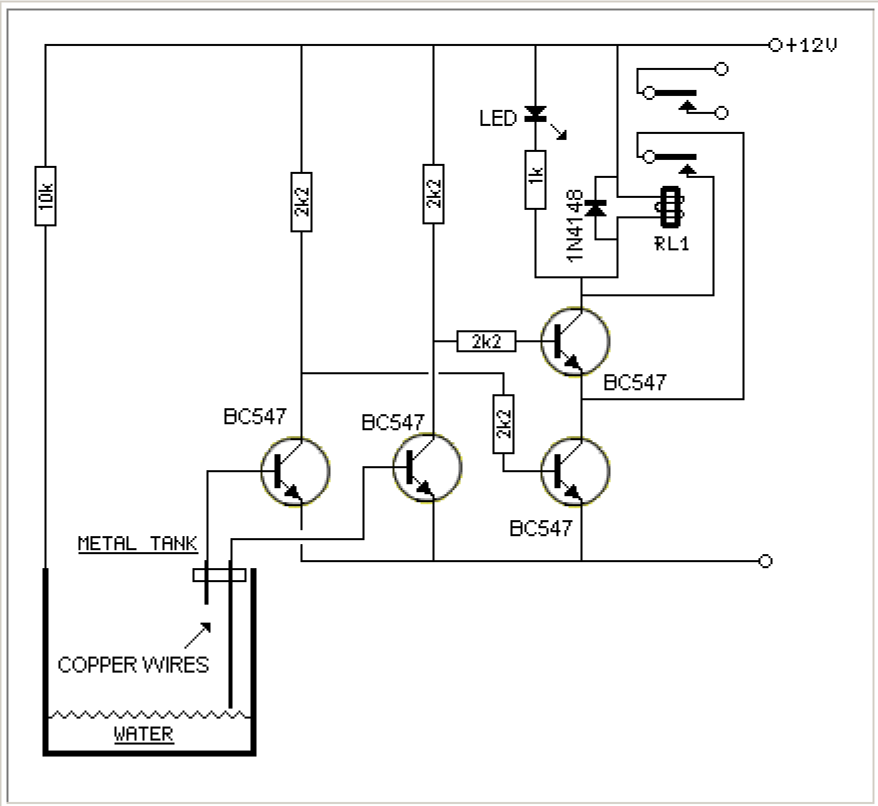
WATER LEVEL DETECTOR

This circuit can be used to automatically keep the header tank filled. It uses a double-pole relay.



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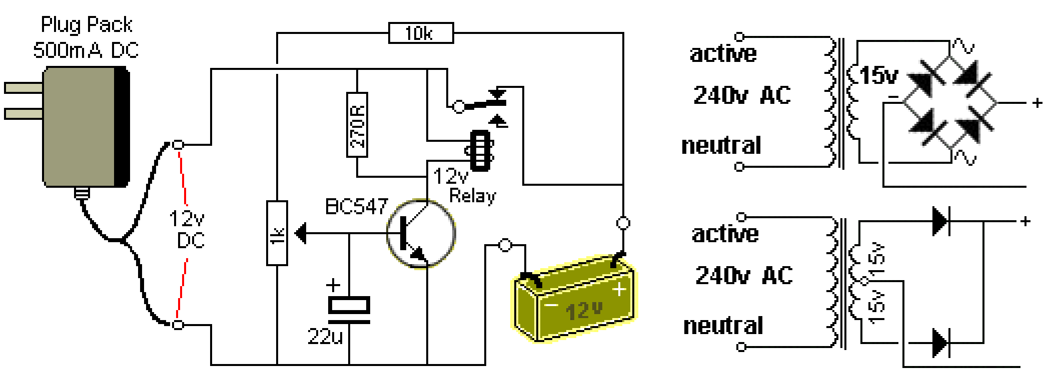
BATTERY CHARGER - world's simplest automatic charger

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.
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, 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.



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 important.
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.

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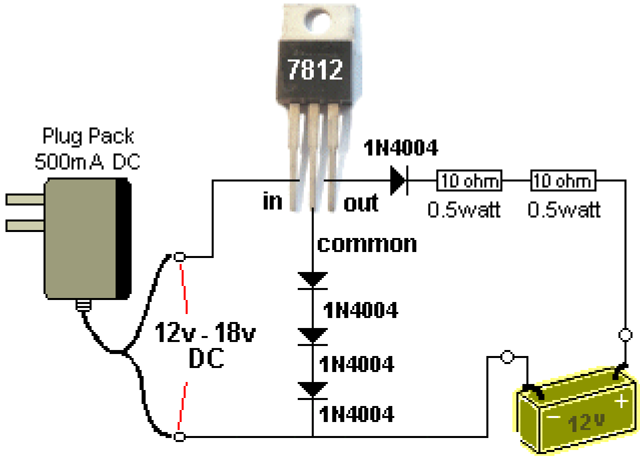
BATTERY CHARGER MkII - a very simple design to keep a battery "topped up."



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.

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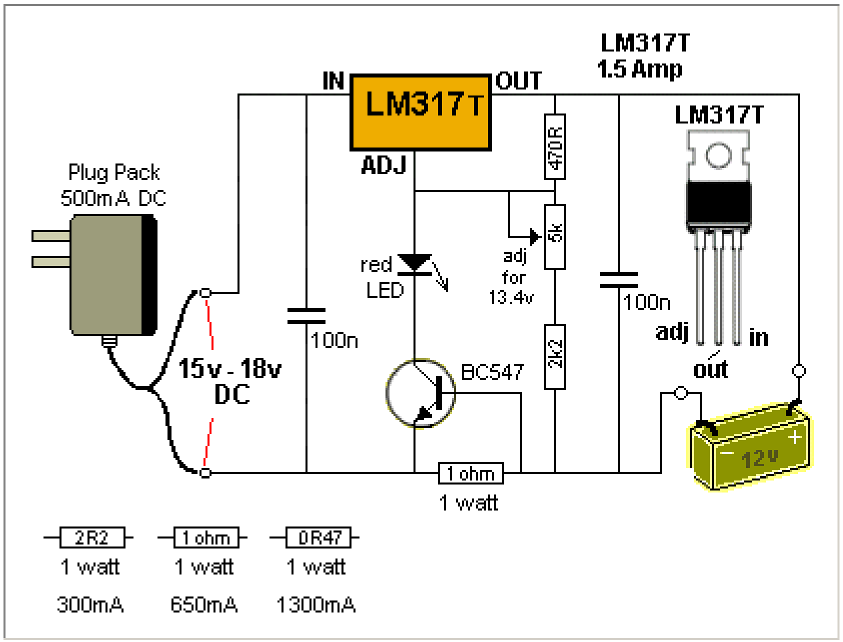
GELL CELL BATTERY CHARGER

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.



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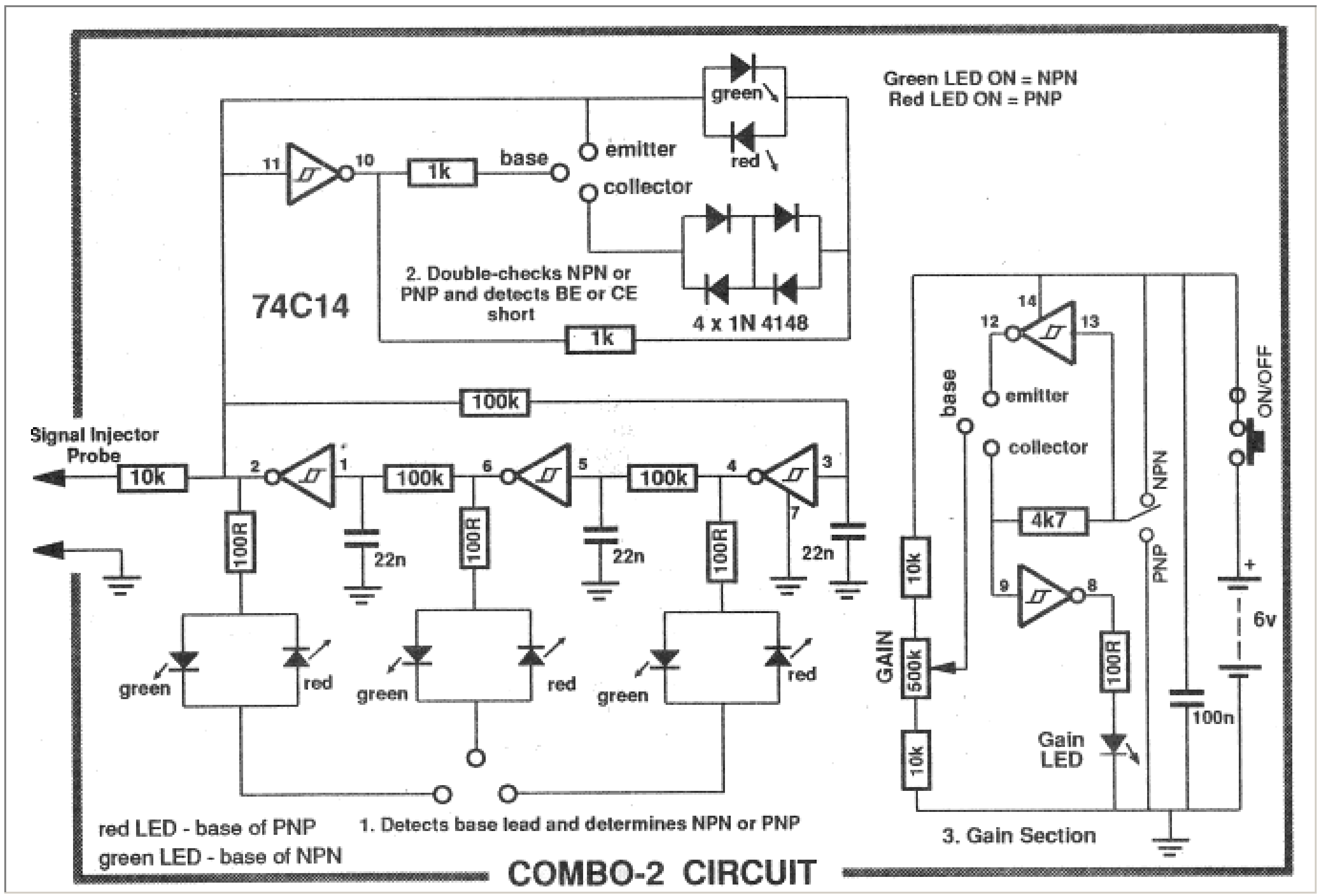
TRANSISTOR TESTER   COMBO-2

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:
Test 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.
Test 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.
Test 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.



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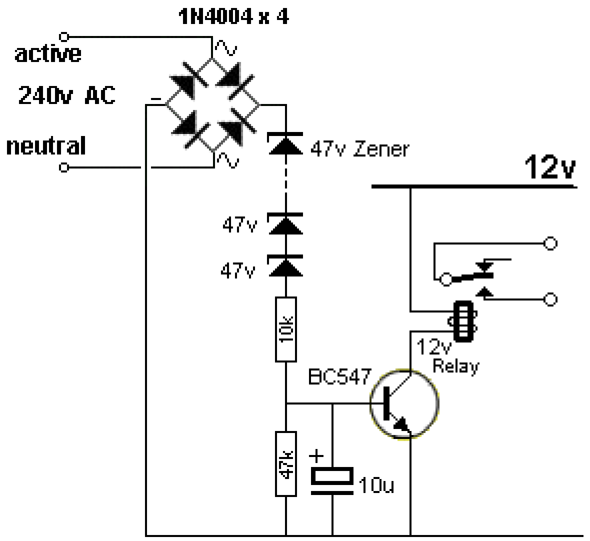
LOW MAINS DROPOUT

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.



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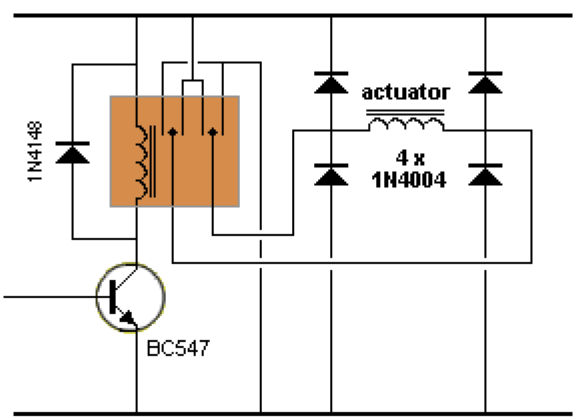
PROTECTING THE CONTACTS OF A RELAY:
The contacts of a relay can be protected from the damaging effects of reversing an actuator. The circuit shows a double-pole double-throw relay driving an actuator. The 4 "bridge diodes" around the actuator "squelch" the back-emf from damaging the contacts.



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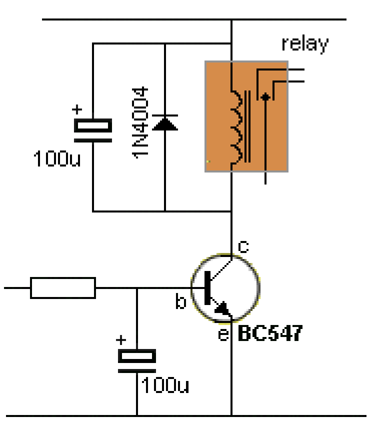
REDUCING RELAY CHATTER:
To reduce the relay clicking or chattering during the activation of the relay driver transistor, an electrolytic can be placed between the base and 0v rail. In addition an electro can be placed across the relay if there is a possibility of the supply voltage glitching or temporally failing.



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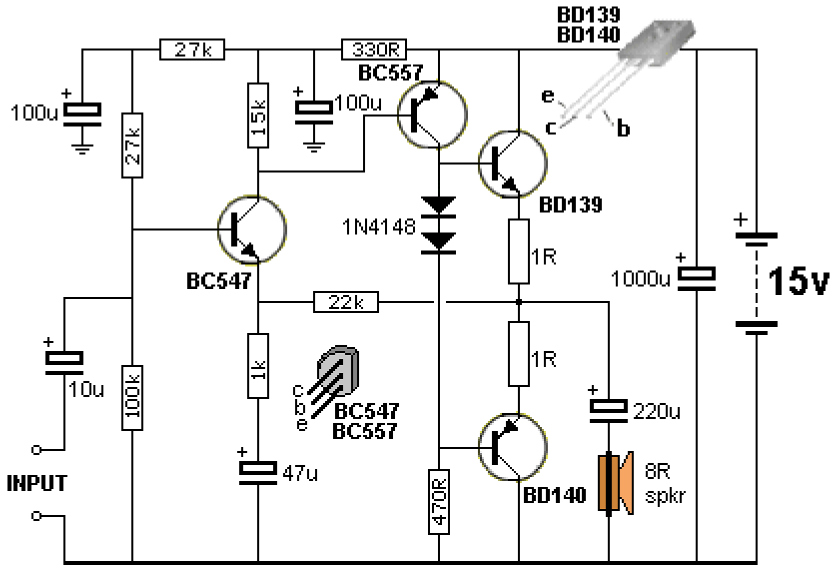
4 TRANSISTOR AMPLIFIER:
This circuit is fully documented in The Transistor Amplifier as Fig 105.



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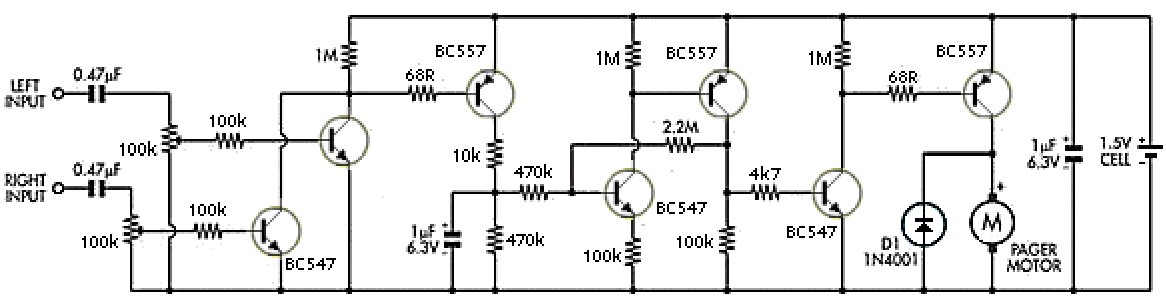
Vibrating VU Indicator

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.

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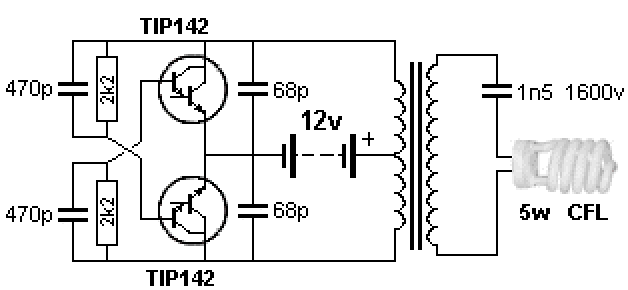
CFL DRIVER
This circuit will drive a 5watt Compact Fluorescent Lamp from 12v:



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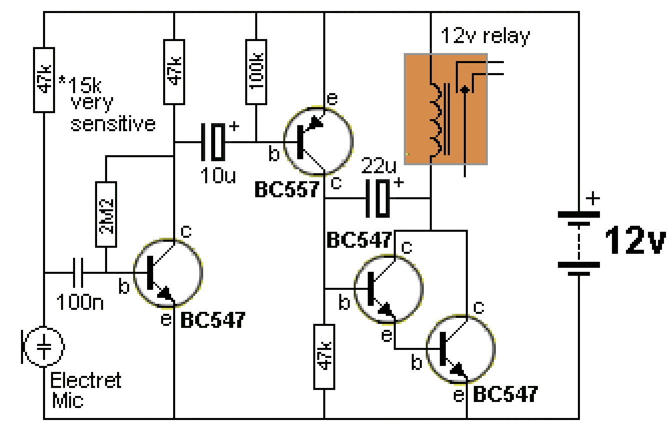
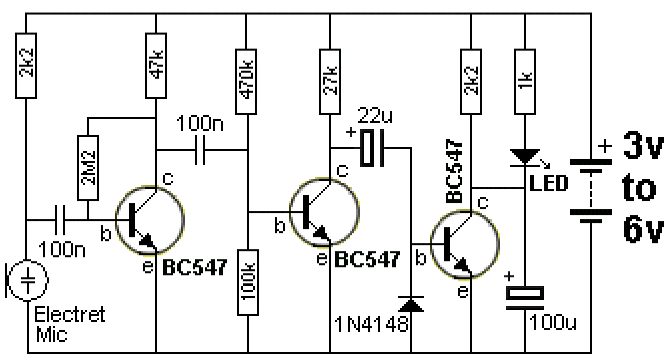
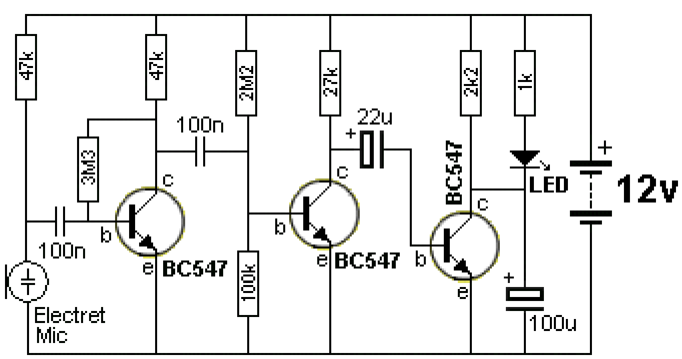
VOX
These circuits detect audio and operate a relay or produce an output pulse. See full details in: The Transistor Amplifier eBook - under VOX



SENSITIVE VOX CIRCUIT



3v to 6v VOX CIRCUIT



12v VOX CIRCUIT

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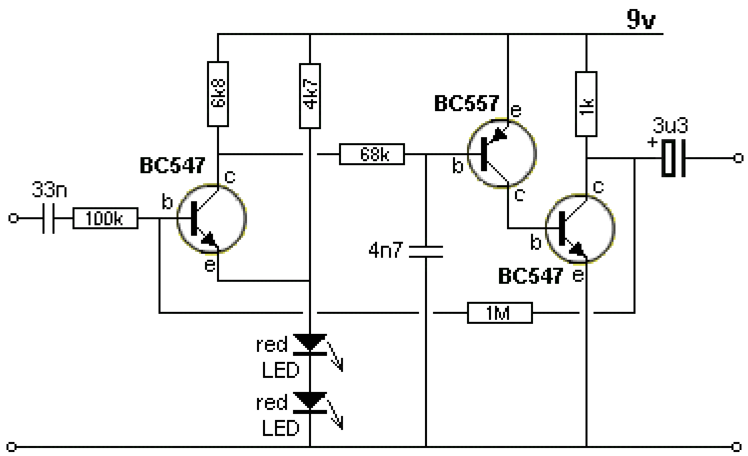
OP-AMP WITH 3 TRANSISTORS:
This circuit shows how a simple operational amplifier can be made with 3 transistors.



3-TRANSISTOR OP-AMP

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 1kΩ. The square-wave response is good at 10kHz, and the output reduces by 3dB at 50kHz.

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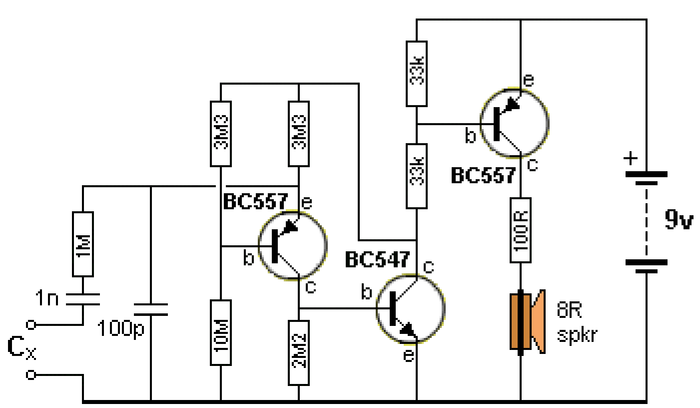
CAPACITOR TESTER
Circuit designed by: Charles Wenzel charles@wenzel.com
This circuit will test very small capacitors. The tone from the speaker will change when a capacitor is placed across the test-points "Cx."
The operation of the circuit is explained in our eBook: The Transistor Amplifier (high impedance circuit).



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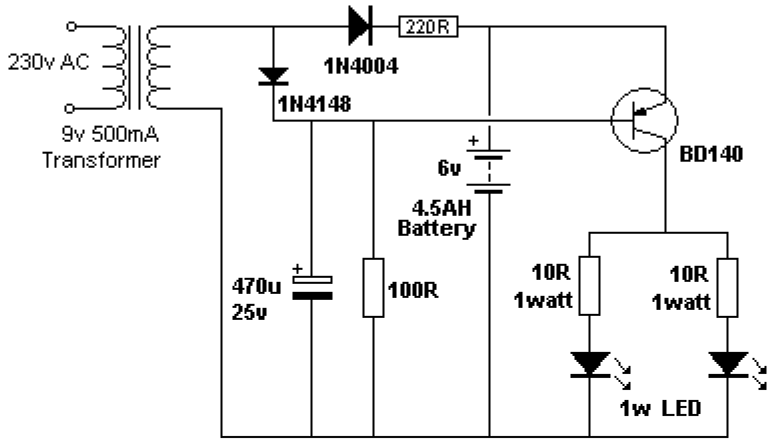
High bright LED Emergency Light



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).

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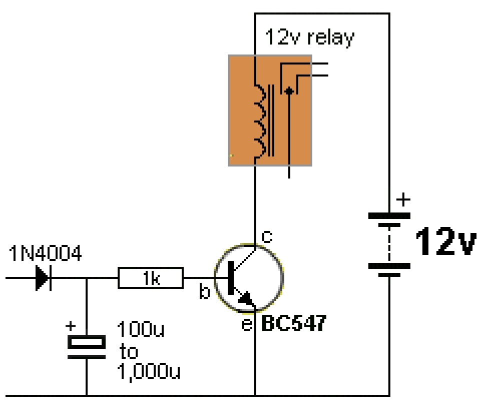
RELAY OFF DELAY

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.



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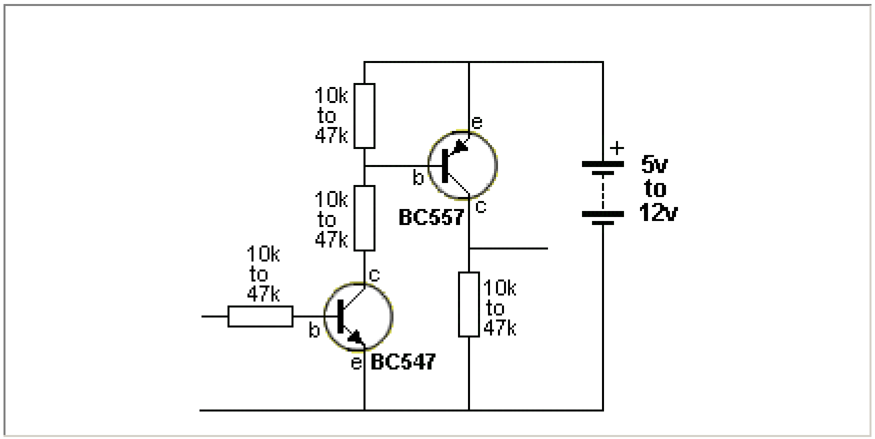
AMPLIFYING A DIGITAL SIGNAL

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.



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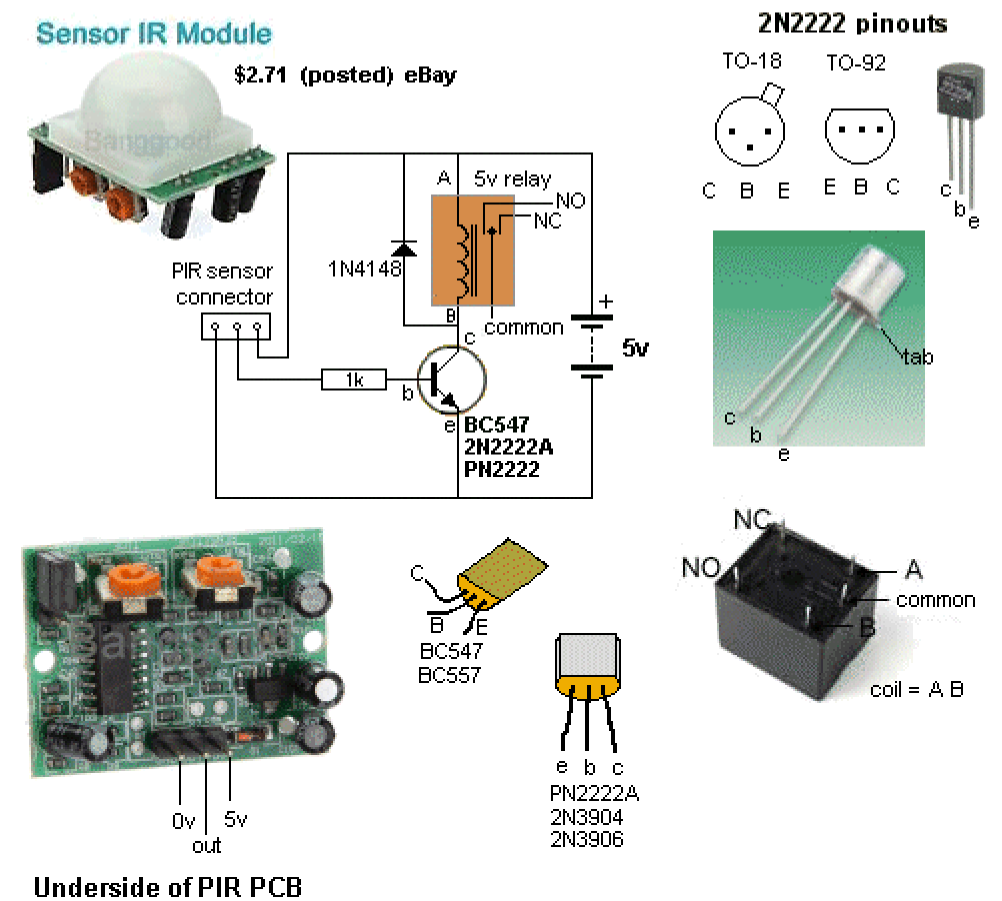
PIR DETECTOR
This circuit detects movement and operates a relay. The PIR module has "Sensitivity" and "Time Delay" pots. They can be purchased on eBay for $2.71 including postage!



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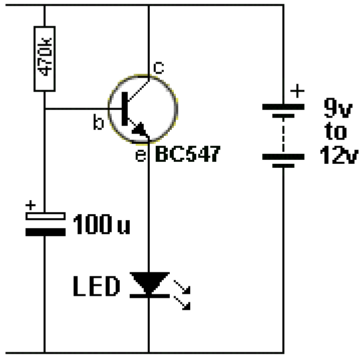
10 SECOND DELAY
This clever circuit turns on the LED 10 seconds after the power has been switched ON. The secret to its performance is the gain of the transistor.
With a gain of 200, the transistor will appear as a 470/200 = 2k3 resistor for the LED and for a 12v supply, this will create a current of 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!



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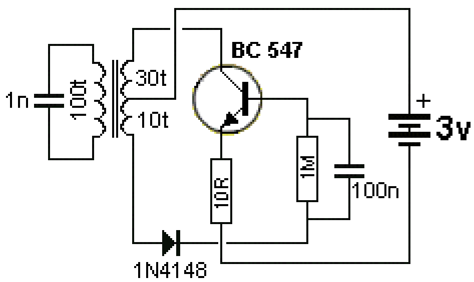
FERRET FINDER:
This circuit produces a beep-beep-beep at approx 600kHz on an AM radio.
The transformer (coil) is wound on 10mm dia ferrite rod 10mm long. The secondary winding is 0.25mm wire. The 100t is 0.01mm wire.



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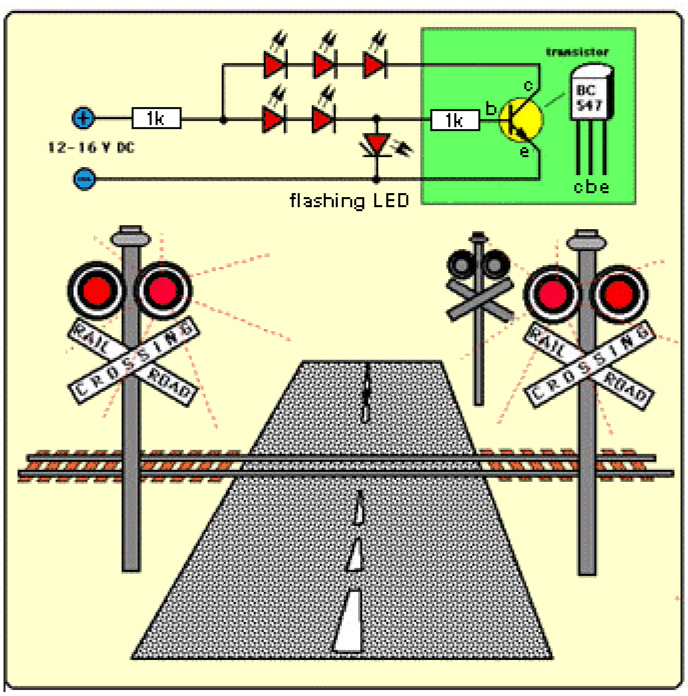
FLASHING LIGHTS FOR MODEL RAILWAY CROSSING:
A flashing LED is used to create the timing for the flash-rate and the transistor provides the alternate flash for the second set of LEDs.



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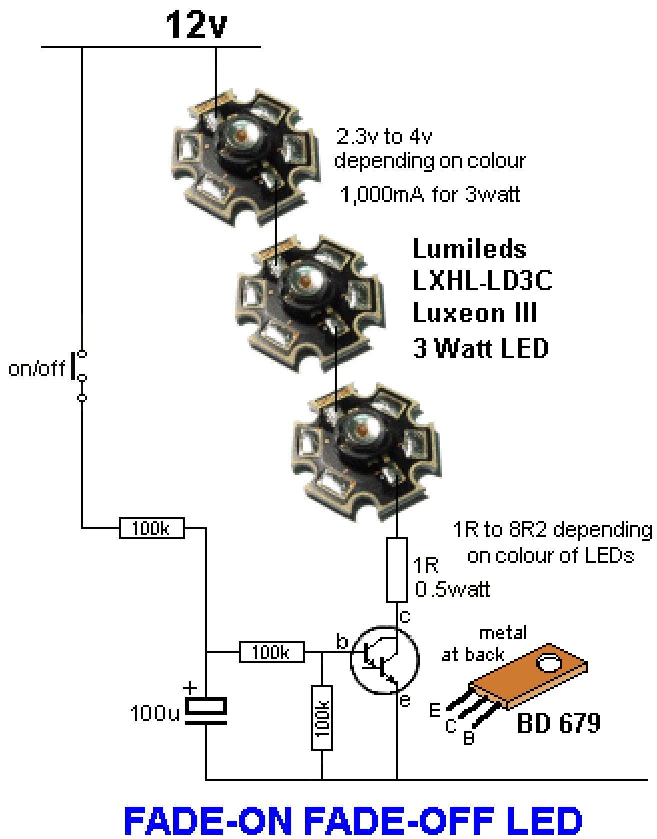
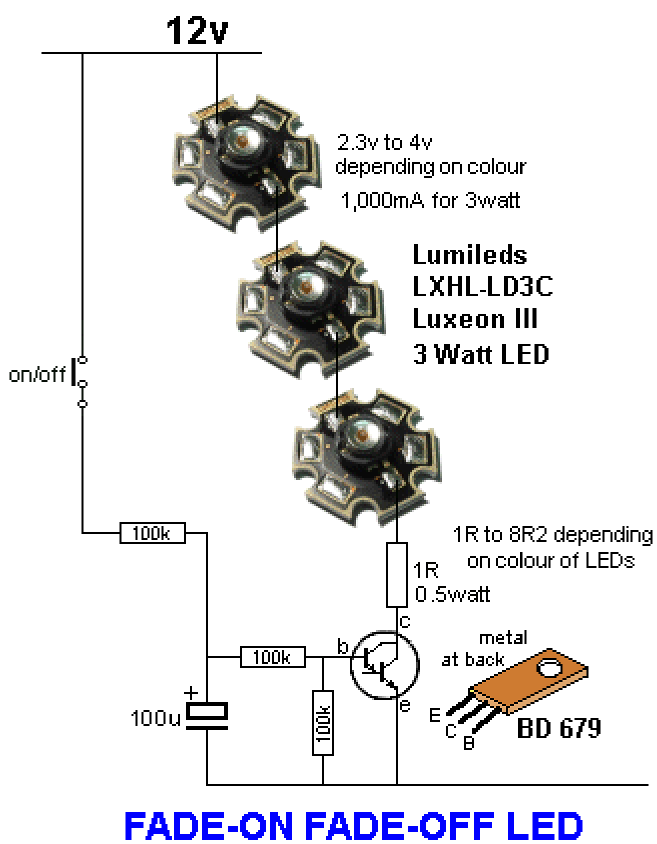
FADE-ON FADE-OFF LED

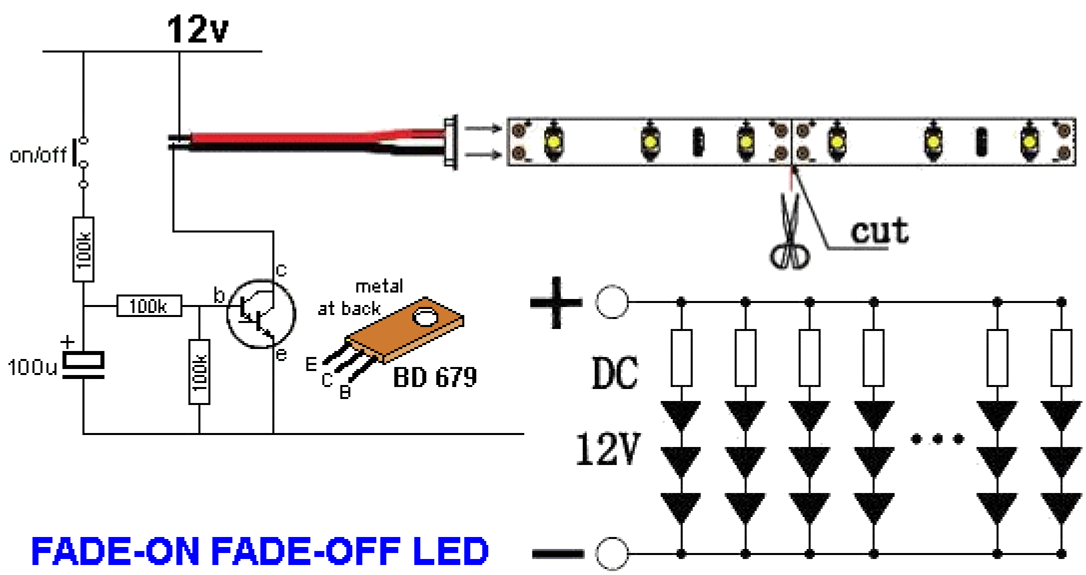
The LEDs in is circuit fade on when the power is applied and fade-off when switched off:



f you just want fade-ON and fade-
ƆFF, this circuit is all you need:



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.

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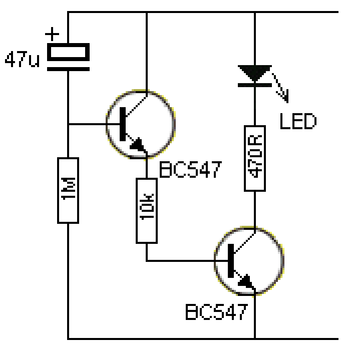
3-SECOND DELAY:

When this circuit is connected to a supply (from 3v to 12v), the LED turns on and gradually fades after about 3 seconds.



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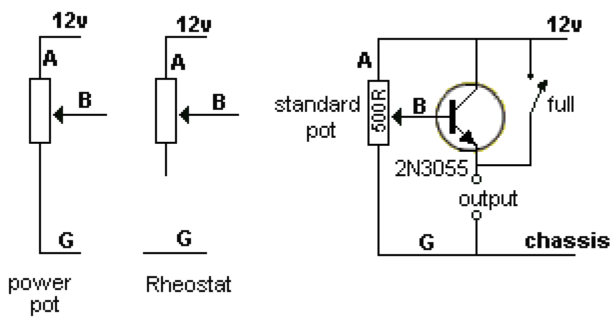
REPLACING A "POWER POT":

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."

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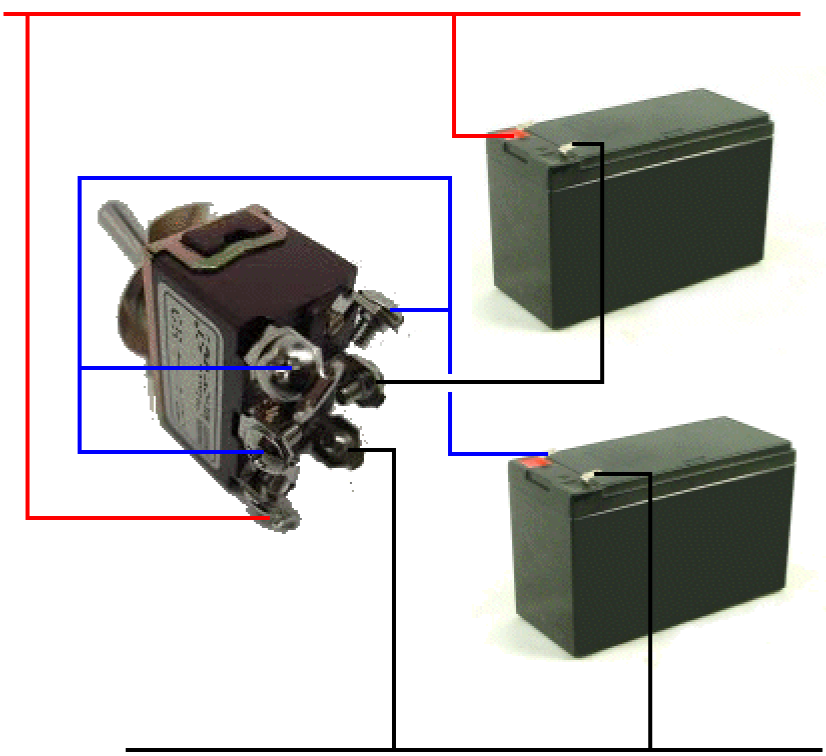
CHANGING 24v to 12v:
This circuit allows to you charge a 24v project from a 12v charger. It converts the two 12v batteries from series to parallel:



CHANGING 24v TO 12v

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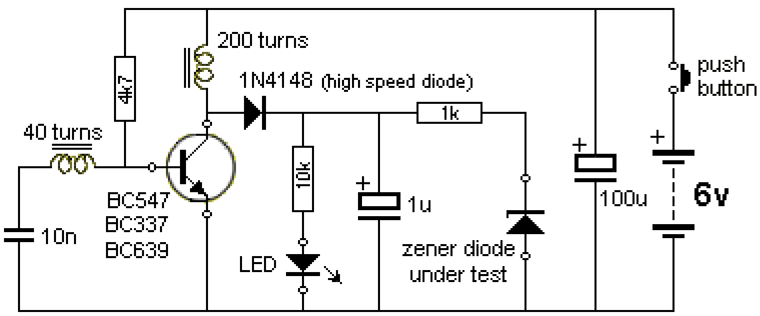
ZENER DIODE TESTER

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.



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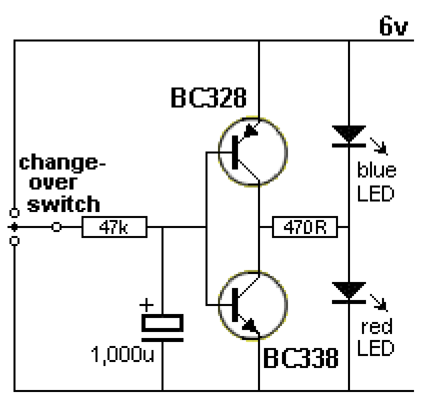
LED FADER

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.



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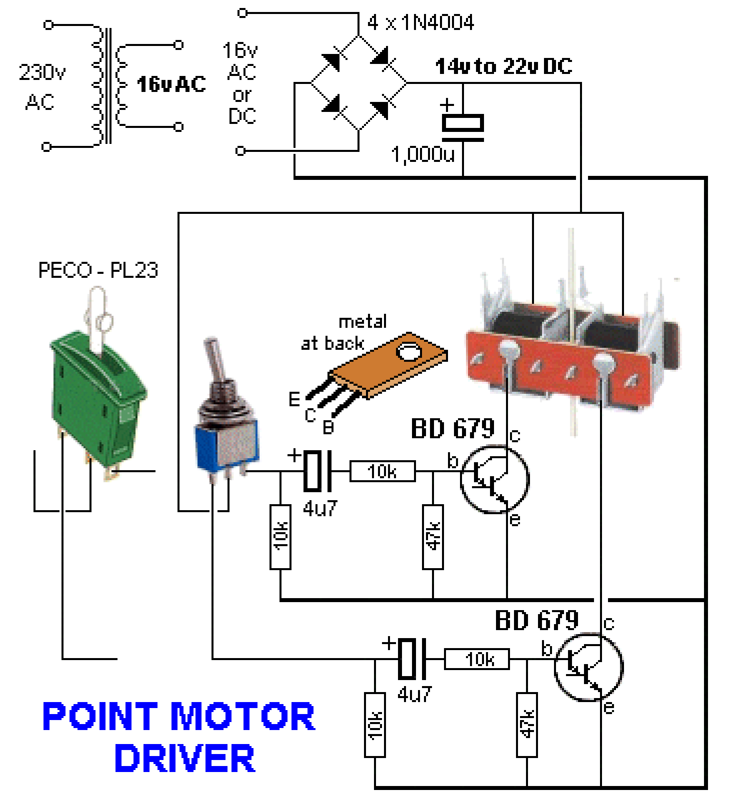
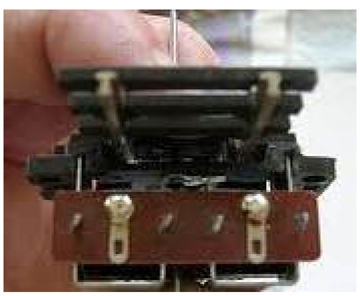
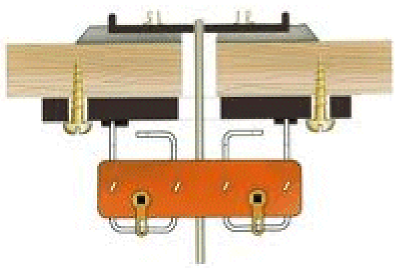
POINT MOTOR DRIVER

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.

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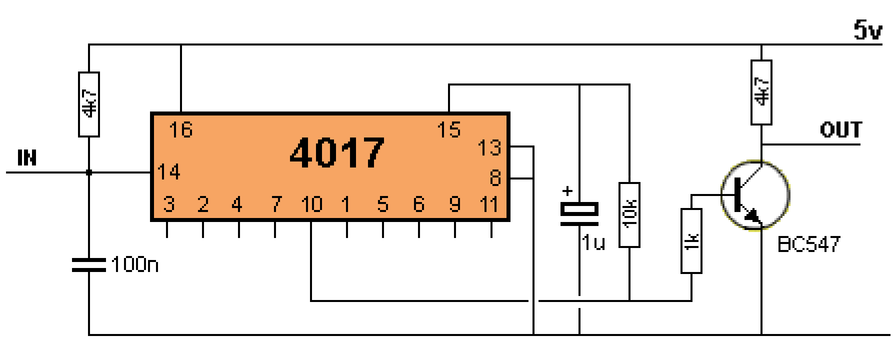
COIN COUNTER:

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:



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MORE CIRCUITS TO BE ADDED HERE:

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Circuit Symbols

The list below covers almost every symbol you will find on an electronic circuit diagram. It allows you to identify a symbol and also draw circuits. It is a handy reference and has some symbols that have never had a symbol before, such as a Flashing LED and electroluminescence panel.
Once you have identified a symbol on a diagram you will need to refer to specification sheets to identify each lead on the actual component.
The symbol does not identify the actual pins on the device. It only shows the component in the circuit and how it is wired to the other components, such as input line, output, drive lines etc. You cannot relate the shape or size of the symbol with the component you have in your hand or on the circuit-board.
Sometimes a component is drawn with each pin in the same place as on the chip etc. But this is rarely the case.
Most often there is no relationship between the position of the lines on the circuit and the pins on the component.

That's what makes reading a circuit so difficult.

This is very important to remember with transistors, voltage regulators, chips and so many othe r components as the position of the pins on the symbol are not in the same places as the pins or leads on the component and sometimes the pins have different functions according to the manufacturer. Sometimes the pin numbering is different according to the component, such as positive and negative regulators.
These are all things you have to be aware of.

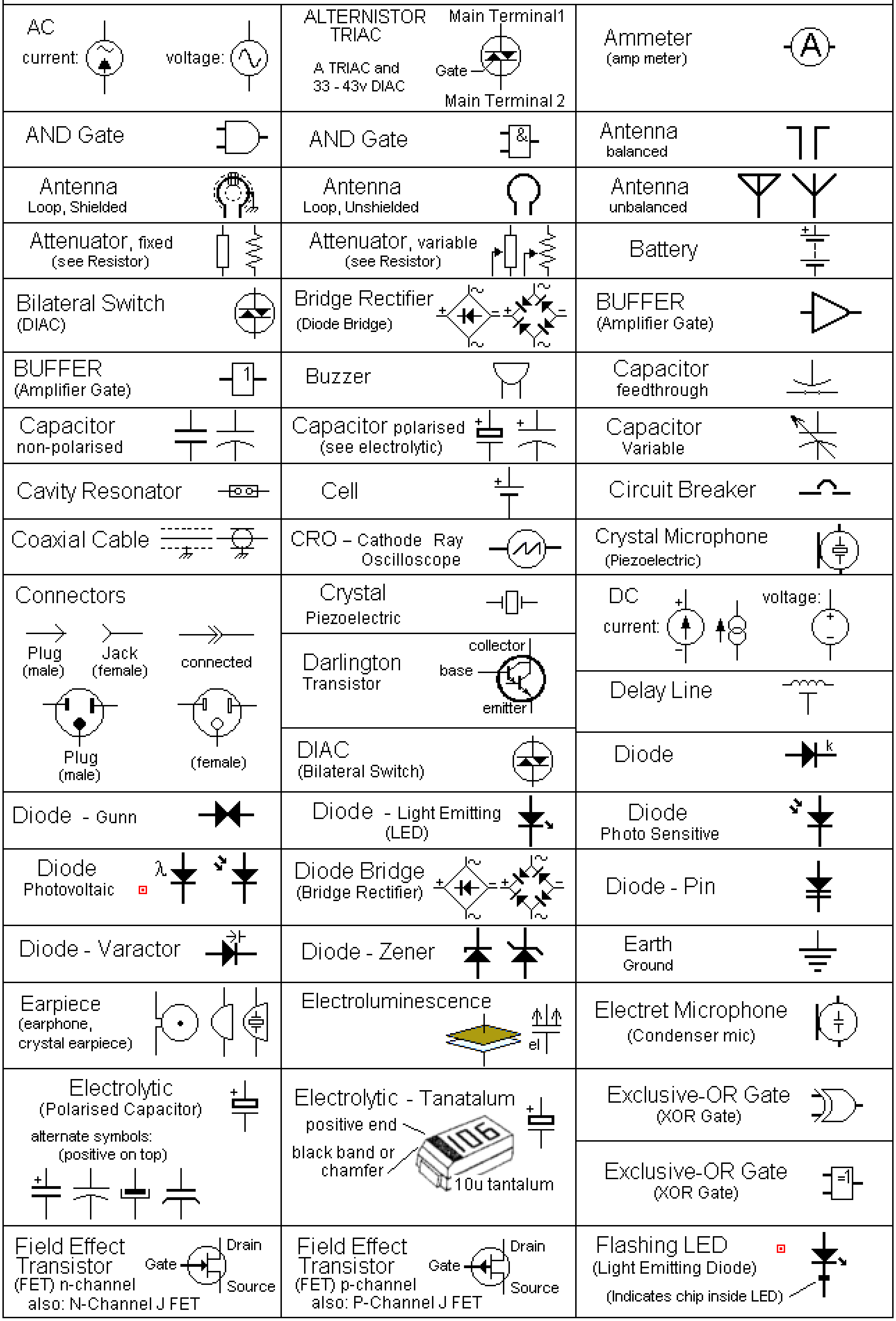
You must to refer to the manufacturer's specification sheet to identify each pin, to be sure you have identified them correctly.

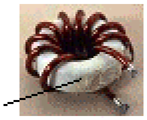
Colin Mitchell

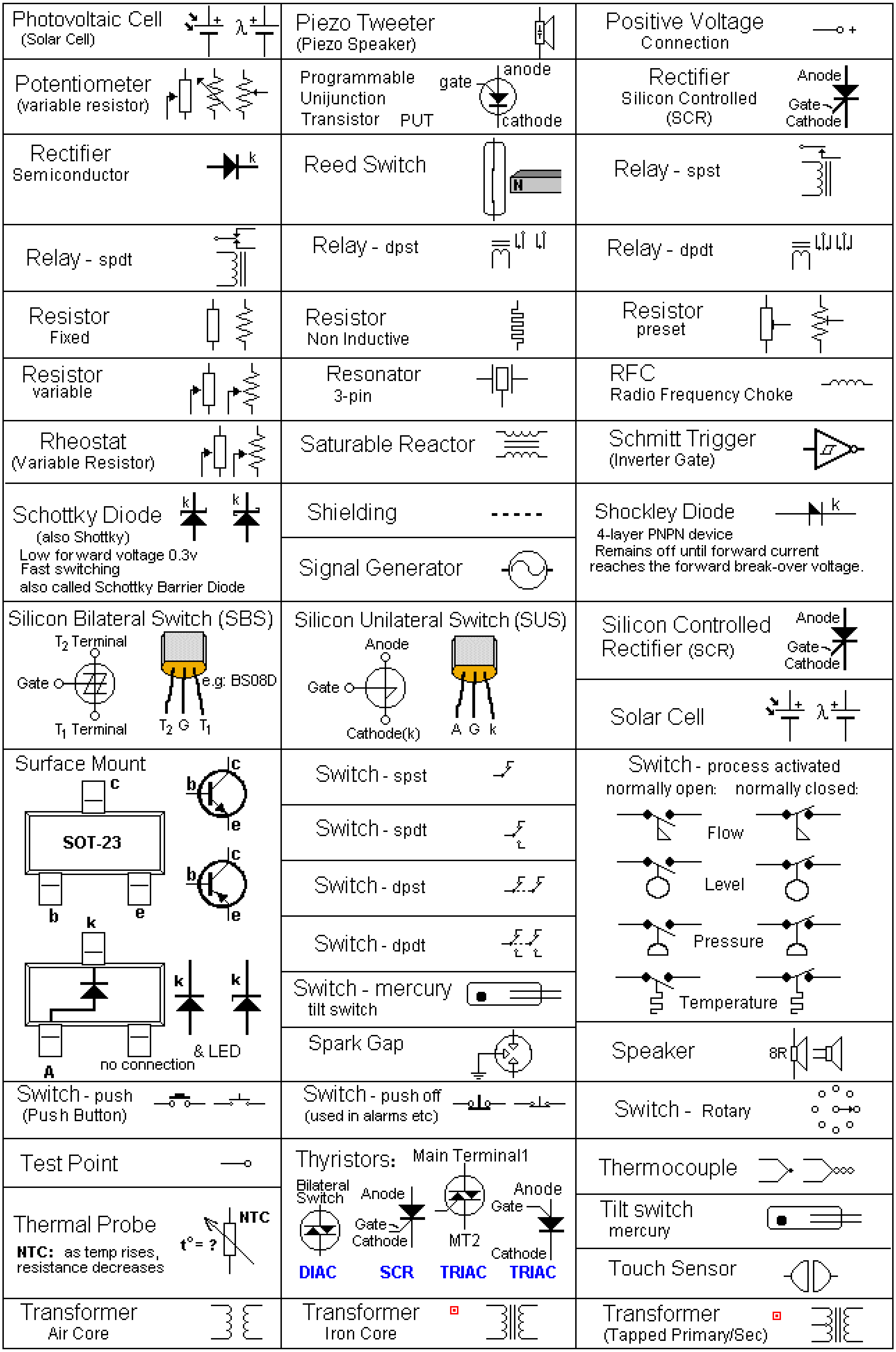
CIRCUIT SYMBOLS

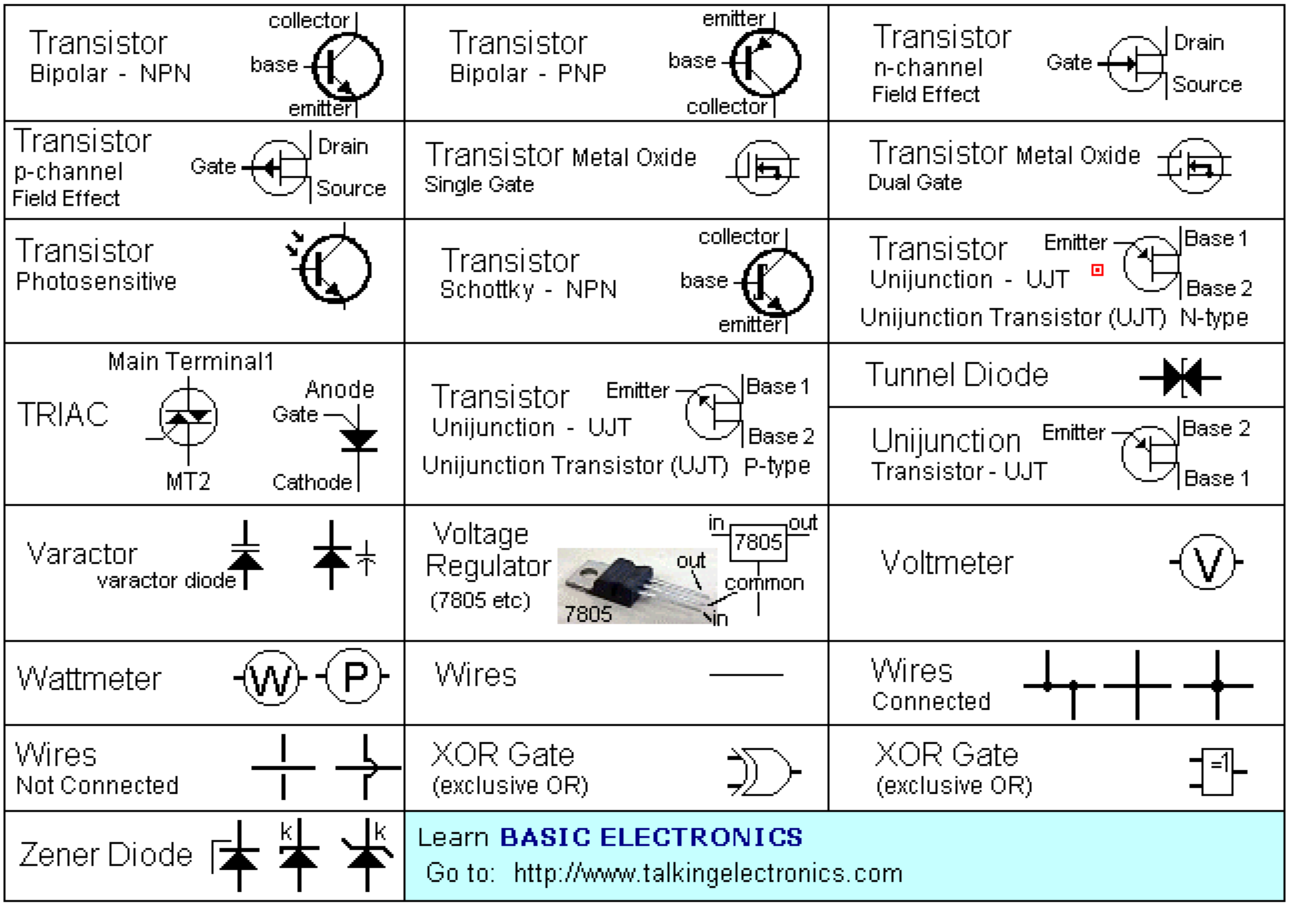
Some additional symbols have been added to the following list. See **Circuit Symbols** on the index of
Talking Electronics.com

CIRCUIT SYMBOLS by TALKING ELECTRONICS



Ferrite Bead	Fuse	Galvanometer G
Globe	Ground Chassis	Ground Earth
Heater (immersion heater) (cooker etc)	IC Integrated Circuit power ground	Inductor Air Core
Headphone		Inductor Iron Core or ferrite core 
Inductor Tapped	Inductor Variable	Integrated Circuit 
Inverter (NOT Gate)	INVERTER (NOT Gate) 1	
Jack Co-axial	Jack Phone (Phone Jack)	Jack Phone (Switched)
Jack Phone (3 conductor)	Key Telegraph (Morse Key)	Lamp Incandescent
Lamp - Neon	LASCR (Light Activated Silicon Controlled Rectifier)	LDR (Light Dependent Resistor)
LASER diode laser diode photo diode	Light Emitting Diode (LED) 	Light Emitting Diode (LED - flashing) (Indicates chip inside LED)
Mercury Switch	Micro-amp meter (micro-ammeter) µA	Microphone (see Electret Mic) 
Microphone (Crystal - piezoelectric)	Milliamp meter (milli-ammeter) mA	Motor MOT
NAND Gate	NAND Gate &	Nitinol wire "Muscle wire"
Negative Voltage Connection	NOR Gate	NOR Gate
NOT Gate Inverter	NOT Gate Inverter 1	Ohm meter Ω
Operational Amplifier (Op Amp)	Optocoupler (Transistor output)	Opto Coupler (Opto-isolator) a c k e Photo-transistor output
Optocoupler (Darlington output)	Opto Coupler (Opto-isolator) a c k e TRIAC output	OR Gate
OR Gate	Oscilloscope see CRO	Outlet (Power Outlet)
Piezo Diaphragm	Photo Cell (photo sensitive resistor)	Photo Diode
Photo Darlington Transistor	Photo FET Gate Drain Source (Field Effect Transistor)	Photo Transistor


Photovoltaic Cell
(Solar Cell)
Piezo Tweeter
(Piezo Speaker)
Positive Voltage
Connection
Potentiometer
(variable resistor)
Programmable
Unijunction
Transistor PUT
gate
anode
cathode
Rectifier
Silicon Controlled
(SCR)
Anode
Gate
Cathode
Rectifier
Semiconductor
k
Reed Switch
N
Relay - spst
Relay - spdt
Relay - dpst
Relay - dpdt
Resistor
Fixed
Resistor
Non Inductive
Resistor
preset
Resistor
variable
Resonator
3-pin
RFC
Radio Frequency Choke
Rheostat
(Variable Resistor)
Saturable Reactor
Schmitt Trigger
(Inverter Gate)
Schottky Diode
(also Shottky)
Low forward voltage 0.3v
Fast switching
also called Schottky Barrier Diode
k
k
Shielding
Signal Generator
Shockley Diode
k
4-layer PNPN device
Remains off until forward current
reaches the forward break-over voltage.
Silicon Bilateral Switch (SBS)
T2 Terminal
Gate
T1 Terminal
e.g: BS08D
T2 G T1
Silicon Unilateral Switch (SUS)
Anode
Gate
Cathode(k)
A G k
Silicon Controlled
Rectifier (SCR)
Anode
Gate
Cathode
Solar Cell
Surface Mount
c
SOT-23
b
e
b
c
e
b
c
e
k
k
k
A
no connection
& LED
Switch - spst
Switch - spdt
Switch - dpst
Switch - dpdt
Switch - mercury
tilt switch
Spark Gap
Switch - process activated
normally open:
normally closed:
Flow
Level
Pressure
Temperature
Speaker
8R
Switch - push
(Push Button)
Switch - push off
(used in alarms etc)
Switch - Rotary
Test Point
Thyristors:
Main Terminal1
Bilateral
Switch
Anode
Gate
Cathode
MT2
Anode
Gate
Cathode
DIAC
SCR
TRIAC
TRIAC
Thermocouple
Thermal Probe
NTC
t° = ?
NTC: as temp rises,
resistance decreases
Tilt switch
mercury
Touch Sensor
Transformer
Air Core
Transformer
Iron Core
Transformer
(Tapped Primary/Sec)



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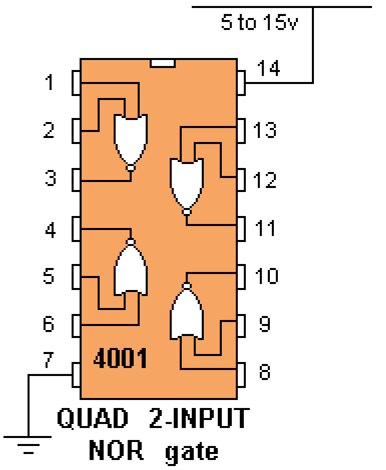
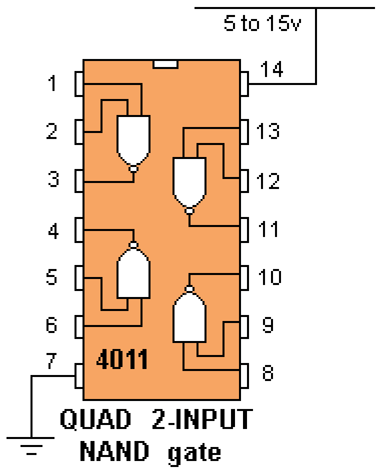
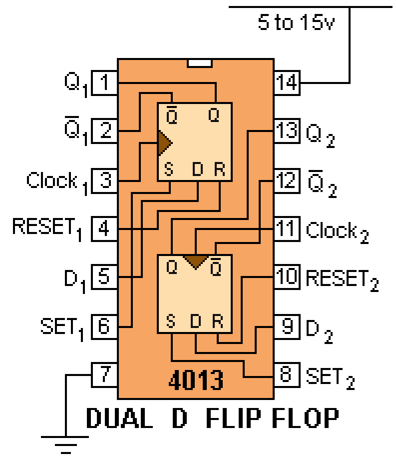
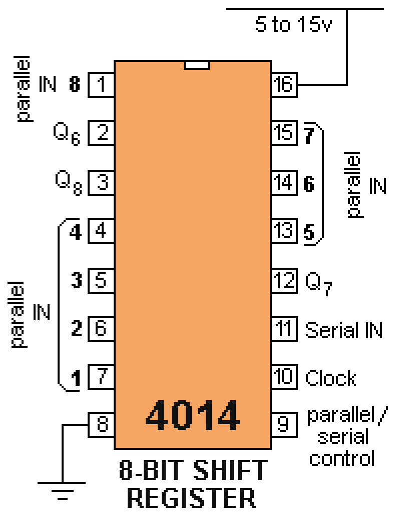
IC PINOUTS

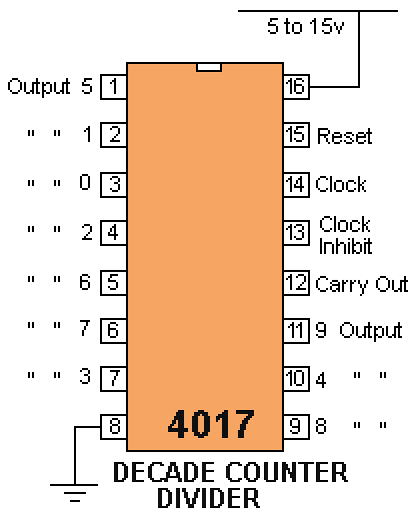
The following list covers just a few of the IC's on the market and these are the "simple" or "basic" or "digital" or "op-amp" IC's suitable for experimenting.
When designing a circuit around an IC, you have to remember two things:
1. Is the IC still available? and
2. Can the circuit be designed around a microcontroller?
Sometimes a circuit using say 3 or 4 IC's can be re-designed around an 8-pin or 16-pin microcontroller and the program can be be kept from prying eyes due to a feature called "code protection." A microcontroller project is more up-to-date, can be cheaper and can be re-programmed to alter the features.
This will be covered in the next eBook. It is worth remembering - as it is the way of the future.

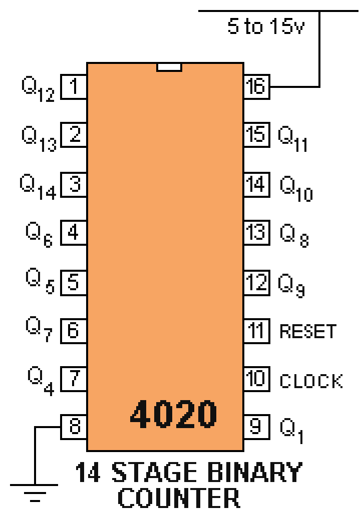

5 to 15v
1
2
3
4
5
6
7
14
13
12
11
10
9
8
4001
QUAD 2-INPUT
NOR gate

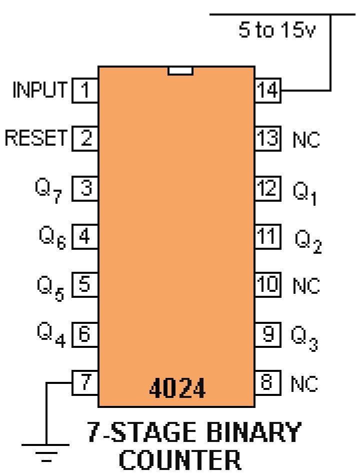

5 to 15v
1
2
3
4
5
6
7
14
13
12
11
10
9
8
4011
QUAD 2-INPUT
NAND gate

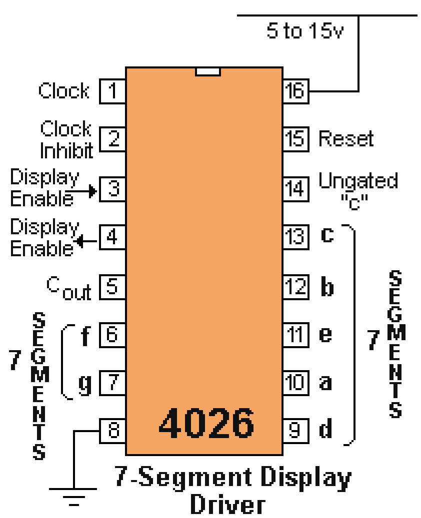

5 to 15v
Q1 1
Q̄1 2
Clock1 3
RESET1 4
D1 5
SET1 6
7
14
13 Q2
12 Q̄2
11 Clock2
10 RESET2
9 D2
8 SET2
Q̄ Q
S D R
Q Q̄
S D R
4013
DUAL D FLIP FLOP

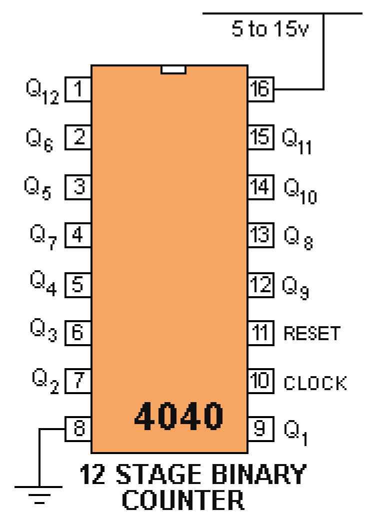

5 to 15v
parallel IN 8 1
Q6 2
Q8 3
4 4
3 5
2 6
1 7
parallel IN
8
16
15 7
14 6
13 5
parallel IN
12 Q7
11 Serial IN
10 Clock
9 parallel / serial control
4014
8-BIT SHIFT
REGISTER

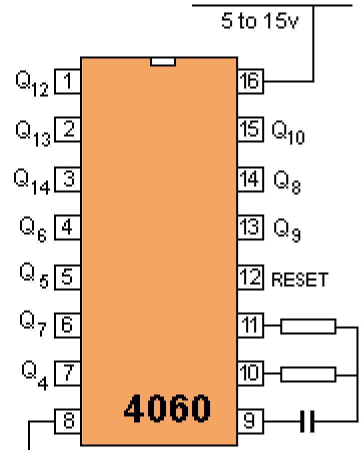

5 to 15v
Output 5 1
" " 1 2
" " 0 3
" " 2 4
" " 6 5
" " 7 6
" " 3 7
8
16
15 Reset
14 Clock
13 Clock Inhibit
12 Carry Out
11 9 Output
10 4 " "
9 8 " "
4017
DECADE COUNTER
DIVIDER


5 to 15v
Q12 1
Q13 2
Q14 3
Q6 4
Q5 5
Q7 6
Q4 7
8
16
15 Q11
14 Q10
13 Q8
12 Q9
11 RESET
10 CLOCK
9 Q1
4020
14 STAGE BINARY
COUNTER

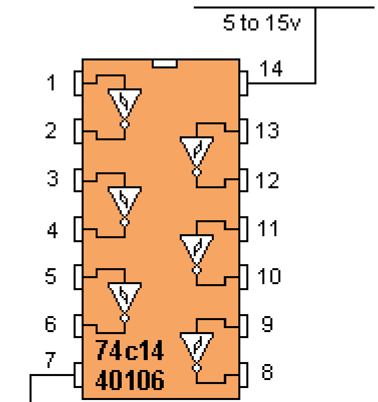

5 to 15v
INPUT 1
RESET 2
Q7 3
Q6 4
Q5 5
Q4 6
7
14
13 NC
12 Q1
11 Q2
10 NC
9 Q3
8 NC
4024
7-STAGE BINARY
COUNTER


5 to 15v
Clock 1
Clock Inhibit 2
Display Enable 3
Display Enable 4
Cout 5
f 6
g 7
7 SEGMENTS
8
16
15 Reset
14 Ungated "c"
13 c
12 b
11 e
10 a
9 d
7 SEGMENTS
4026
7-Segment Display
Driver

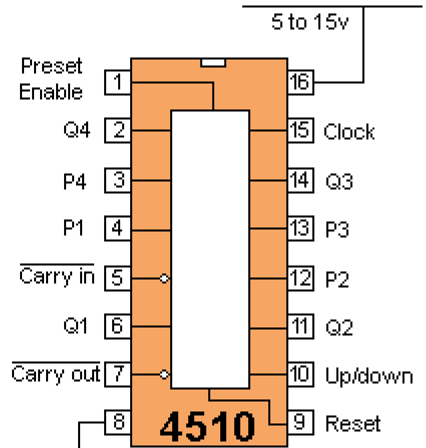

5 to 15v
Q12 1
Q6 2
Q5 3
Q7 4
Q4 5
Q3 6
Q2 7
8
16
15 Q11
14 Q10
13 Q8
12 Q9
11 RESET
10 CLOCK
9 Q1
4040
12 STAGE BINARY
COUNTER



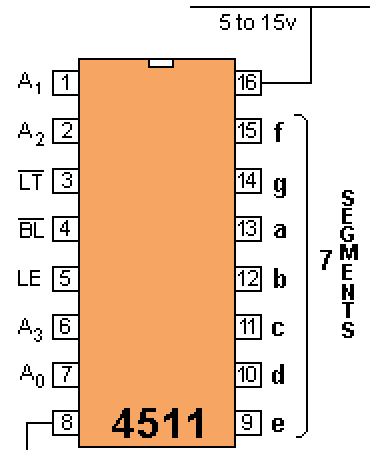
14 STAGE BINARY COUNTER with OSC



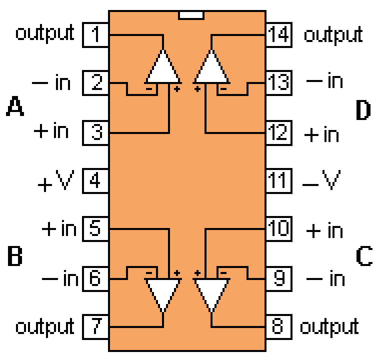
HEX Schmitt Trigger Inverter



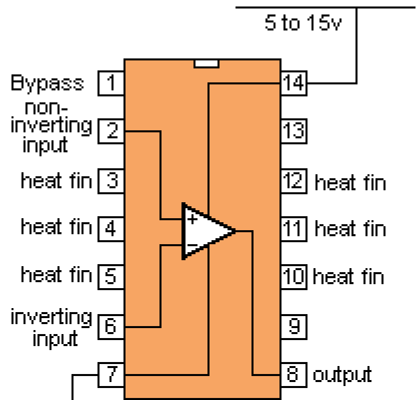
BCD UP/DOWN COUNTER



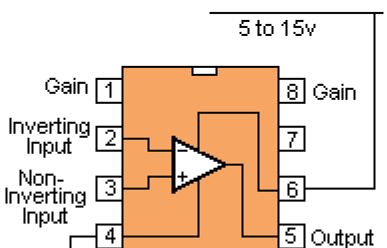
BCD to 7-Segment Display Driver



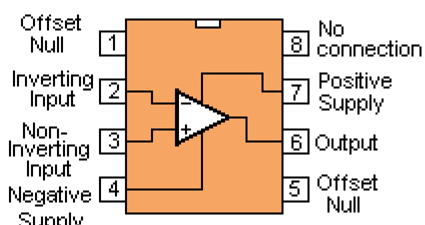
LM 324
QUAD OP-AMP



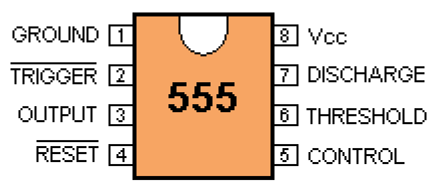
LM 380
4-watt audio amp



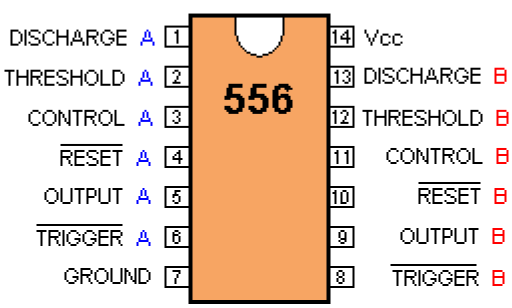
LM 386



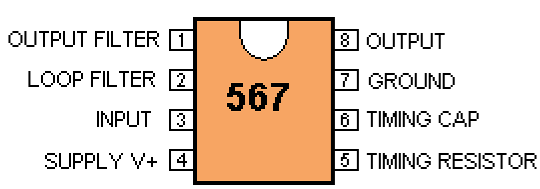
LM 741



555



556

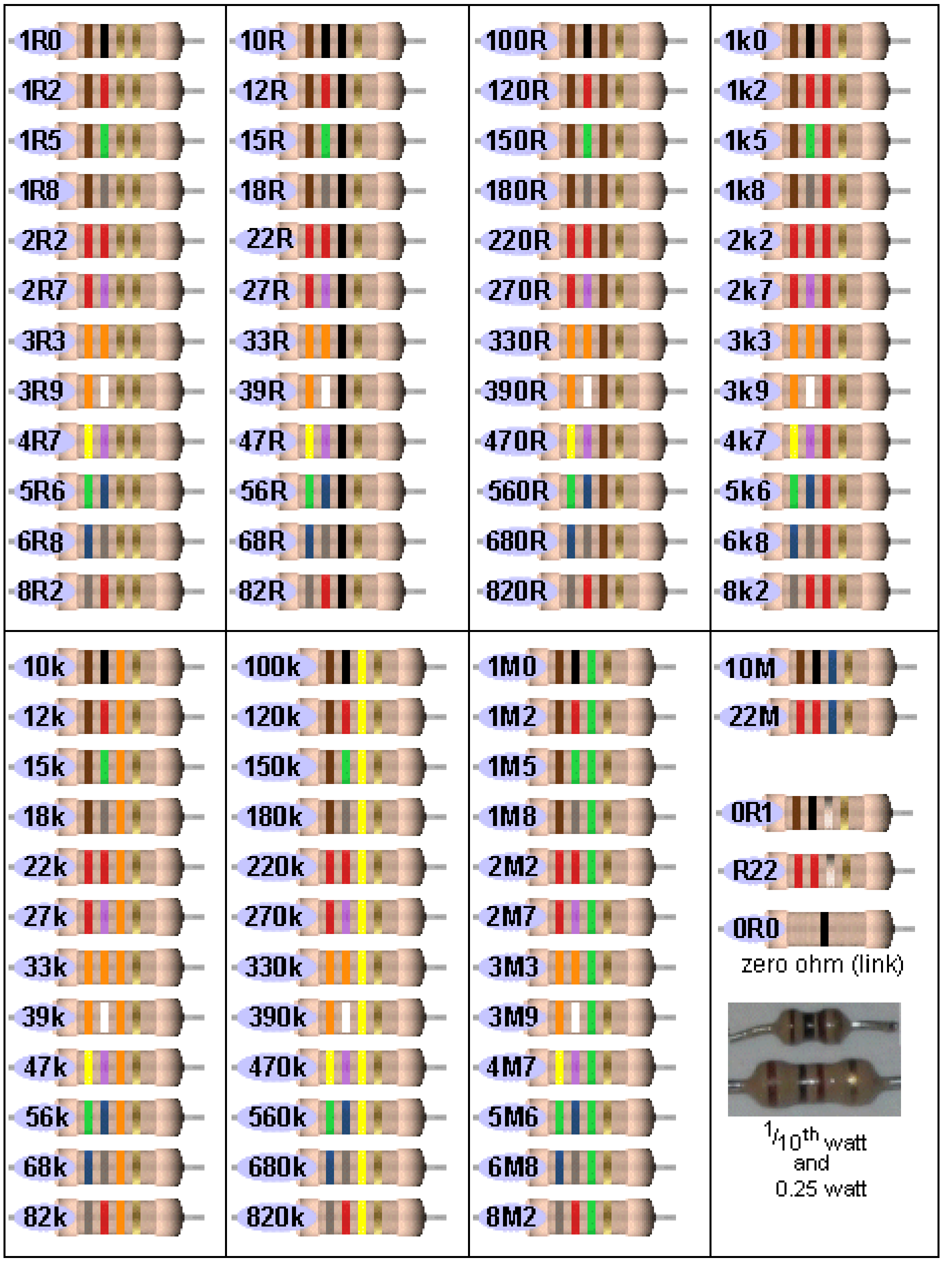


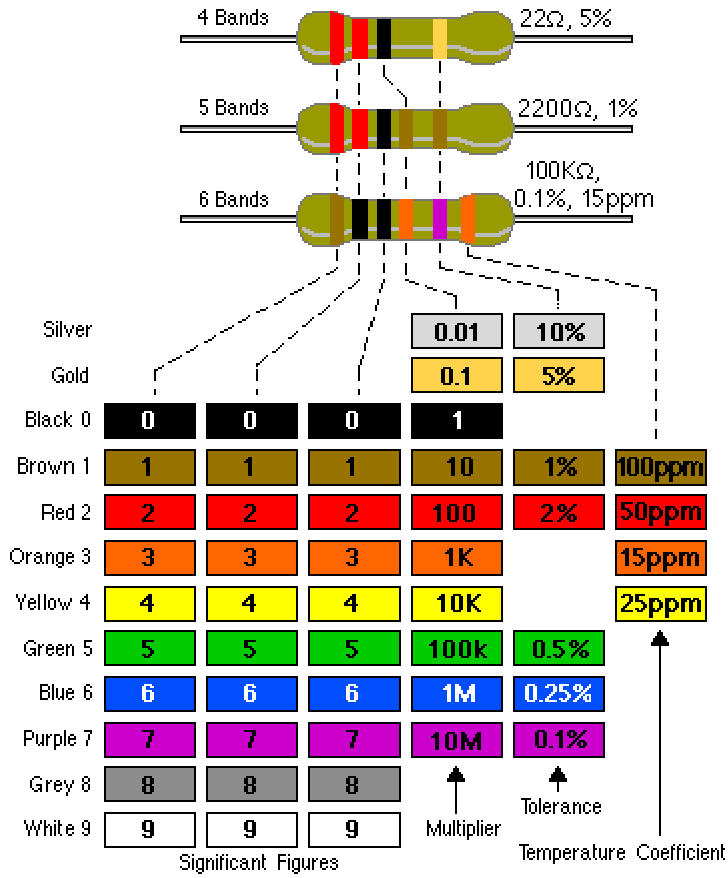
567 Tone Decoder

to Index

All the resistor colours:

This is called the "normal" or "3 colour-band" (5%) range. If you want the 4 colour-band (1%) series, refer to Talking Electronics website and click: **Resistors 1%** on the left index. Or you can use the table below.


1R0
1R2
1R5
1R8
2R2
2R7
3R3
3R9
4R7
5R6
6R8
8R2
10R
12R
15R
18R
22R
27R
33R
39R
47R
56R
68R
82R
100R
120R
150R
180R
220R
270R
330R
390R
470R
560R
680R
820R
1k0
1k2
1k5
1k8
2k2
2k7
3k3
3k9
4k7
5k6
6k8
8k2
10k
12k
15k
18k
22k
27k
33k
39k
47k
56k
68k
82k
100k
120k
150k
180k
220k
270k
330k
390k
470k
560k
680k
820k
1M0
1M2
1M5
1M8
2M2
2M7
3M3
3M9
4M7
5M6
6M8
8M2
10M
22M
0R1
R22
0R0
zero ohm (link)
1/10th watt
and
0.25 watt



Resistor Color Code System

to Index

MAKE ANY RESISTOR VALUE:

If you don't have the exact resistor value for a project, don't worry. Most circuits will work with a value slightly higher or lower.
But if you want a particular value and it is not available, here is a chart.
Use 2 resistors in series or parallel as shown:

Required Value	R1	Series/ Parallel	R2	Actual value:
10	4R7	S	4R7	9R4
12	10	S	2R2	12R2
15	22	P	47	14R9
18	22	P	100	18R
22	10	S	12	22
27	22	S	4R7	26R7
33	22	S	10	32R
39	220	P	47	38R7
47	22	S	27	49
56	47	S	10	57
68	33	S	33	66
82	27	S	56	83

There are other ways to combine 2 resistors in parallel or series to get a particular value. The examples above are just one way.
4R7 = 4.7 ohms

to Index

MAKE ANY CAPACITOR VALUE:

If you don't have the exact capacitor value for a project, don't worry. Most circuits will work with a value slightly higher or lower.
But if you want a particular value and it is not available, here is a chart.
Use 2 capacitors in series or parallel as shown. "p" is "puff" but can be "n" (nano) or "u" (microfarad).

Required Value	C1	Series/ Parallel	C2	Actual value:
10	4p7	P	4p7	9p4
12	10	P	2p2	12p2
15	22	S	47	14p9
18	22	S	100	18p
22	10	P	12	22
27	22	P	4p7	26p7
33	22	P	10	32p
39	220	S	47	38p7
47	22	P	27	49
56	47	P	10	57
68	33	P	33	66
82	27	P	56	83

There are other ways to combine 2 capacitors in parallel or series to get a particular value. The examples above are just one way. 4p7 = 4.7p