

200 TRANSISTOR CIRCUITS

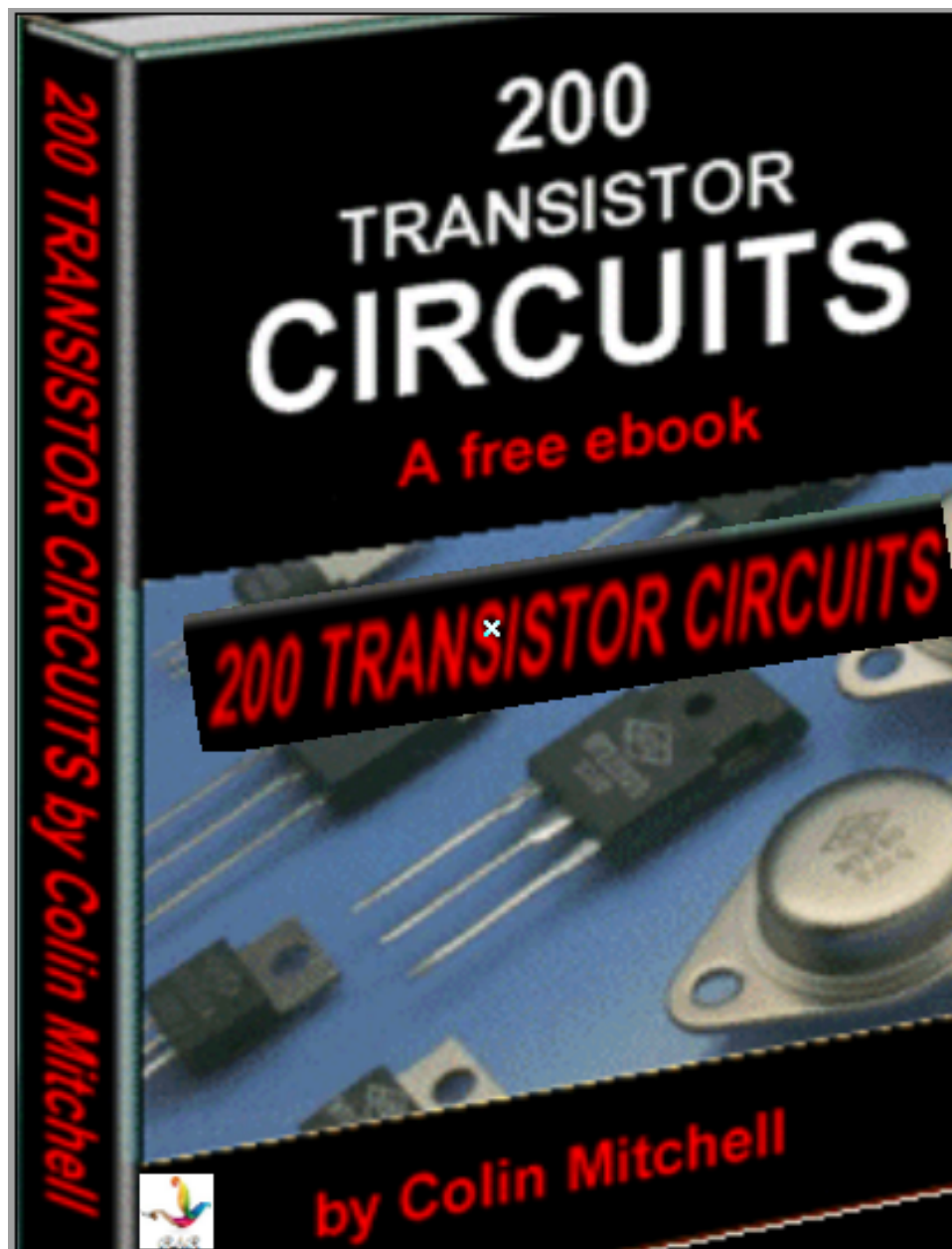
A free ebook

200 TRANSISTOR CIRCUITS

by Colin Mitchell



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Talking Electronics

See [TALKING ELECTRONICS](http://talkingtpg.com.au) WEBSITE

email Colin Mitchell: talking@tpg.com.au

INTRODUCTION

This e-book contains 100 transistor circuits. The second part of this e-book will contain a further 100 circuits.

Most of them can be made with components from your "junk box" and hopefully you can put them together in less than an hour.

The idea of this book is to get you into the fun of putting things together and there's nothing more rewarding than seeing something work.

It's amazing what you can do with a few transistors and some connecting components. And this is the place to start.

Most of the circuits are "stand-alone" and produce a result with as little as 5 components.

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

To save space we have not provided lengthy explanations of how the circuits work. This has already been covered in TALKING ELECTRONICS Basic Electronics Course, and can be obtained on a [CD for \\$10.00](#) (posted to anywhere in the world) See Talking Electronics website for more details:

<http://www.talkingelectronics.com>

Transistor data is at the bottom of this page and a transistor tester circuit is also provided. There are lots of categories and I am sure many of the circuits will be new to you, because some of them have been designed recently by me.

Basically there are two types of transistor: PNP and NPN.

All you have to do is identify the leads of an unknown device and you can build almost anything.

You have a choice of building a circuit "in the air," or using an experimenter board (solderless breadboard) or a matrix board or even a homemade printed circuit board. The choice is up to you but the idea is to keep the cost to a minimum - so don't buy anything expensive.

If you take parts from old equipment it will be best to solder them together "in the air" (as they will not be suitable for placing on a solderless breadboard as the leads will be bent and very short).

This way they can be re-used again and again.

No matter what you do, I know you will be keen to hear some of the "noisy" circuits in operation.

Before you start, the home-made **Speaker Transformer** project and Transistor Tester are the first things you should look at.

If you are starting in electronics, see the **World's Simplest Circuit**. It shows how a transistor works and three transistors in the **6 Million Gain** project will detect microscopic levels of static electricity! You can look through the Index but the names of the projects don't give you a full description of what they do. You need to look at everything. And I am sure you will.

KIT OF PARTS

Talking Electronics supplies a kit of parts that can be used to build the majority of the circuits in this book.

The [kit costs \\$15.00](#) plus postage.

In many cases, a resistor or capacitor not in the kit, can be created by putting

two resistors or capacitors in series or parallel or the next higher or lower value can be used.

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

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Lie Detector	1-watt LED
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Light Alarm-2	1.5v to 10v Inverter
Light Alarm-3	1.5v LED Flasher
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Listener - phone amplifier	3v White LED flasher
Logic Probe - Simple	5v from old cells
Logic Probe with Pulse	5 LED Chaser
Low fuel Indicator	5 Transistor Radio
Mains Night Light	5v Regulated Supply from 3v
Make any resistor value	6 Million Gain
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Making 0-1A Ammeter	12v Flashing Beacon (Warning Beacon)
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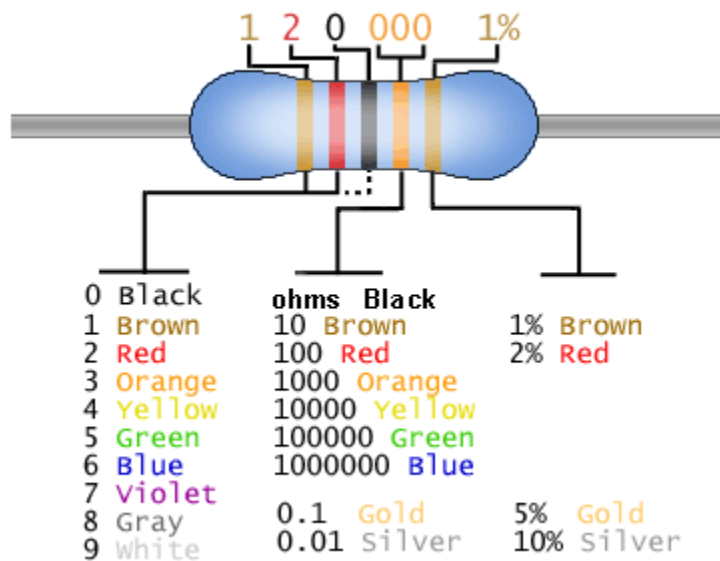
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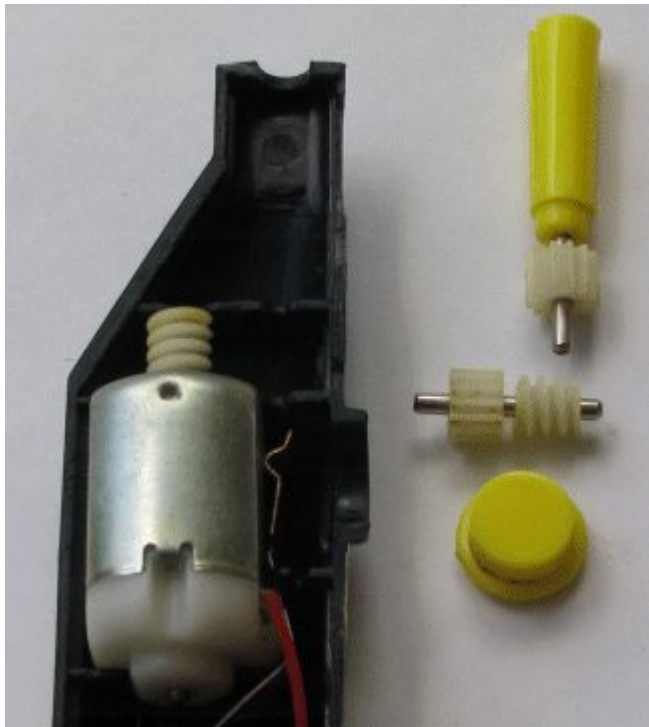
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RESISTOR COLOUR CODE



See [resistors from 0.22ohm to 22M](#) in full colour at bottom of this page and another [resistor table](#)



A two-worm reduction gearbox producing a reduction of 12:1 and 12:1 = 144:1 The gears are in the correct positions to produce the reduction.

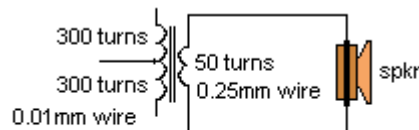
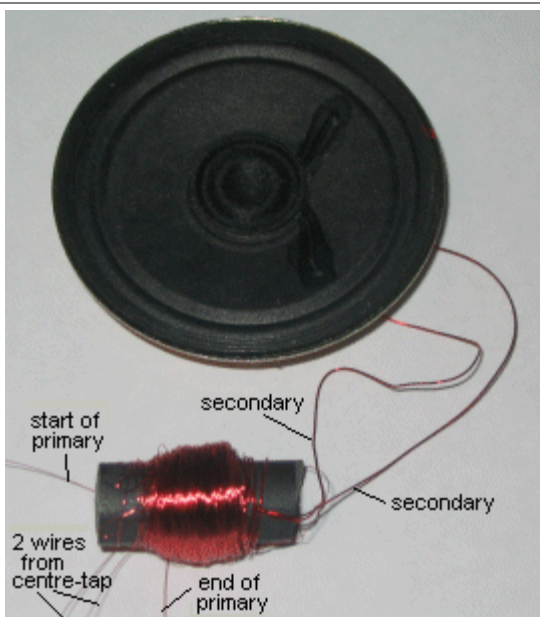
BOXES FOR PROJECTS

One of the most difficult things to find is a box for a project. Look in your local "junk" shop, \$2.00 shop, fishing shop, and toy shop. And in the medical section, for handy boxes. It's surprising where you will find an ideal box.

The photo shows a suitable box for a Logic Probe or other design. It is a toothbrush box. The egg shaped box holds "Tic Tac" mouth sweeteners and the two worm reduction twists a "Chuppa Chub." It cost less than \$4.00 and the equivalent reduction in a hobby shop costs up to \$16.00!



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HOME MADE SPEAKER TRANSFORMER

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

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

called the secondary winding.

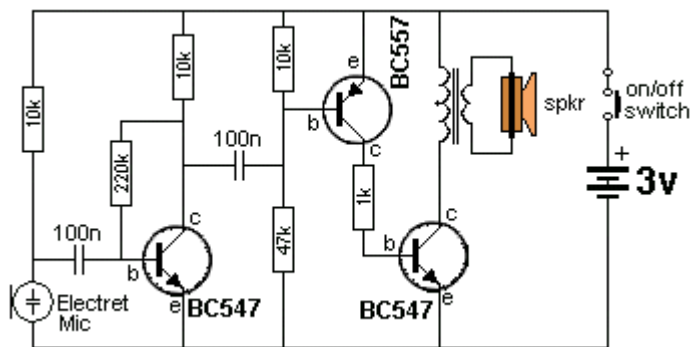
The primary winding is made by winding 300 turns of 0.01mm wire (this is very fine wire) over the secondary and ending with a loop of wire we call the centre tap.

Wind another 300 turns and this completes the transformer.

It does not matter which end of the secondary is connected to the top of the speaker.

It does not matter which end of the primary is connected to the collector of the transistor in the circuits in this book.

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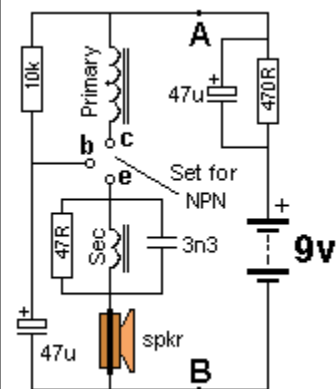


SUPER EAR

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

conditions and the quiescent current is just 5mA. The project is ideal for listening to conversations or TV etc in another room with long leads connecting the microphone to the amplifier.

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TRANSISTOR TESTER-1
CIRCUIT



10mH choke with 150 turns for the secondary

TRANSISTOR TESTER - 1

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

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

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

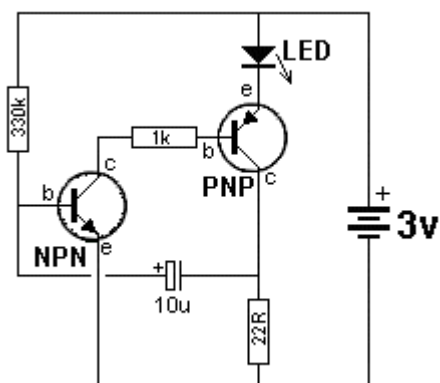
Almost any transformer will work and any speaker will be suitable.

If you use the speaker transformer described in the **Home Made Speaker Transformer** article, use one-side of the primary.

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TRANSISTOR TESTER - 2

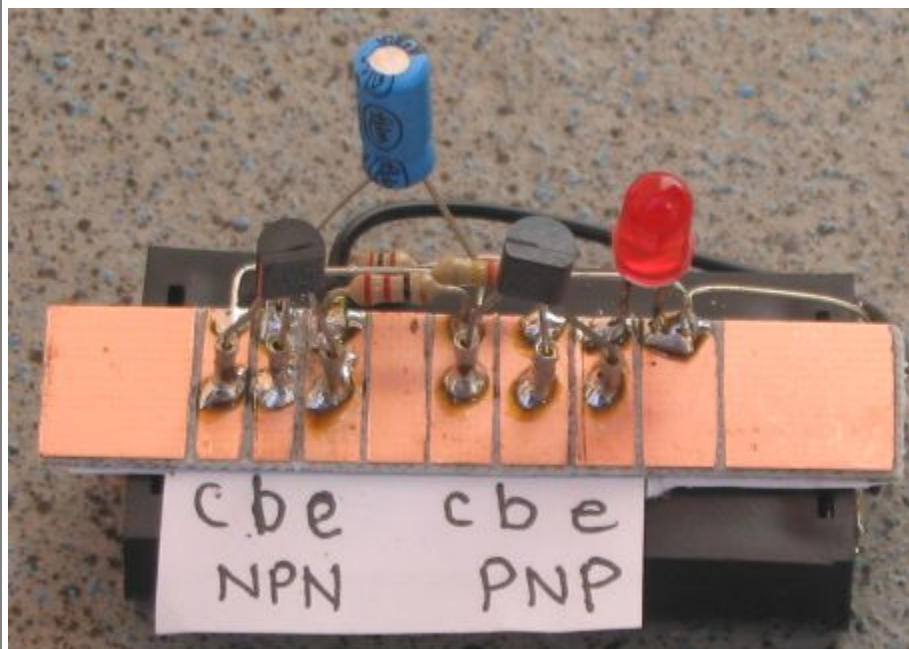
Here is another transistor tester.

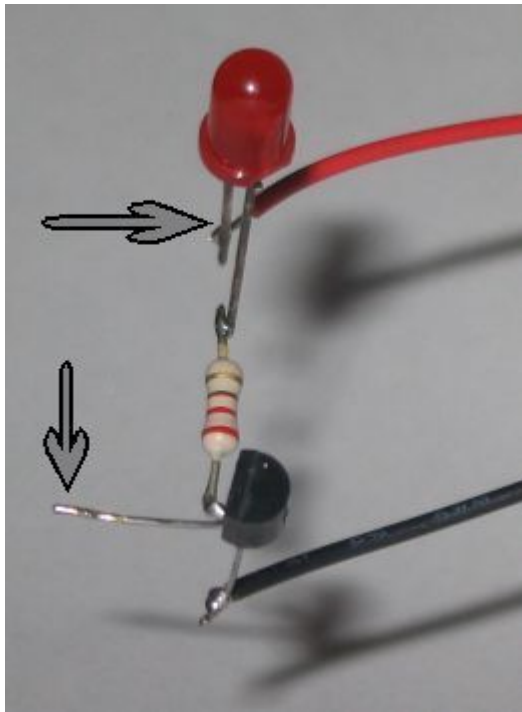


This is basically a high gain amplifier with feedback that causes the LED to flash at a rate determined by the 10u and 330k resistor.

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

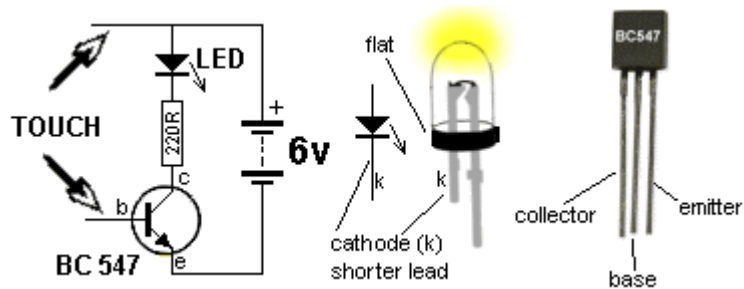
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WORLD'S SIMPLEST CIRCUIT

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



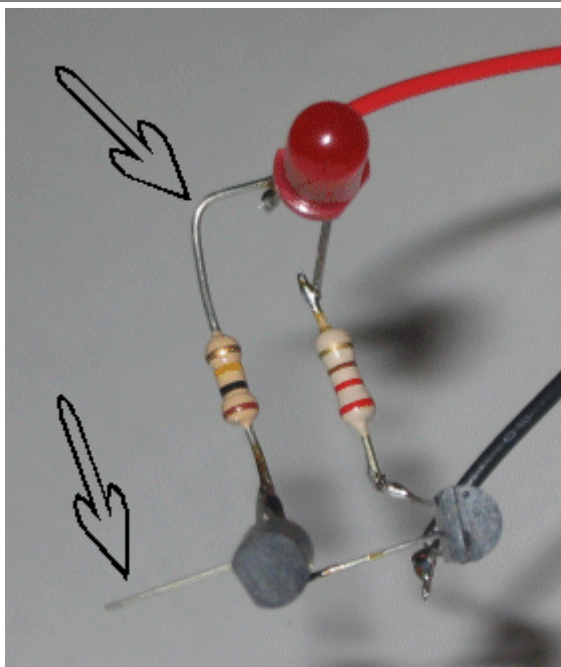
Connect the LED, 220 ohm resistor and transistor as shown in the photo.

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

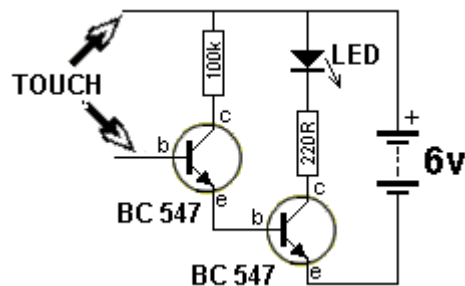
The LED will turn on brighter when you squeeze harder.

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

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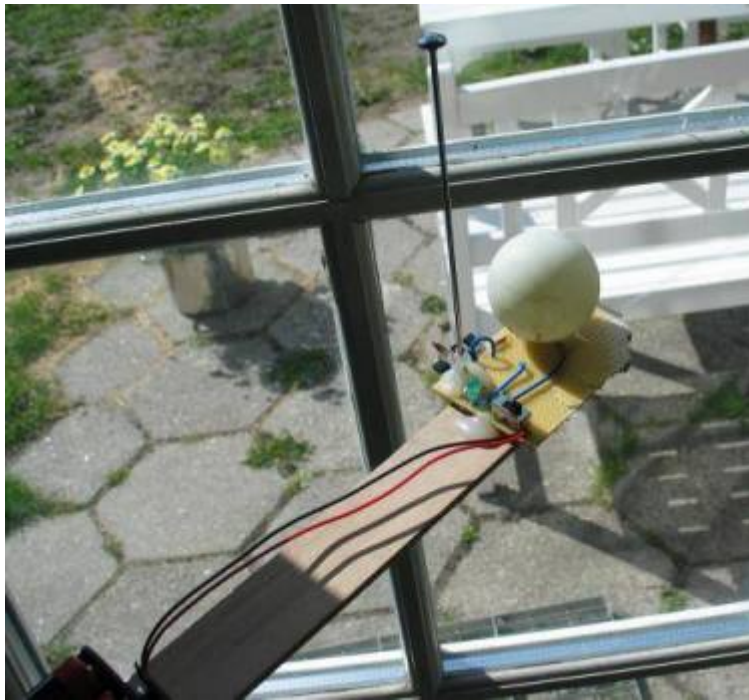
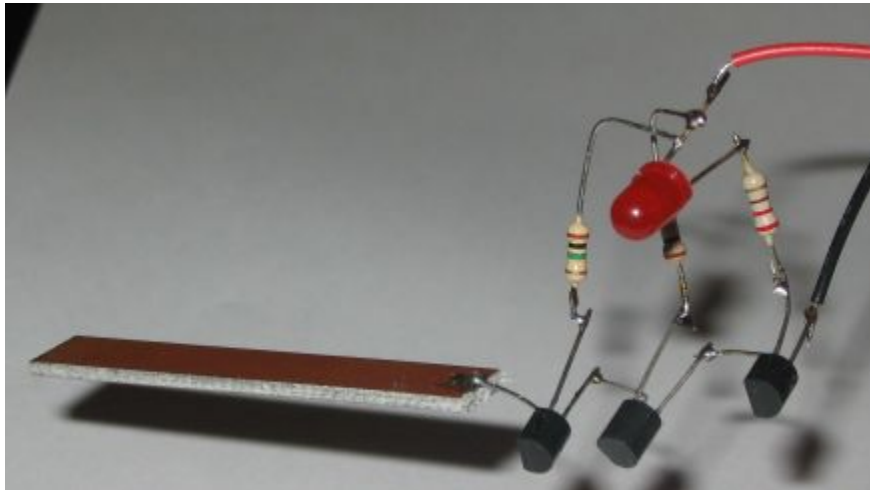


SECOND SIMPLEST CIRCUIT



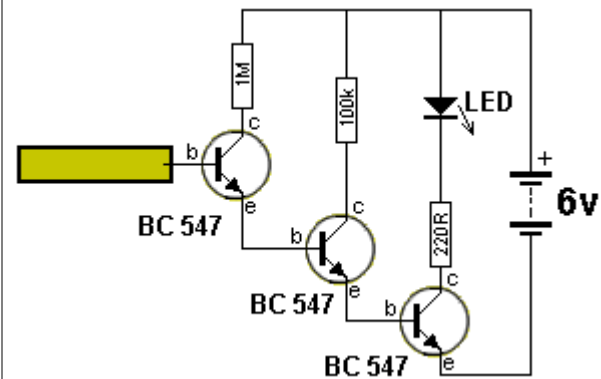
This is the second simplest circuit in the world. A second transistor has been added in place of your fingers. This transistor has a gain of about 200 and when you touch the points shown on the diagram, the LED will illuminate with the slightest touch. The transistor has amplified the current (through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

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6 MILLION GAIN!

This circuit is so sensitive it will detect "mains hum". Simply move it across any wall and it will detect where the mains cable is located. It has a gain of about $200 \times 200 = 6,000,000$ and will also detect static electricity and the presence of your hand without a direct contact. You will be amazed what it detects! There is static electricity EVERYWHERE! The input of this circuit is classified as very high impedance.

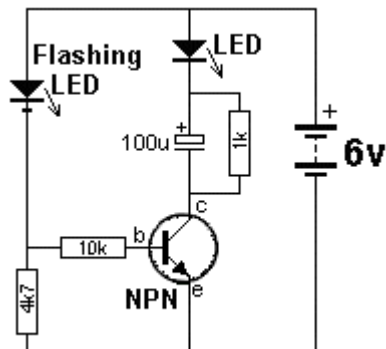


Here is a photo of the circuit, produced by a constructor, where he claimed he detected "ghosts".

<http://letsmakerobots.com/node/12034>

<http://letsmakerobots.com/node/18933>

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

LED FLASHER WITH ONE TRANSISTOR!

This is a novel flasher circuit using a single driver transistor that takes its flash-rate from a flashing LED. The flasher in the photo is 3mm.

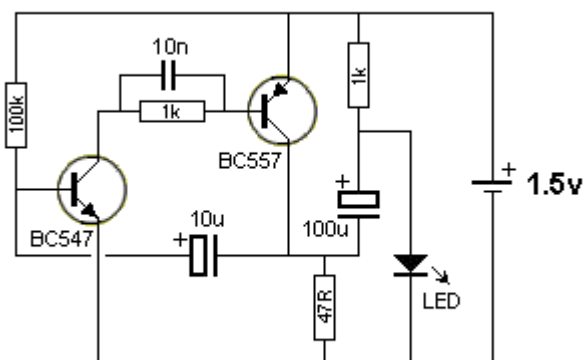


An ordinary LED will not work.

The flash rate cannot be altered by the brightness of the high-bright white LED can be adjusted by altering the 1k resistor across the 100u electrolytic to 4k7 or 10k. The 1k resistor discharges the 100u so that when the transistor turns on, the charging current into the 100u illuminates the white LED.

If a 10k discharge resistor is used, the 100u is not fully discharged and the LED does not flash as bright. All the parts in the photo are in the same places as in the circuit diagram to make it easy to see how the parts are connected.

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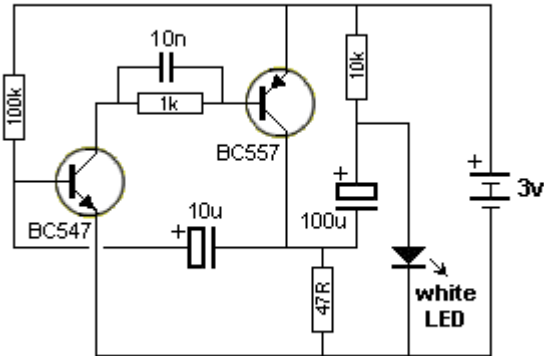
1.5v LED FLASHER

1.5v LED FLASHER

This will flash a LED, using a single 1.5v cell. It will even flash a white LED even though this type of LED needs about 3.2v to 3.6v for operation.

The circuit takes about 2mA but produces a very bright flash.

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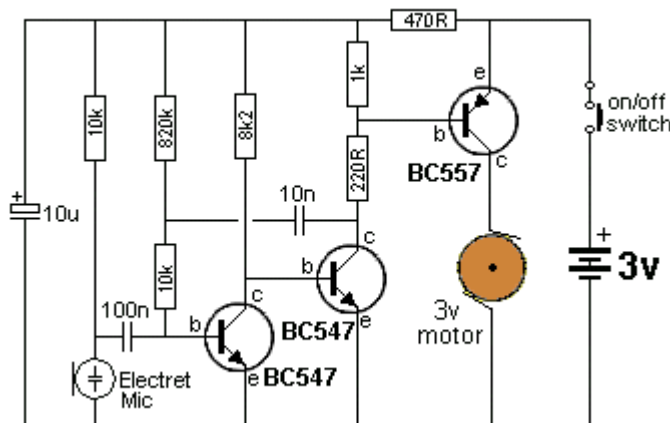
3v WHITE LED FLASHER

3v WHITE LED FLASHER

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

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

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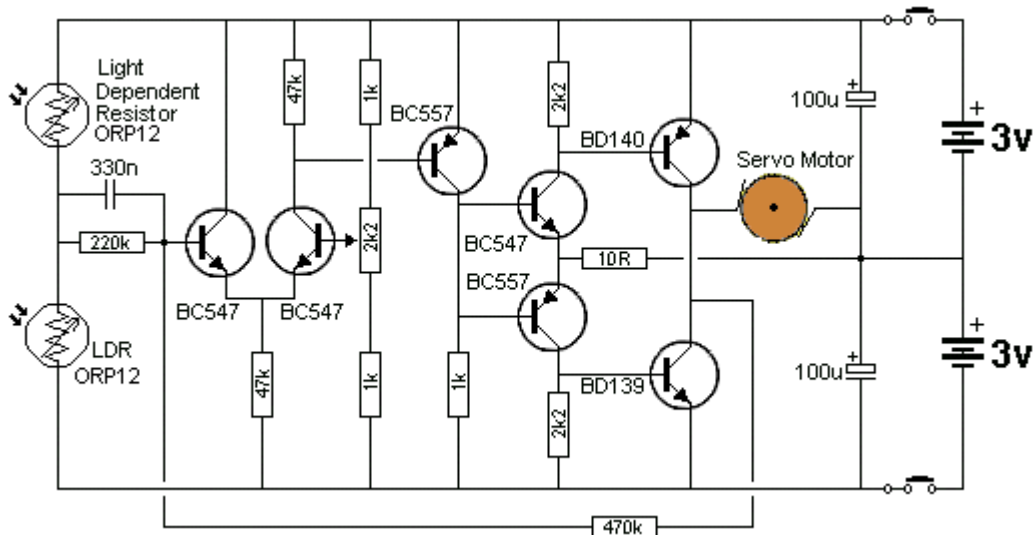
DANCING FLOWER

This circuit was taken from a dancing flower.

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

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

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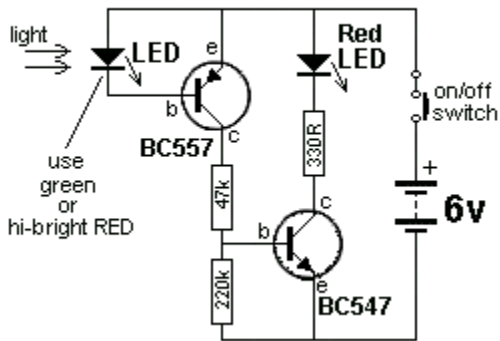


WHITE LINE FOLLOWER

This circuit can be used for a toy car to follow a white line. The motor is either a 3v type with gearing to steer the car or a rotary actuator or a servo motor. When equal light is detected by the photo resistors the voltage on the base of the first transistor will be mid rail and the circuit is adjusted via the 2k2 pot so the motor does not receive any voltage. When one of the LDR's receives more (or less) light, the motor is activated. And the same

thing happens when the other LDR receives less or more light.

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LED DETECTS LIGHT

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

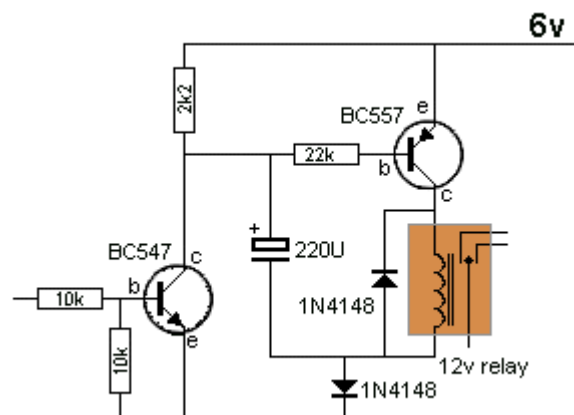
A green LED will detect light and a high-bright red LED will respond about 100 times better than a green LED, but the LED in this position in the circuit is classified as very high impedance and it requires a considerable amount of amplification to turn the detection into a worthwhile current-source.

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

The accompanying circuit amplifies the output of the LED and enables it to be used for a number of applications.

The LED only responds when the light enters the end of the LED and this makes it ideal for solar trackers and any time there is a large difference between the dark and light conditions. It will not detect the light in a room unless the lamp is very close.

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12v RELAY ON 6V SUPPLY

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

Alternatively you can rewind a 12v relay by removing about half the turns.

Join up what is left to the terminals. Replace the turns you took off, by connecting them in parallel with the original half, making sure the turns go the same way around

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MAKE TIME FLY!

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

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

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

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

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

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

HOW THE MOTOR WORKS

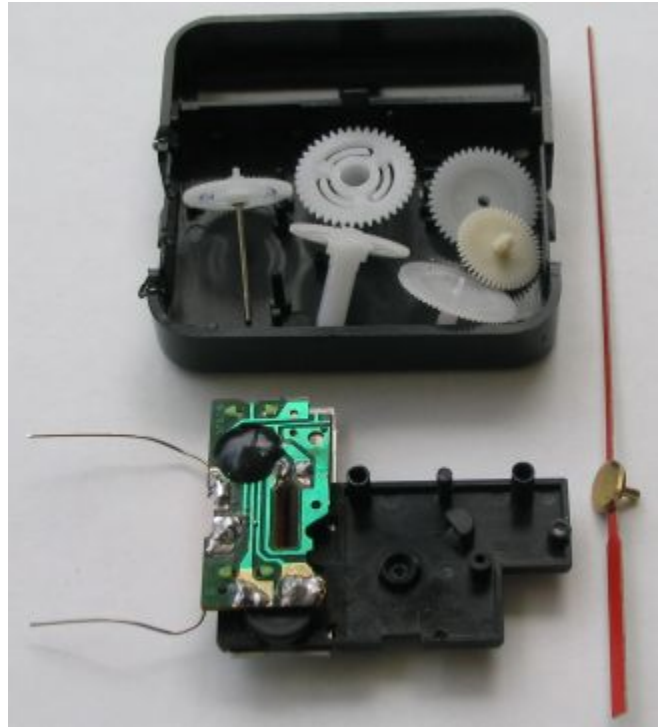
The rotor is a magnet with the north pole shown with the red mark and the south pole opposite.

The electromagnet actually produces poles. A strong North near the end of the electromagnet, and a weak North at the bottom. A strong South at the top left and weak South at bottom left. The rotor rests with its poles being attracted to the 4 pole-pieces equally.

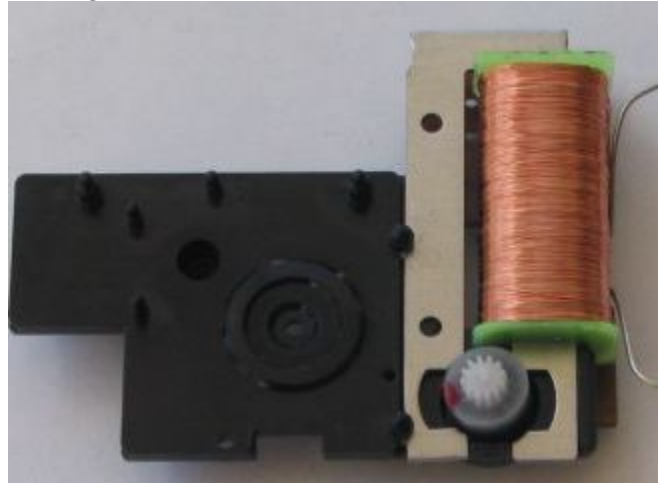


motor is much more complex than you think!!

Voltage must be applied to the electromagnet around the correct way so that repulsion occurs. Since the rotor is sitting equally between the North poles, for example, it will see a strong pushing force from the pole near the electromagnet and this is how the motor direction is determined. A reversal of voltage will revolve the rotor in the same direction as before. The design of the

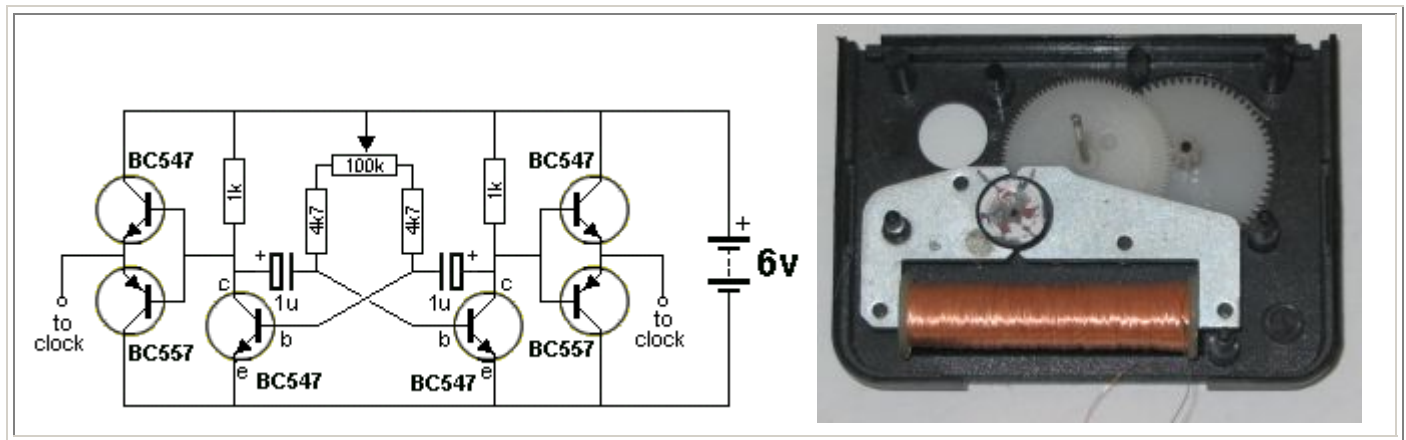


The crystal removed and a "cut track" to the coil.
The 6 gears must be re-fitted for the hands to work.

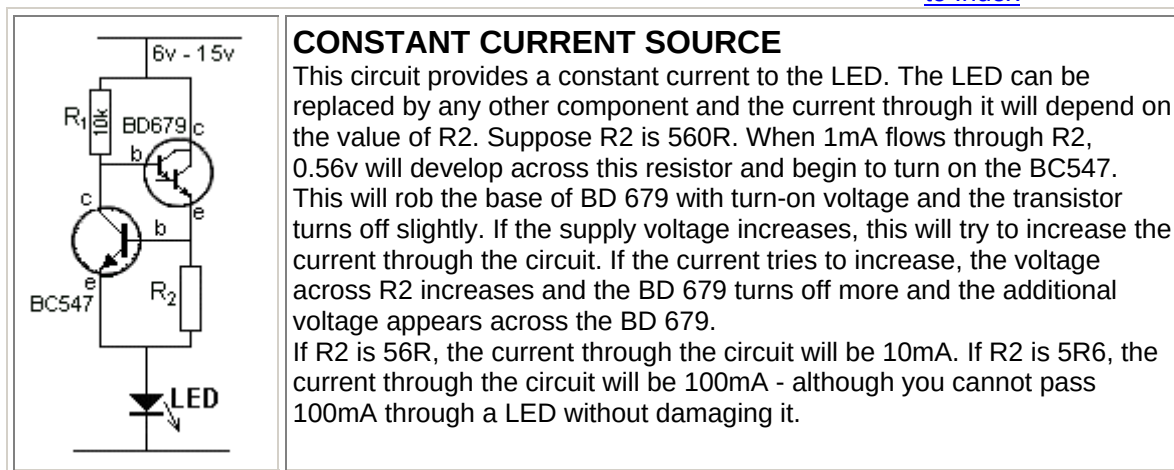


A close-up of the clock motor

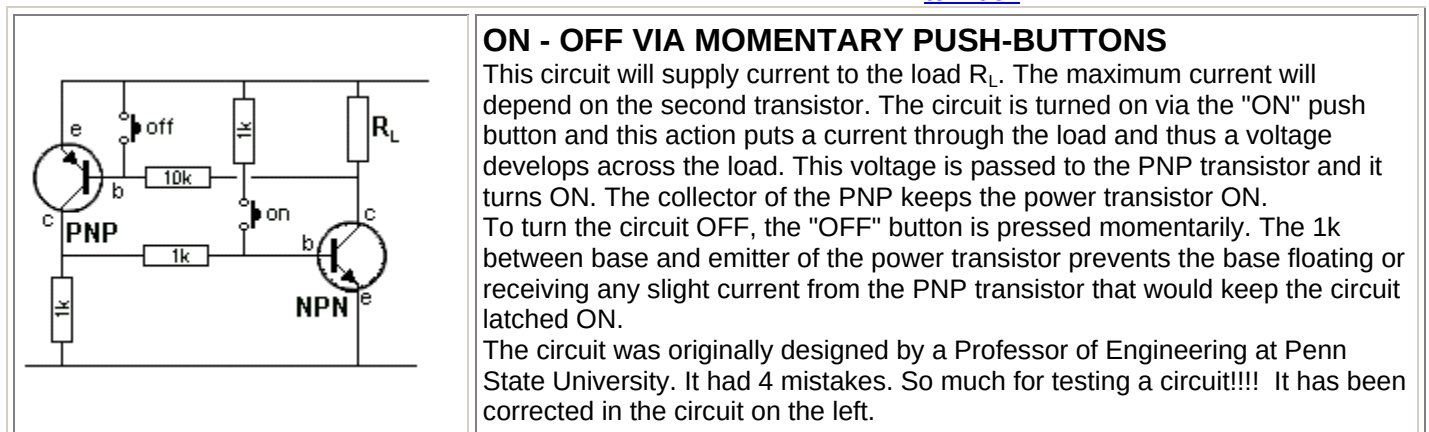
Another clock motor is shown below. Note the pole faces spiral closer to the rotor to make it revolve in one direction. What a clever design!!



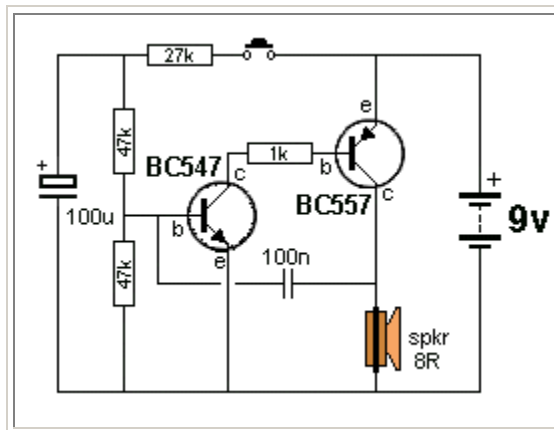
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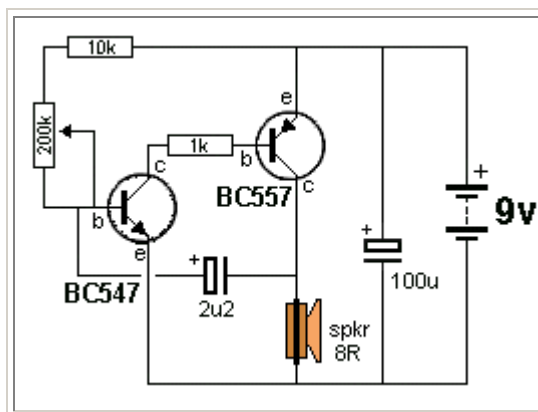
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SIREN

This circuit produces a wailing or siren sound that gradually increases and decreases in frequency as the 100u charges and discharges when the push-button is pressed and released. In other words, the circuit is not automatic. You need to press the button and release it to produce the up/down sound.

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TICKING BOMB

This circuit produces a sound similar to a loud clicking clock. The frequency of the tick is adjusted by the 220k pot. The circuit starts by charging the 2u2 and when 0.65v is on the base of the NPN transistor, it starts to turn on. This turns on the BC 557 and the voltage on the collector rises. This pushes the small charge on the 2u2 into the base of the BC547 to turn it on more. This continues when the negative end of the 2u2 is above 0.65v and now the electro starts to charge in the opposite direction until both transistors are fully turned on. The BC 547 receives less current into the base and it starts to turn off. Both transistors turn off very quickly and the cycle starts again.

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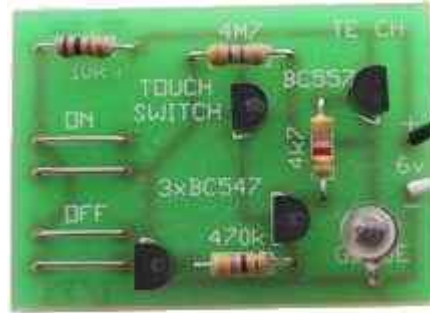
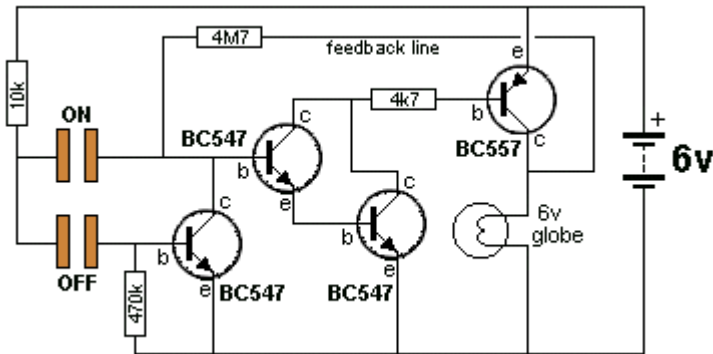
LIE DETECTOR

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

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

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

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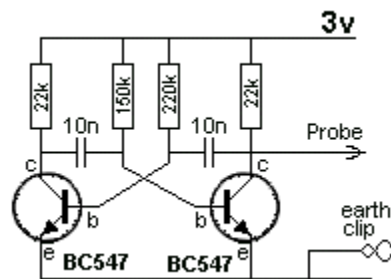


TOUCH SWITCH

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

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

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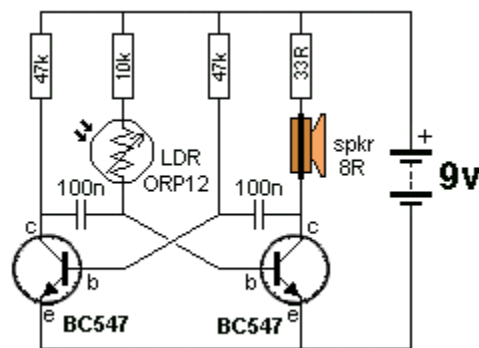


SIGNAL INJECTOR

This circuit is rich in harmonics and is ideal for testing amplifier circuits. To find a fault in an amplifier, connect the earth clip to the 0v rail and move through each stage, starting at the speaker. An increase in volume should be heard at each preceding stage.

This Injects will also go through the IF stages of radios and FM sound sections in TV's.

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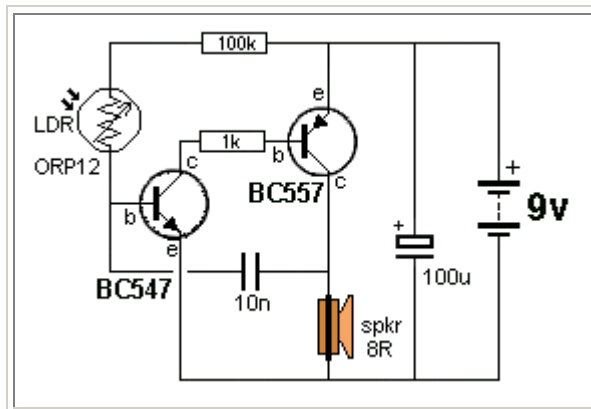


LIGHT ALARM - 1

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

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

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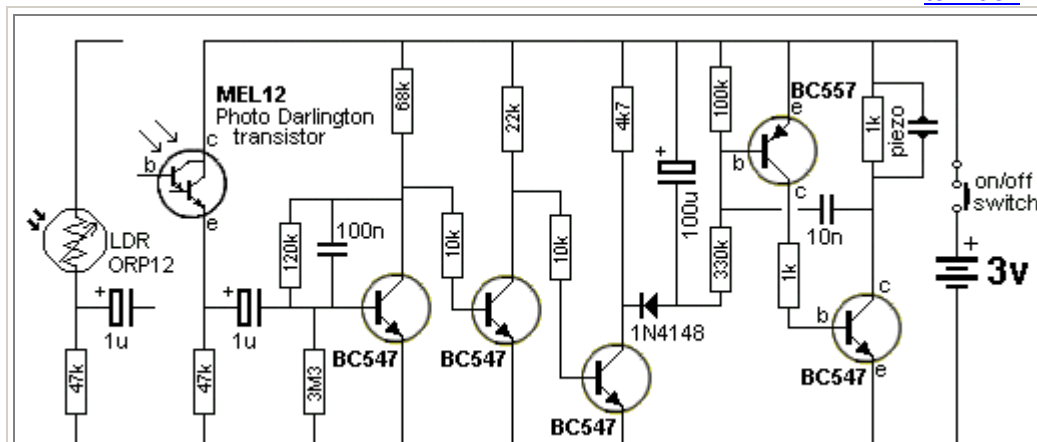
LIGHT ALARM - 2

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

The circuit is basically a high-gain amplifier that is turned on initially by the LDR and then the 10n keeps the circuit turning on until it can turn on no more.

The circuit then starts to turn off and eventually turns off completely. The current through the LDR starts the cycle again.

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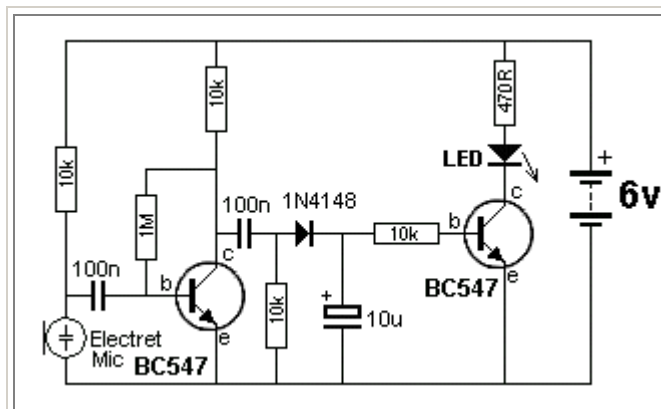


LIGHT ALARM - 3 (MOVEMENT DETECTOR)

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

The circuit is basically a high-gain amplifier (made up of the first three transistors) that is turned on by the LDR or photo Darlington transistor. The third transistor charges the 100u via a diode and this delivers turn-on voltage for the oscillator. The LDR has equal sensitivity to the photo transistor in this circuit.

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SOUND TRIGGERED LED

This circuit turns on a LED when the microphone detects a loud sound.

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

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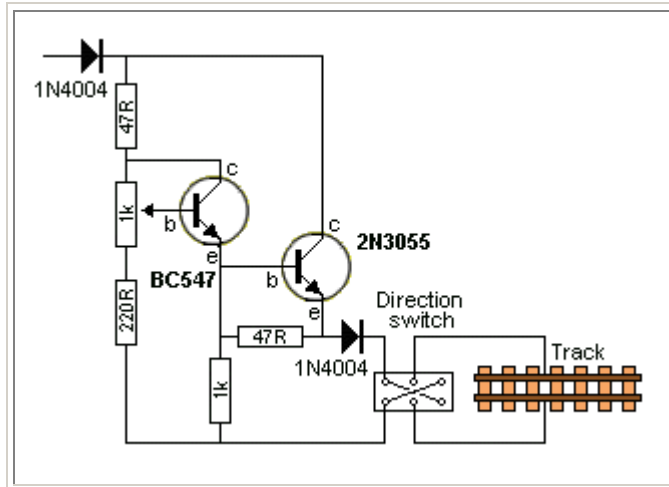


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while concentrating on the probe. Using a multimeter is much slower.

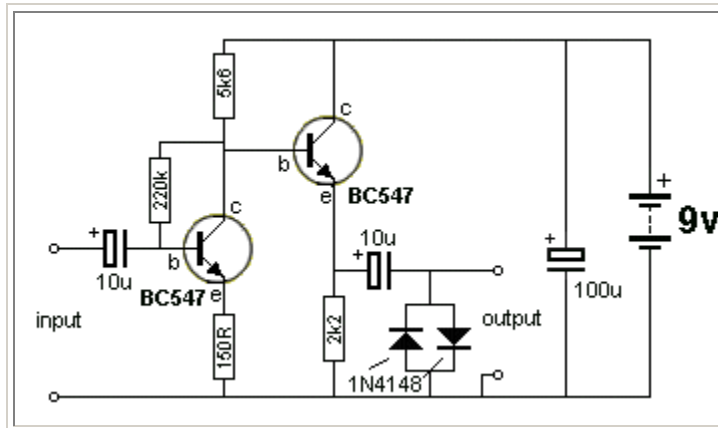
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TRAIN THROTTLE

This circuit is for model train enthusiasts. By adding this circuit to your speed controller box, you will be able to simulate a train starting slowly from rest. Remove the wire-wound rheostat and replace it with a 1k pot. This controls the base of the BC547 and the 2N3055 output is controlled by the BC547. The diodes protect the transistors from reverse polarity from the input and spikes from the rails.

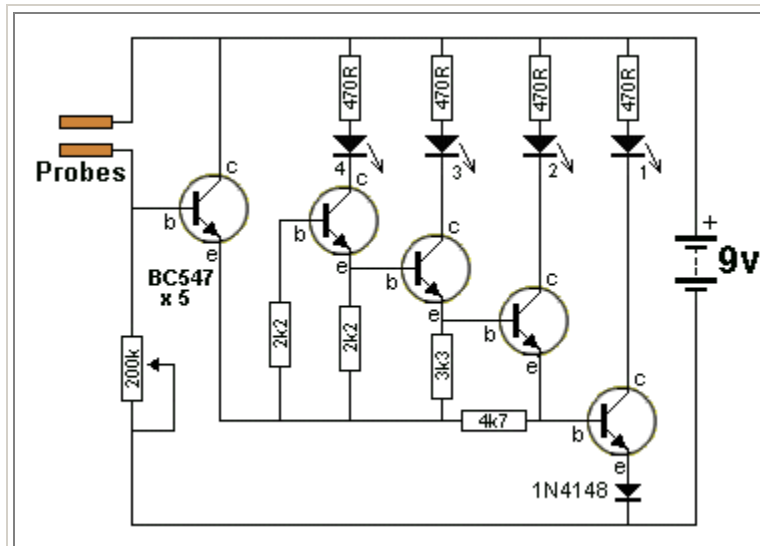
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GUITAR FUZZ

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

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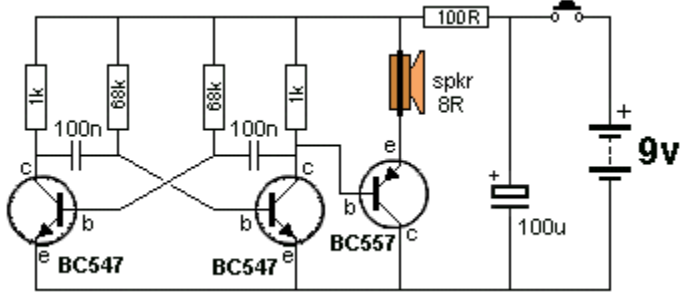


STRENGTH TESTER

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

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

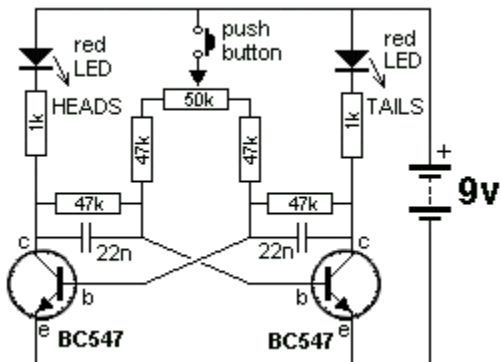
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FOG HORN

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

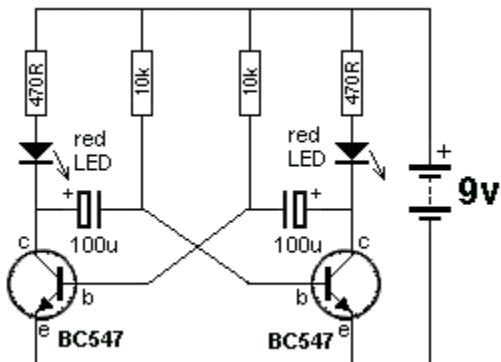
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HEADS OR TAILS

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

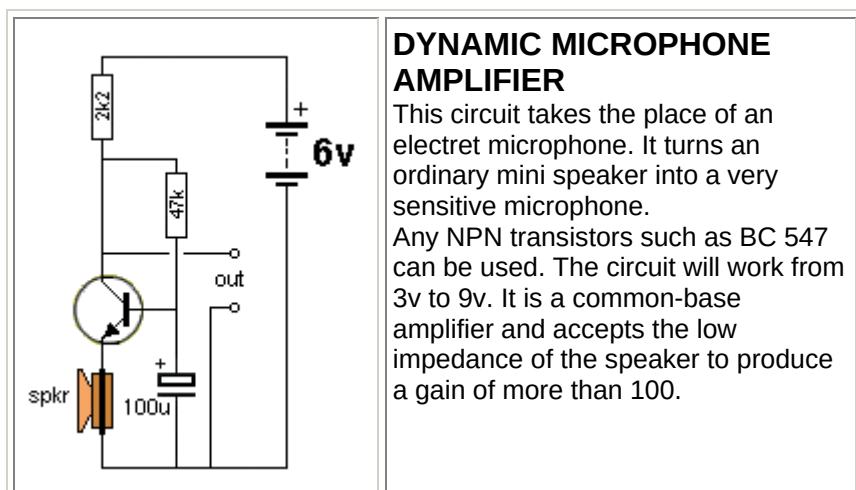
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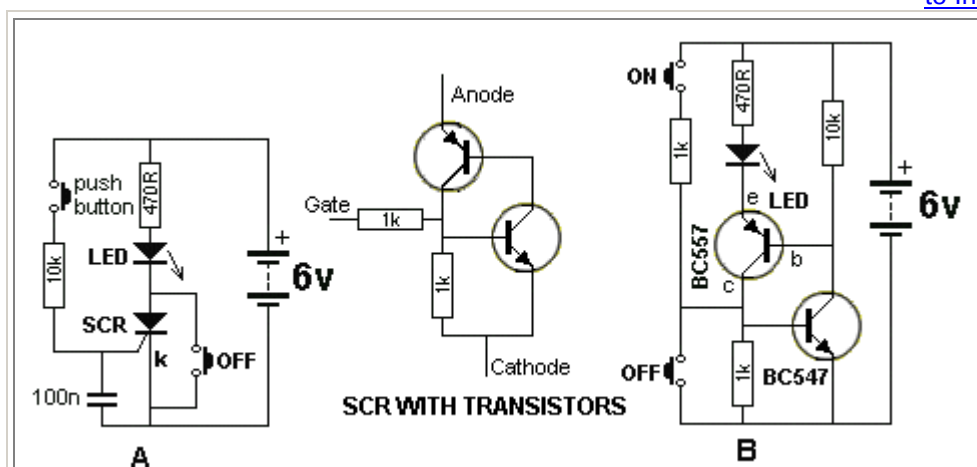
ROBOT MAN

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

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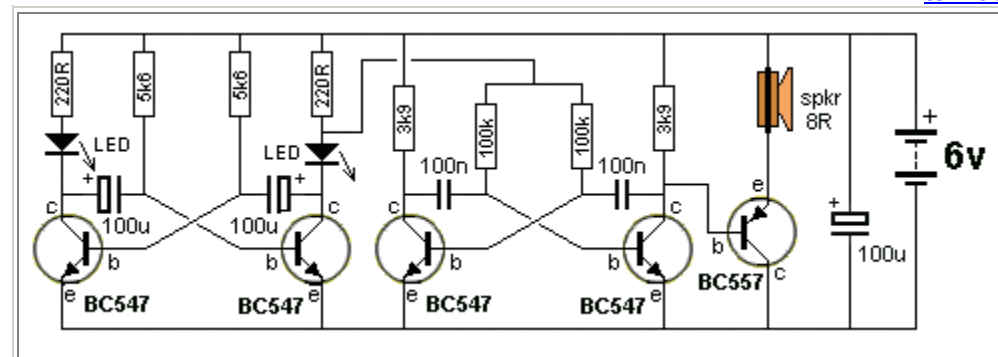
SCR WITH TRANSISTORS

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

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

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

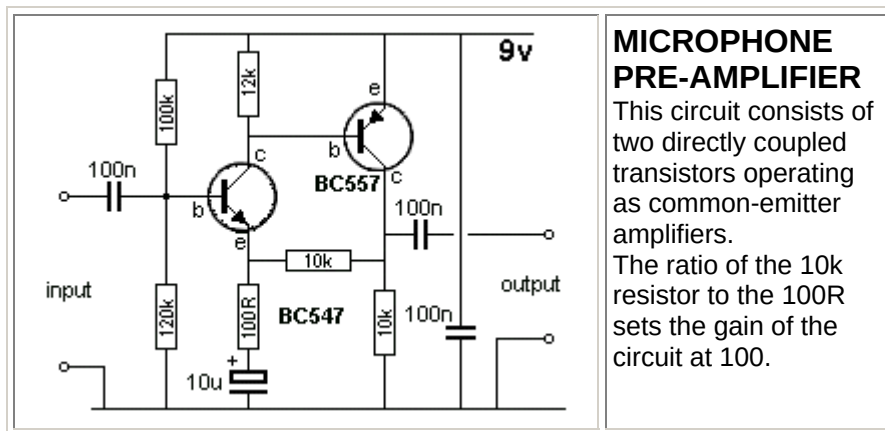
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HEE HAW SIREN

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

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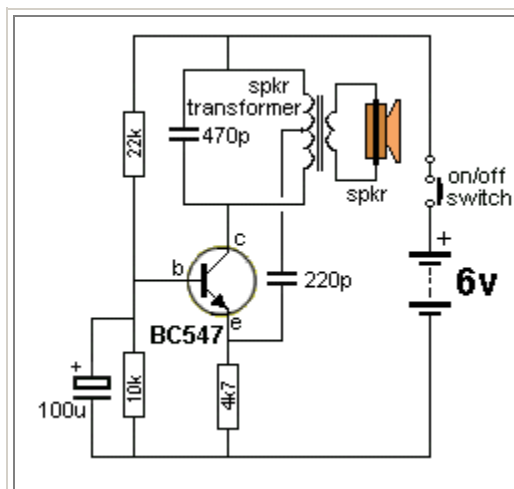


MICROPHONE PRE-AMPLIFIER

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

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

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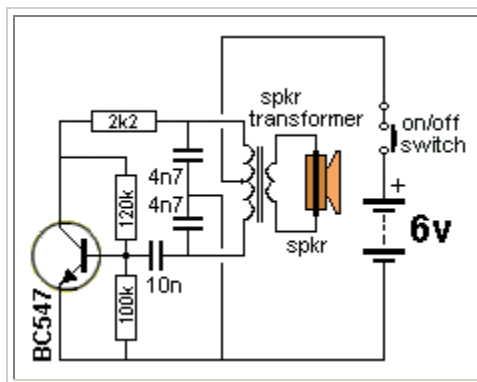


HARTLEY OSCILLATOR

The Hartley Oscillator is characterised by an LC circuit in its collector. The base of the transistor is held steady and a small amount of signal is taken from a tapping on the inductor and fed to the emitter to keep the transistor in oscillation. The transformer can be any speaker transformer with centre-tapped primary.

The frequency is adjusted by changing the 470p.

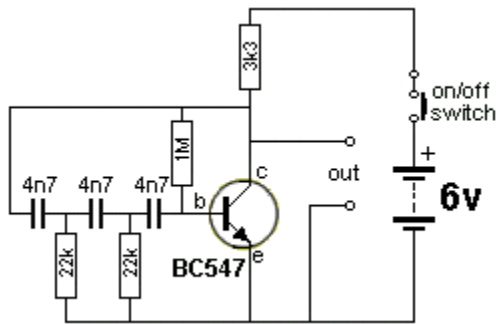
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COLPITTS OSCILLATOR

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

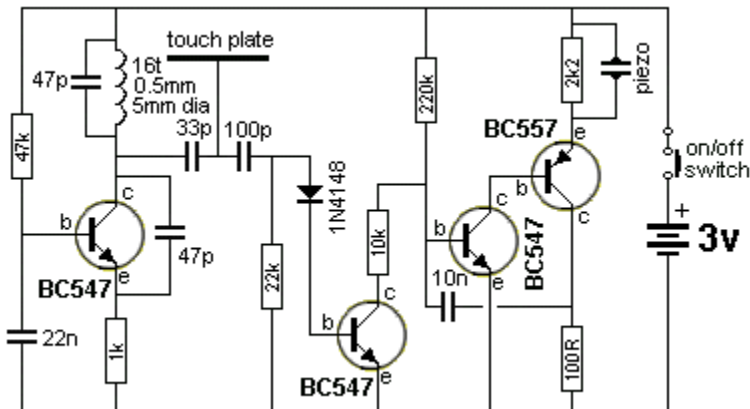
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PHASESHIFT OSCILLATOR

The Phaseshift Oscillator is characterised by 3 high-pass filters, creating a 180° phase shift. The output is a sinewave. Take care not to load the output - this will prevent reliable start-up and may stop the circuit from oscillating. Reduced the 3k3 load resistor if the load prevents the circuit oscillating. See Phase Shift Oscillator in section section of 200 Transistor Circuits for a better design.

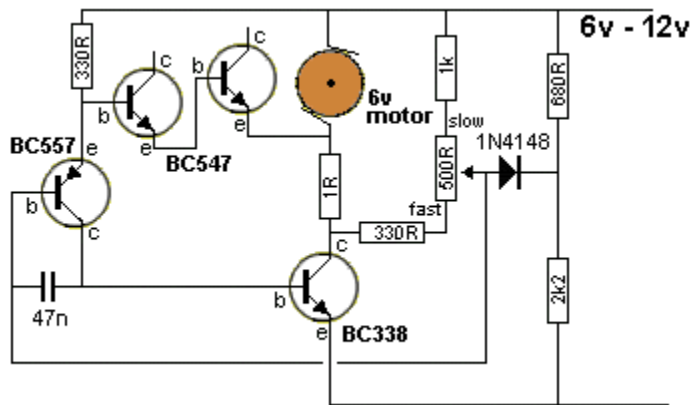
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DOOR-KNOB ALARM

This circuit can be used to detect when someone touches the handle of a door. A loop of bare wire is connected to the point "touch plate" and the project is hung on the door-knob. Anyone touching the metal door-knob will kill the pulses going to the second transistor and it will turn off. This will activate the "high-gain" amplifier/oscillator. The circuit will also work as a "Touch Plate" as it does not rely on main hum, as many other circuits do.

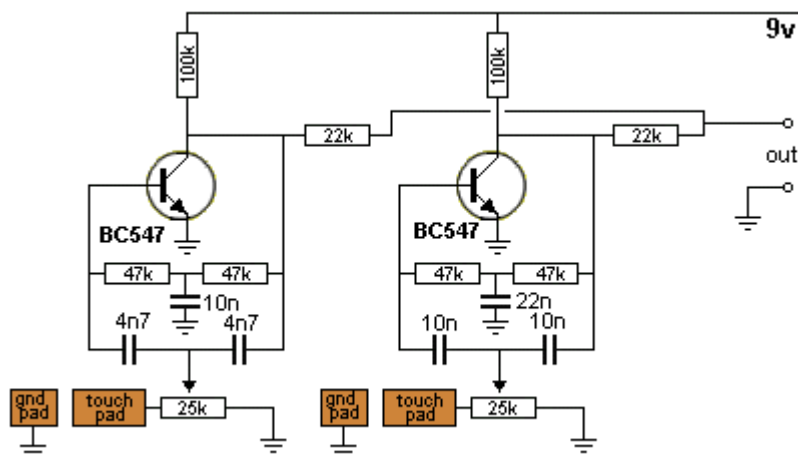
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MOTOR SPEED CONTROLLER

Most simple motor speed controllers simply reduce the voltage to a motor by introducing a series resistance. This reduces the motor's torque and if the motor is stopped, it will not start again. This circuit detects the pulses of noise produced by the motor to turn the circuit off slightly. If the motor becomes loaded, the amplitude of the pulses decreases and the circuit turns on more to deliver a higher current.

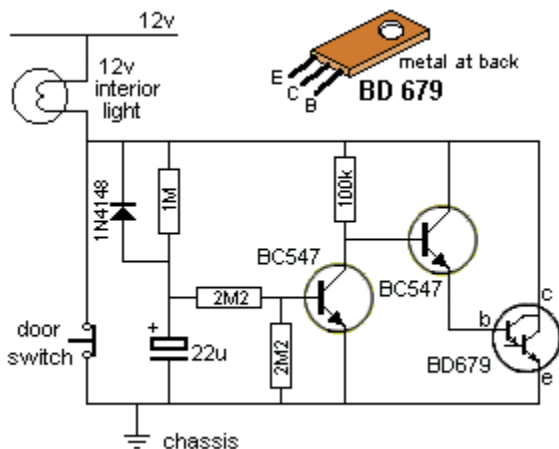
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ELECTRONIC DRUMS

The circuit consists of two "twin-T" oscillators set to a point below oscillation. Touching a Touch Pad will set the circuit into oscillation. Different effects are produced by touching the pads in different ways and a whole range of effects are available. The two 25k pots are adjusted to a point just before oscillation. A "drum roll" can be produced by shifting a finger rapidly across adjacent ground and drum pads.

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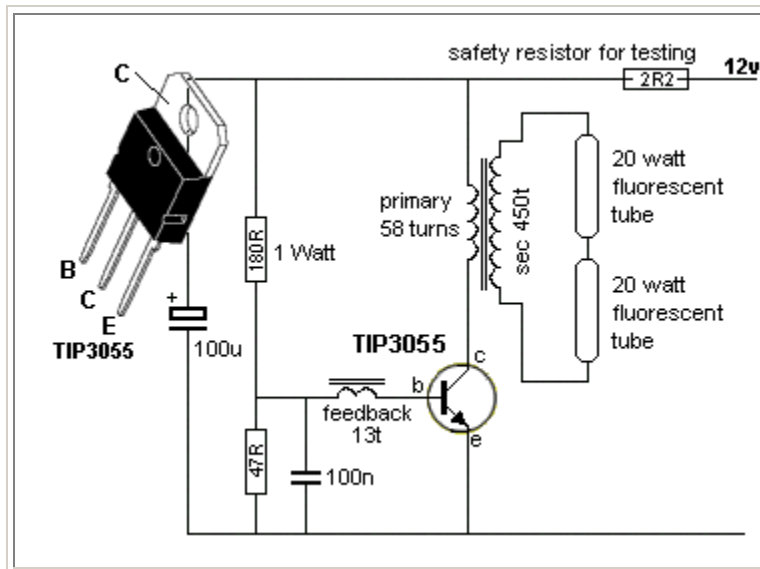
LIGHT EXTENDER

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

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

The 22u gradually charges via the 1M and the first BC547 turns on, robbing the second BC547 of "turn-on" voltage and it starts to turn off the BD679. The 1N4148 discharges the 22u when the door is opened.

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20 WATT FLUORO INVERTER

This circuit will drive a 40 watt fluoro or two 20-watt tubes in series.

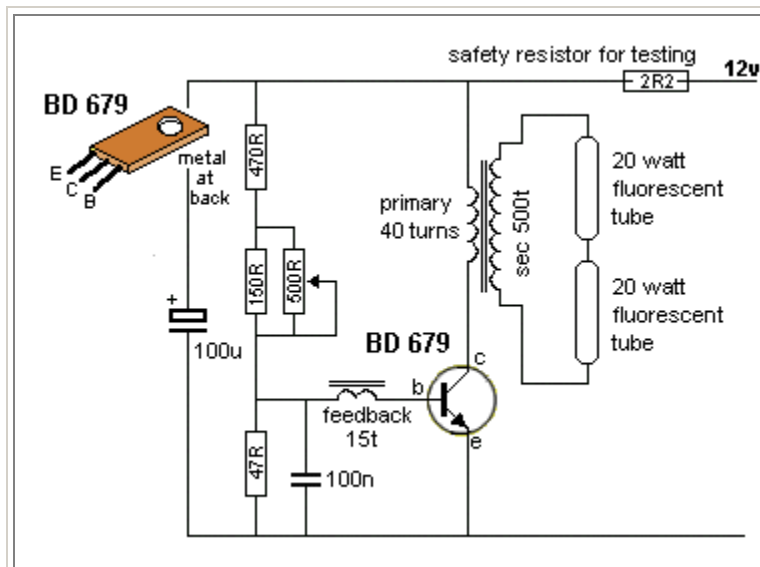
The transformer is wound on a ferrite rod 10mm dia and 8cm long.

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

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

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

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6 to 12 WATT FLUORO INVERTER

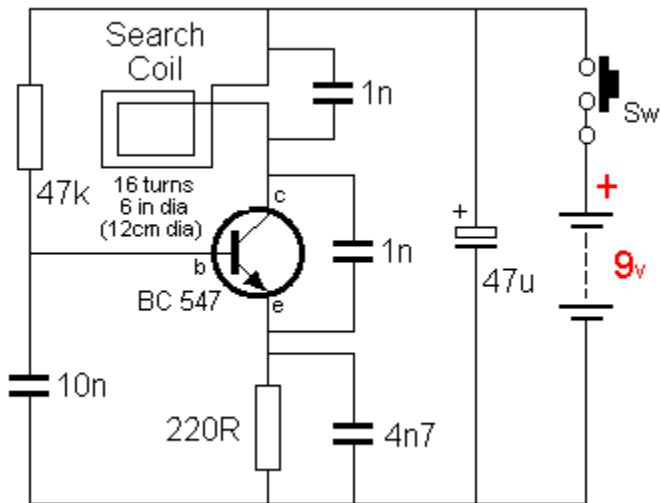
This circuit will drive a 40 watt fluoro or two 20-watt tubes in series but with less brightness than the circuit above and it will take less current.

2 x 20 watt tubes = 900mA to 1.2A and 1 x 20 watt tube 450mA to 900mA depending on pot setting.

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

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

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GOLD DETECTOR

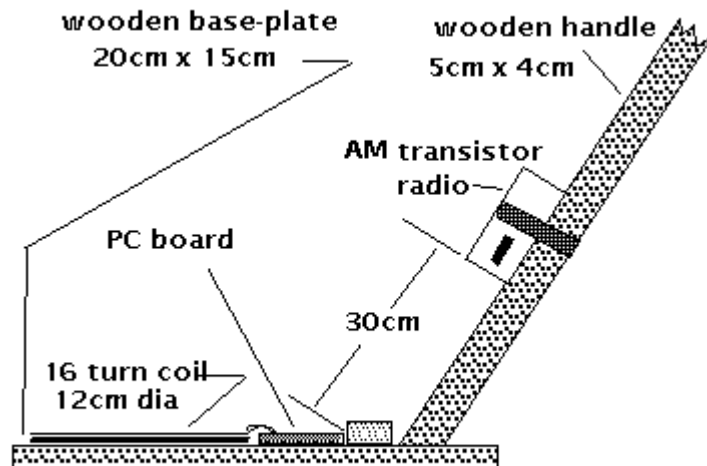
This very simple circuit will detect gold or metal or coins at a distance of approx 20cm - depending on the size of the object.

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

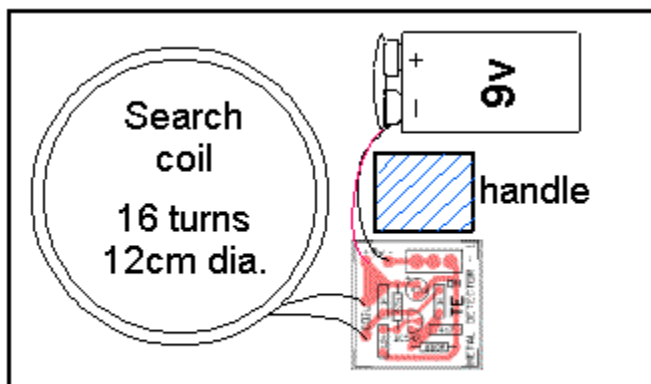
Simply tune the radio until a squeal is detected.

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

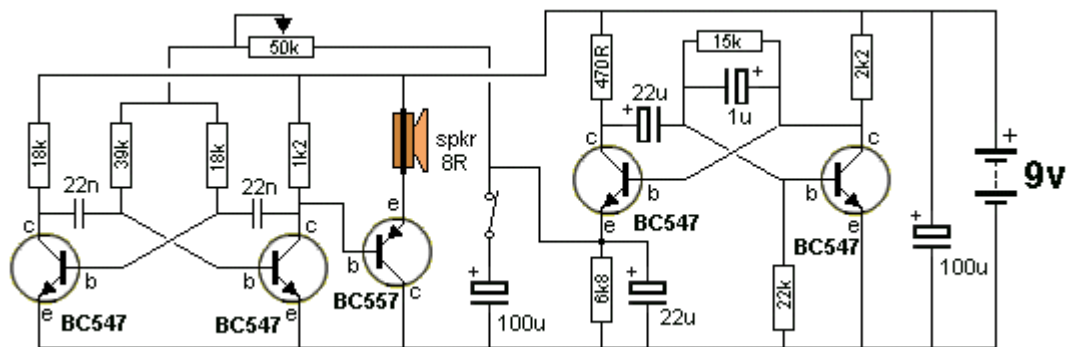
The layout of the circuit is shown and the placement of the radio.



THE LAYOUT OF THE DETECTOR



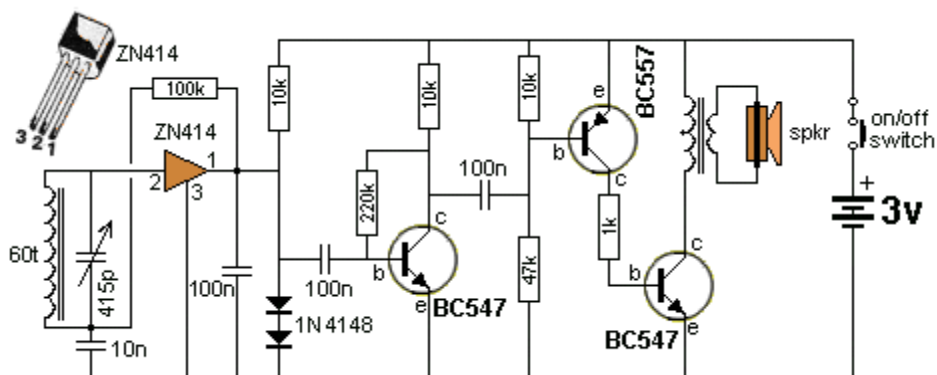
The Layout of Metal Detector -1



PHASER GUN

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

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IC RADIO

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

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

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

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

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

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The LEDs in this circuit produce a chasing pattern similar the running LEDs

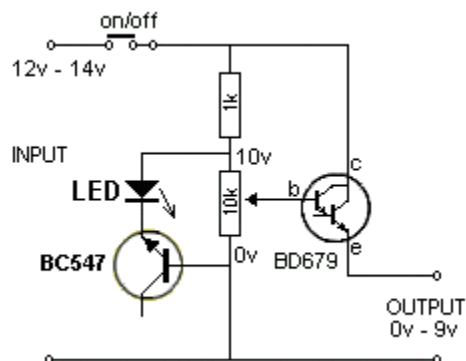
display in video shops.

All transistors will try to come on at the same time when the power is applied, but some will be faster due to their internal characteristics and some will get a different turn-on current due to the exact value of the 22u electrolytics. The last 22u will delay the voltage-rise to the base of the first transistor and make the circuit start reliably.

The circuit can be extended to any number of odd stages.

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BENCH POWER SUPPLY



This power supply can be built in less than an hour on a piece of copper-laminate. The board acts as a heat-sink and the other components can be mounted as shown in the photo, by cutting strips to suit their placement.

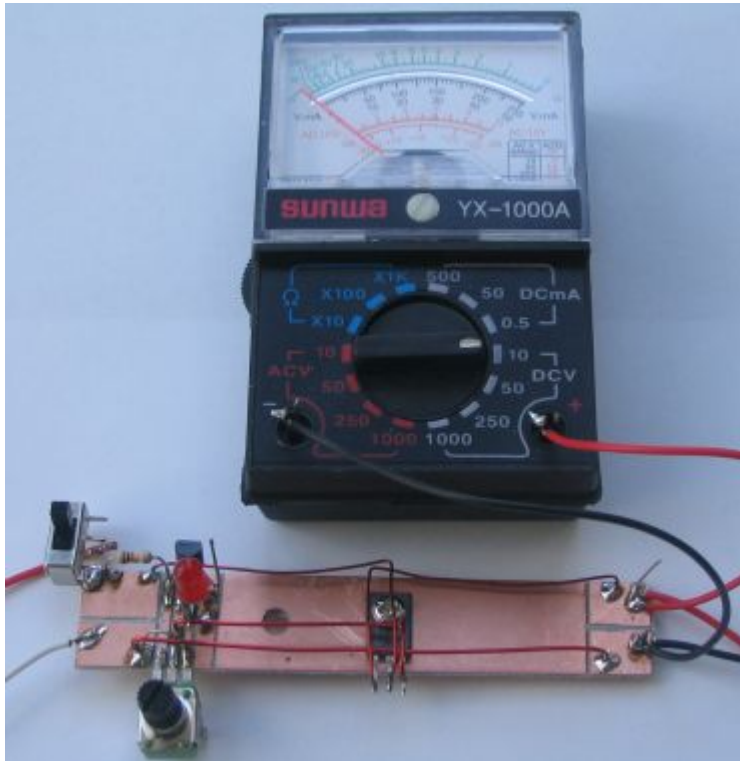
The components are connected with enameled wire and the transistor is bolted to the board to keep it cool.

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

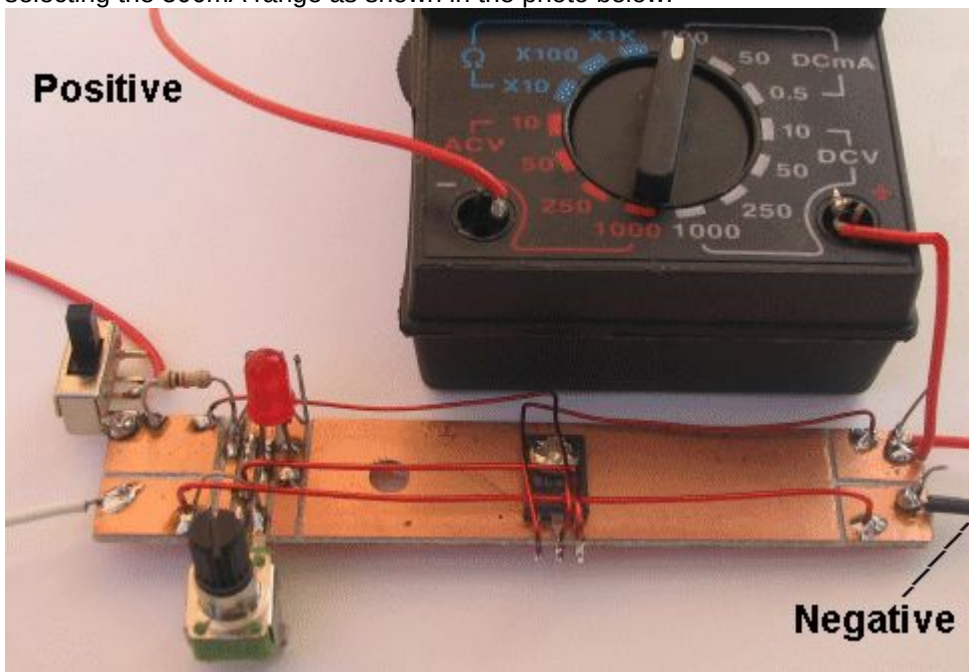
The output of this power supply is regulated by a 10v zener made up of the characteristic zener voltage of 8.2v between the base-emitter leads of a BC547 transistor (in reverse bias) and approx 1.7v across a red LED. The circuit will deliver 0v - 9v at 500mA (depending on the life left in the cells your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

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ADDING A VOLT-METER TO THE BENCH POWER SUPPLY

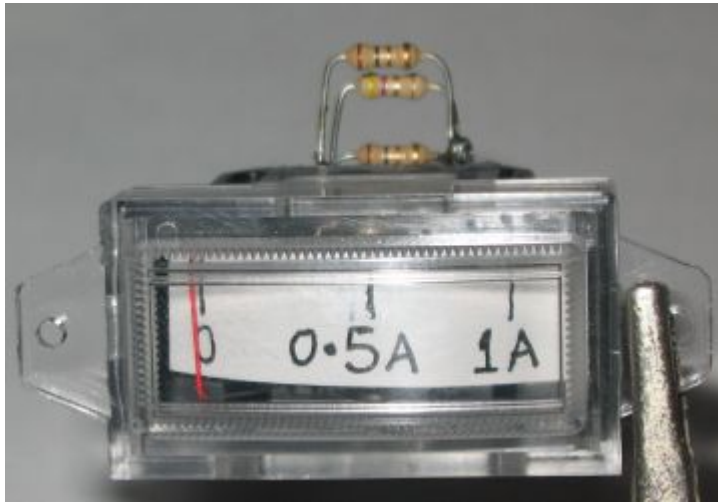


A voltmeter can be added to the Bench Power Supply by using a very low cost multimeter. For less than \$10.00 you can get a mini multimeter with 14 ranges, including a 10v range. The multimeter can **also** be used to monitor current by removing the negative lead and making a new RED lead, fitting it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



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MAKING 0-1Amp meter for the BENCH POWER SUPPLY



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

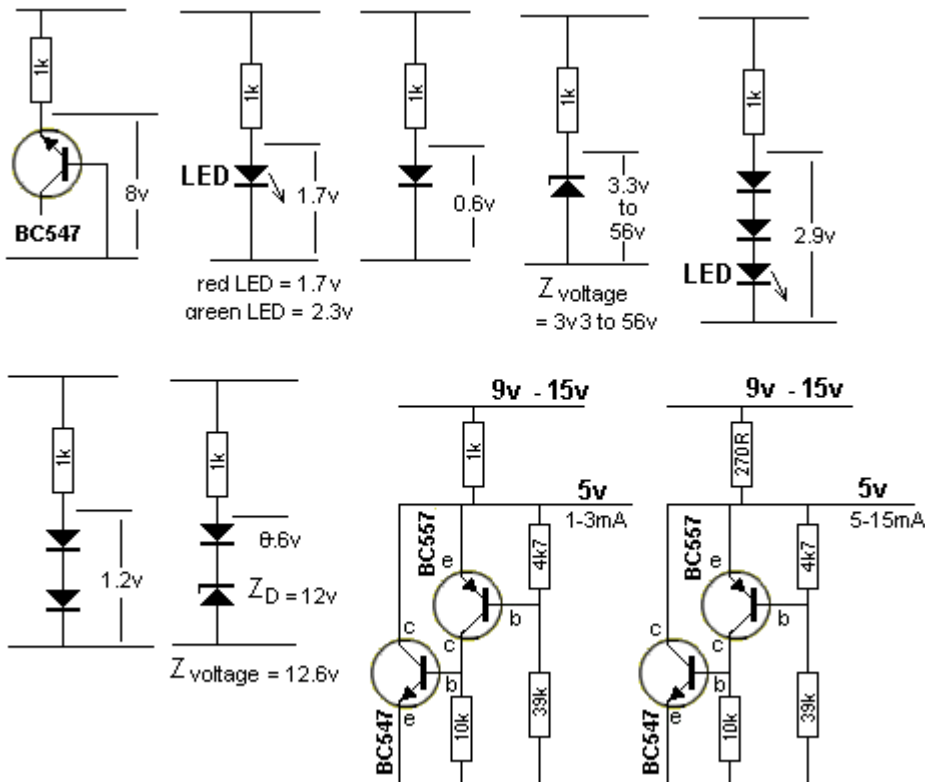
Any Movement can be converted to an ammeter without any mathematics. Simply solder two 1R resistors (in parallel) across the terminals of any movement and connect it in series with an ammeter on the output of the Bench Power Supply. The second ammeter provides a reference so you can calibrate the movement. Connect a globe and increase the voltage. At 500mA, if the pointer is "up scale" (reading too high) add a trim-resistor. In our case it was 4R7.

The three shunt resistors can be clearly seen in the photo. Two 1R and the trim resistor is 4R7. You can get a movement from an old multimeter or they are available in electronics shops as a separate item. The sensitivity does not matter. It can be 20uA or 50uA FSD or any sensitivity.

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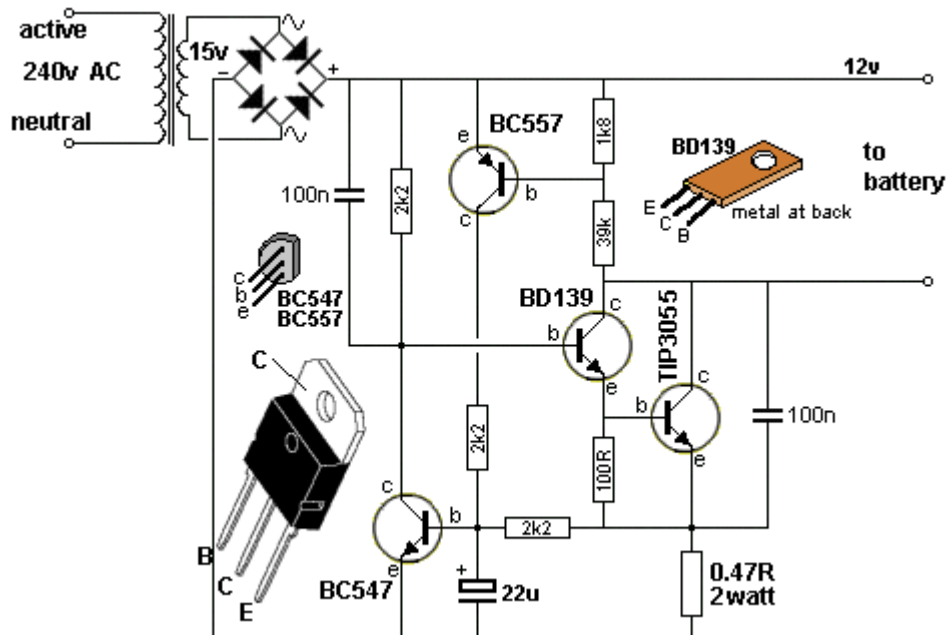
MAKING A ZENER DIODE

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



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12v TRICKLE CHARGER



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

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

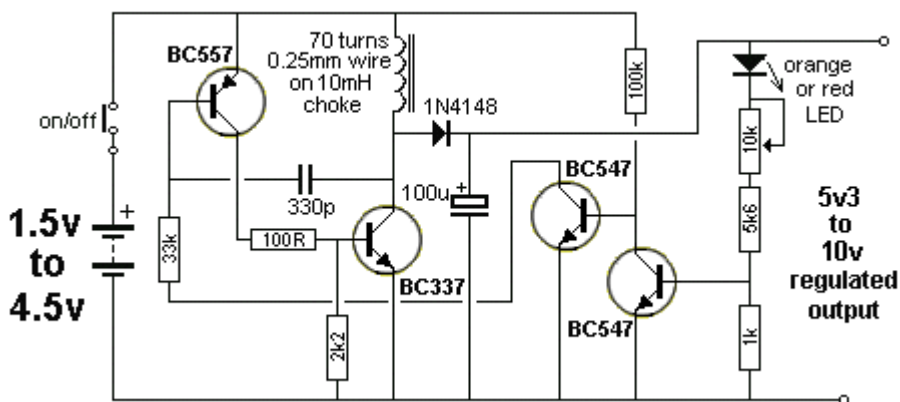
This is how the 2 amp max is created.

As the battery voltage rises, the voltage divider made up of the 1k8 and 39k creates a 0.65v between base and emitter of the BC557 and it starts to turn on at approx 14v. This turns on the BC 547 and it robs the BD136 of "turn-on" voltage and the TIP3055 is nearly fully turned off.

All battery chargers in Australia must be earthed. The negative of the output is taken to the earth pin.

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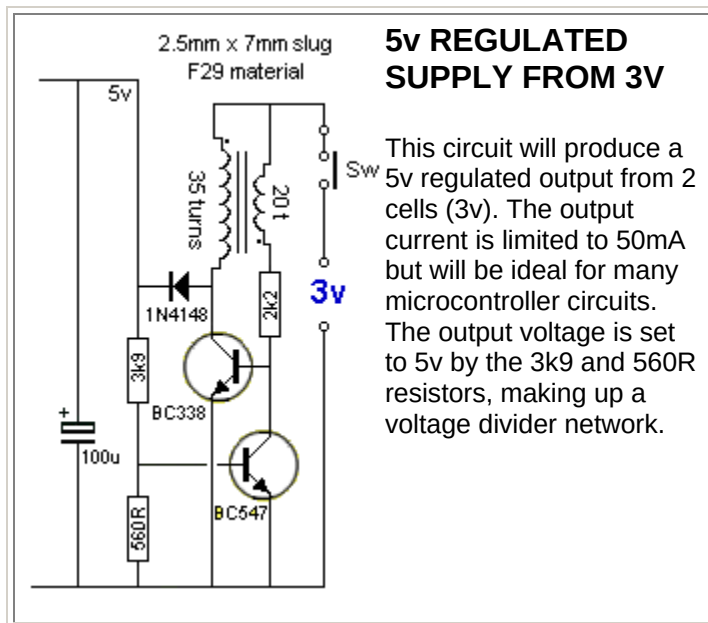
1.5v to 10v INVERTER



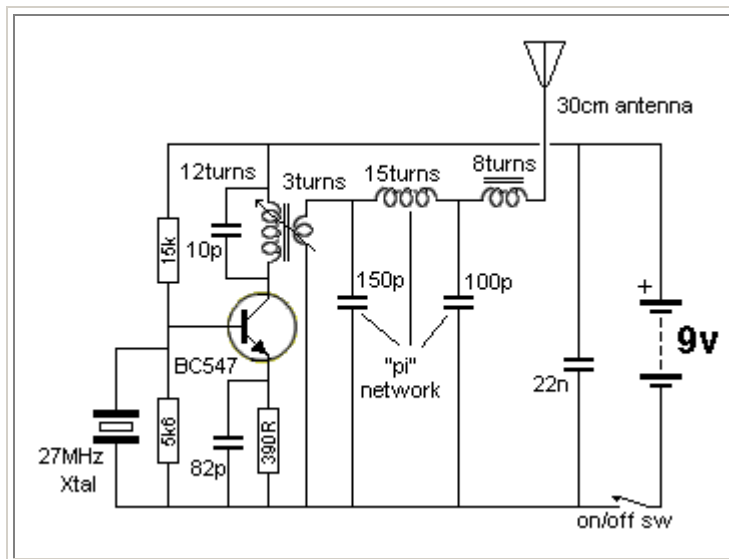
This very clever circuit will convert 1.5v to 10v to take the place of those expensive 9v

batteries and also provide a 5v supply for a microcontroller project. But the clever part is the voltage regulating section. It reduces the current to less than 8mA when no current is being drawn from the output. With a 470R load and 10v, the output current is 20mA and the voltage drop is less than 10mV. The pot will adjust the output voltage from 5.3v to 10v.

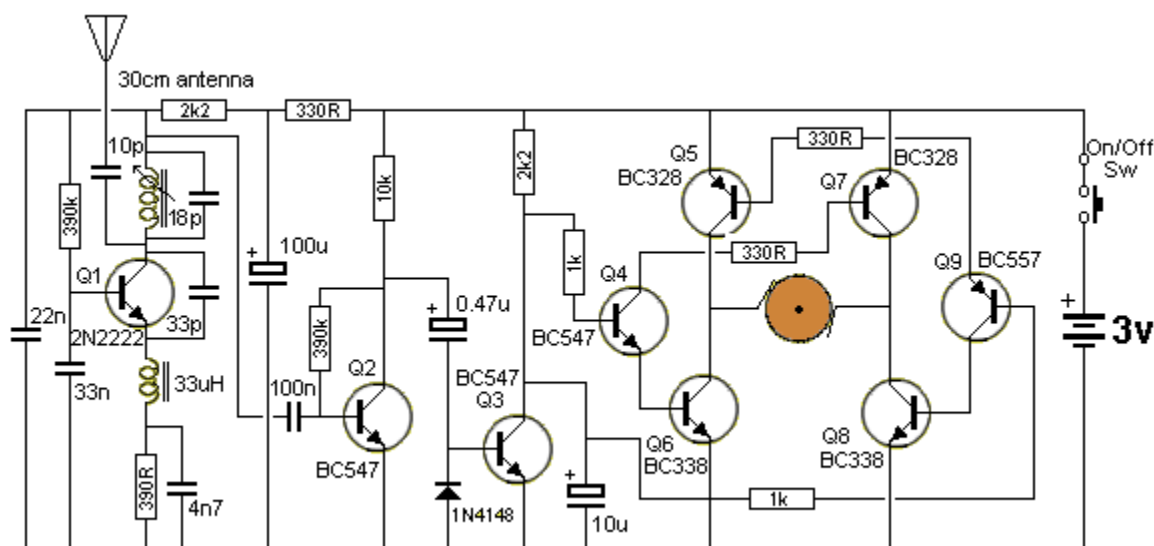
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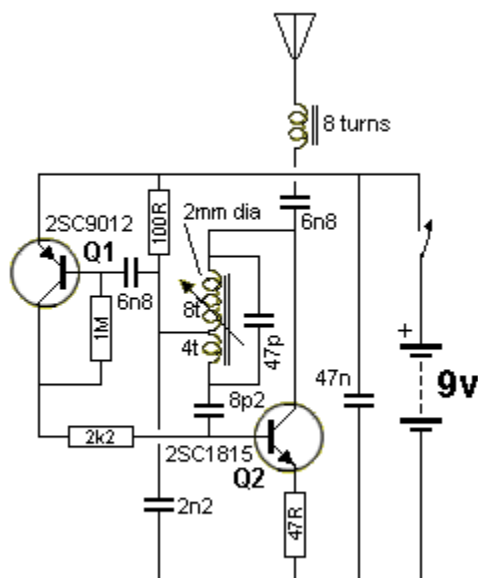


27MHz RECEIVER

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

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

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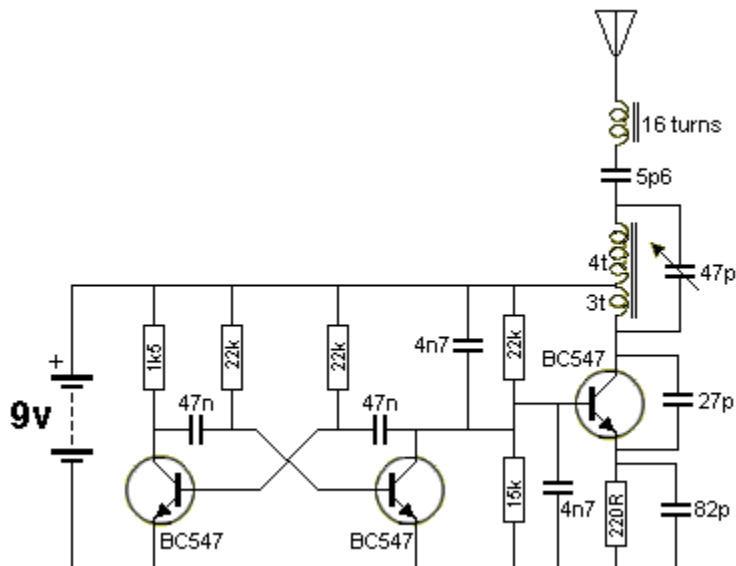
27MHz TRANSMITTER WITHOUT A CRYSTAL

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

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

See full description in [27MHz Links](#) article.

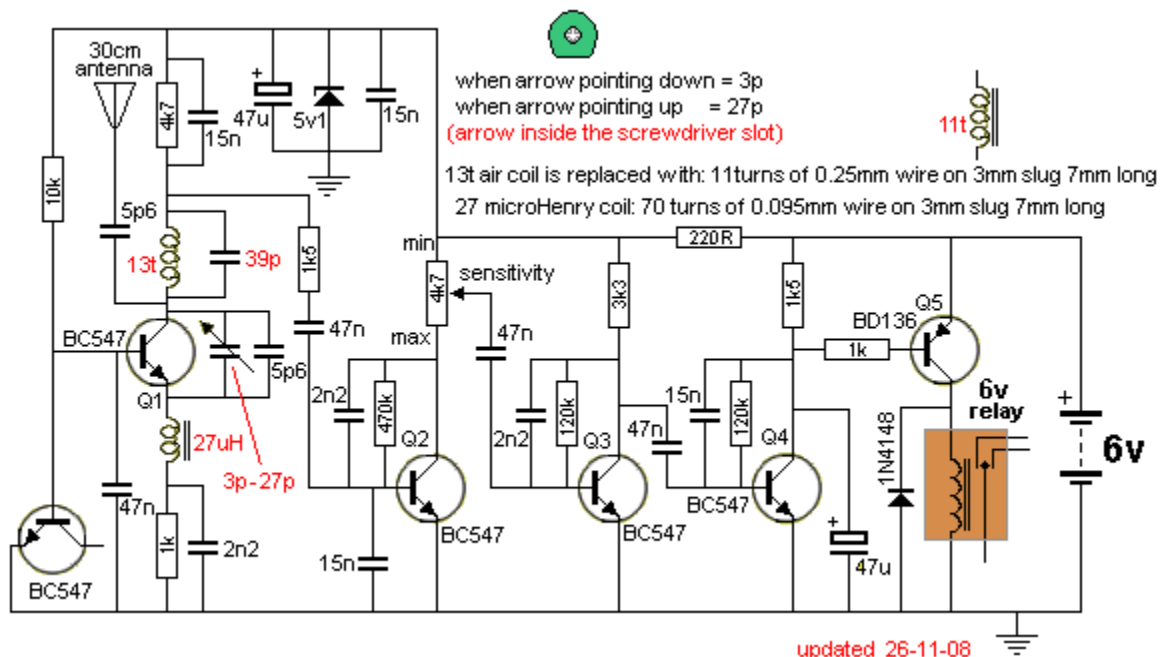
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27MHz TRANSMITTER WITH SQUARE-WAVE OSCILLATOR

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

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27MHz RECEIVER-2

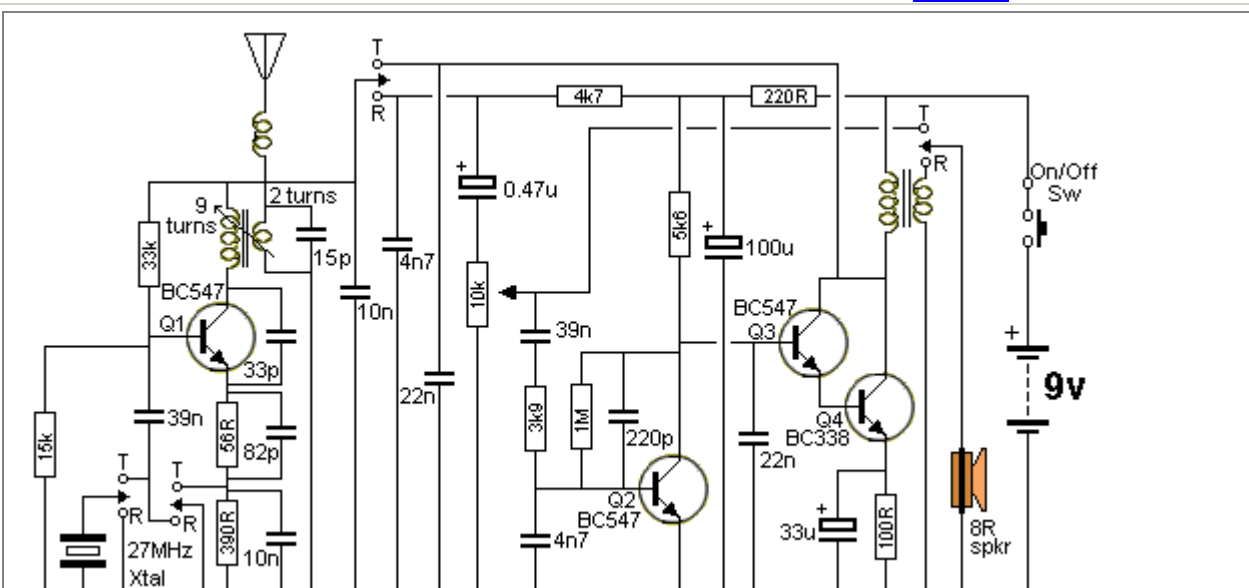
This circuit matches with the 27MHz Transmitter with Square-wave Oscillator. See full description on Talking Electronics website: [27MHz Links](#) article.

The receiver frequency is fixed. The transmitter is adjusted to suit the receiver. The 3-27p trimmer is

adjusted for maximum gain (10p trimmer and 5p6 in our case) and this is a critical adjustment. The base-emitter junction of the first BC547 sets 0.7v (as it is heavily turned on by the 10k) on the base of the oscillator Q1, and this is fixed. Q1 is very lightly turned on (due to the emitter resistor), and this makes it very sensitive when it is oscillating. Any 27MHz signal from the surroundings will upset the oscillator and any tone in the signal will be passed to the stages for amplification. The coil is 13 turns. It can be replaced with 11 turns of 0.25mm wire on 3mm dia slug 7mm long. Although the original Russian product worked very well, our prototype did not have very good sensitivity. The circuit was very difficult to set-up.

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

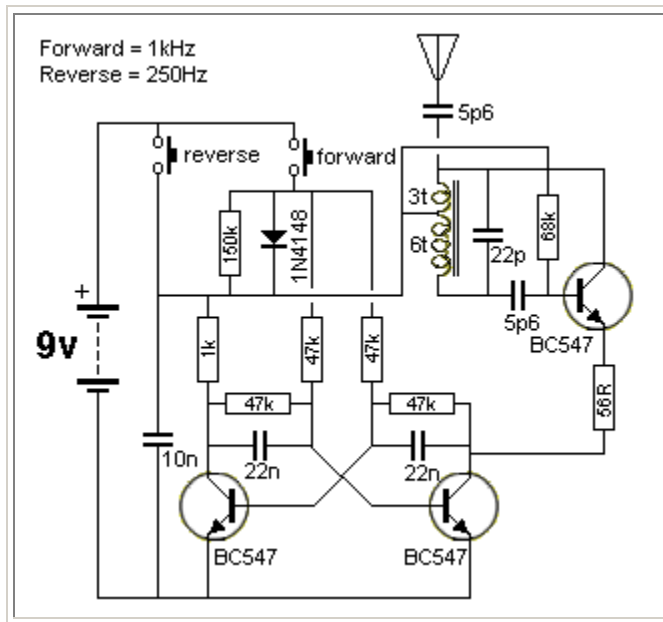
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WALKIE TALKIE

Nearly all the components in the 4-transistor circuit are used for both transmitting and receiving. This makes it a very economical design. The frequency-generating stage only needs the crystal to be removed and it becomes a receiver. Next is a three transistor directly coupled audio amplifier with very high gain. The first transistor is a pre-amplifier and the next two are wired as a super-alpha pair, commonly called a Darlington pair to drive the speaker transformer. See full description in [27MHz Links](#) article.

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27MHz TRANSMITTER - 2 CHANNEL

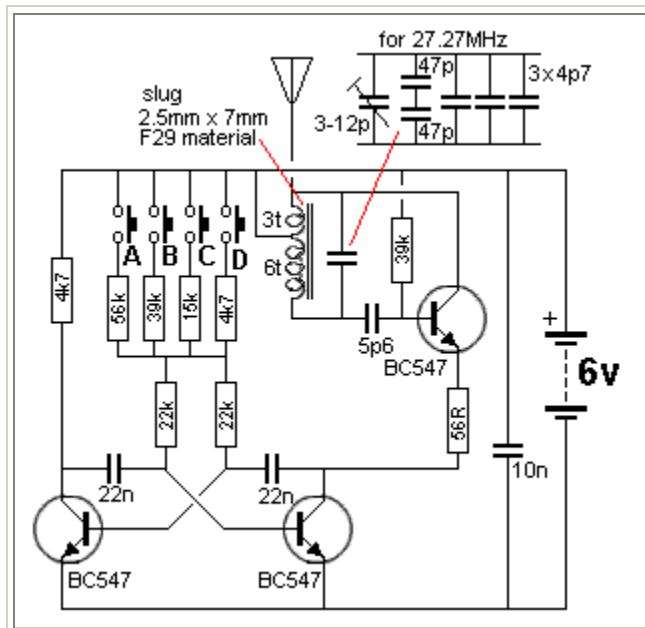
This circuit does not use a crystal but has a clever feature of using the two push buttons to turn the circuit on when it is required to transmit.

The frequency of the multivibrator is determined by the value of resistance on the base of each transistor. The multivibrator is driven directly from the supply with the forward button and via a 150k for the reverse frequency.

The receiver requires a 1kHz tone for forward and 250Hz for reverse.

See full description in [27MHz Links](#) article.

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27MHz TRANSMITTER - 4 CHANNEL

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

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

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

See P4 of:

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

2 Digit Up/Down Counter has the receiver section.

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

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303MHz TRANSMITTER

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

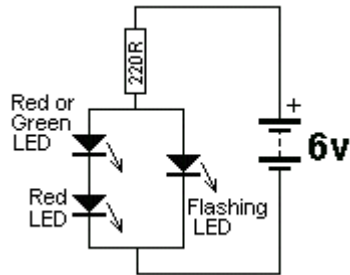
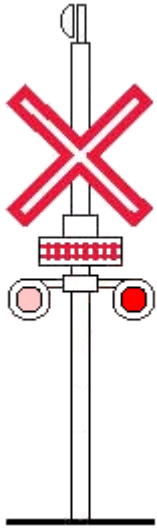
The 303MHz oscillator consists of a self-oscillating circuit made up of the coil on the PC board and a 9p (9 puff) capacitor.

See full description in [Wireless Doorbell](#) article.

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Type:		Gain:	Vbe	Vce	Current	Case
2SC1815	NPN	100	1v	50v	150mA	
2SC3279	NPN	140 to 600 @0.5A	0.75v	10v	2amp	
BC337 BC338	NPN	60 @300mA	0.7v	45v 25v	800mA	
BC547 BC548 BC549	NPN	70 @100mA	0.7v	45v 30v 30v	100mA	
BC557	PNP			45v	100mA	
BD139	NPN	70-100 @150mA	0.5v	80v	1.5A	
BD140	PNP	70-100 @150mA	0.5v	80v	1.5A	
2SCxxx						
8050	NPN			10v	1.5A	
8550	PNP			10v	1.5A	
9012	PNP				500mA	
9013	NPN		1v	20v	500mA	
9014	NPN				100mA	
9015	PNP				100mA	
9018	NPN	700MHz		15v	50mA	

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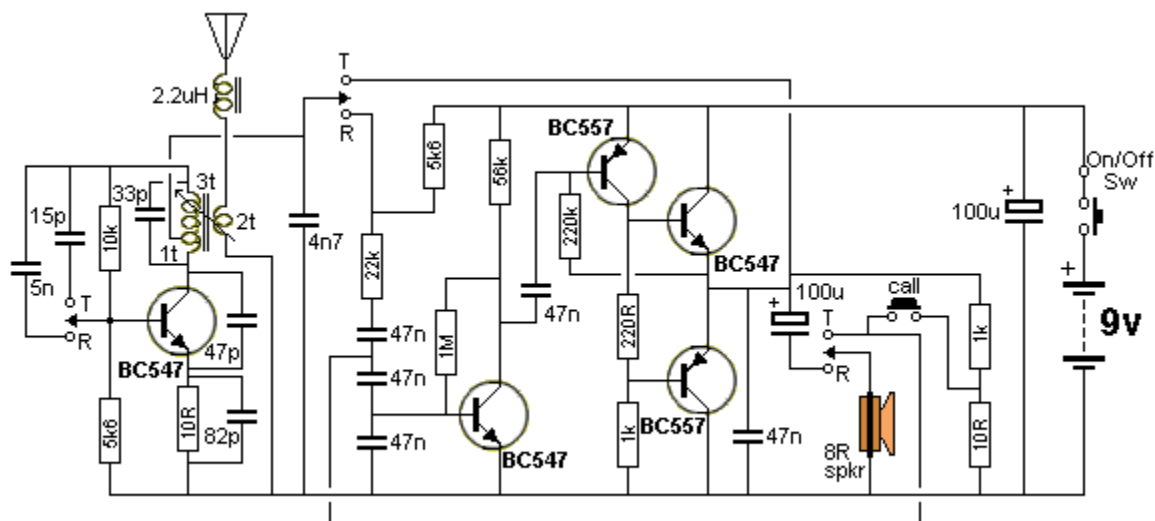
BOOM GATE LIGHTS

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

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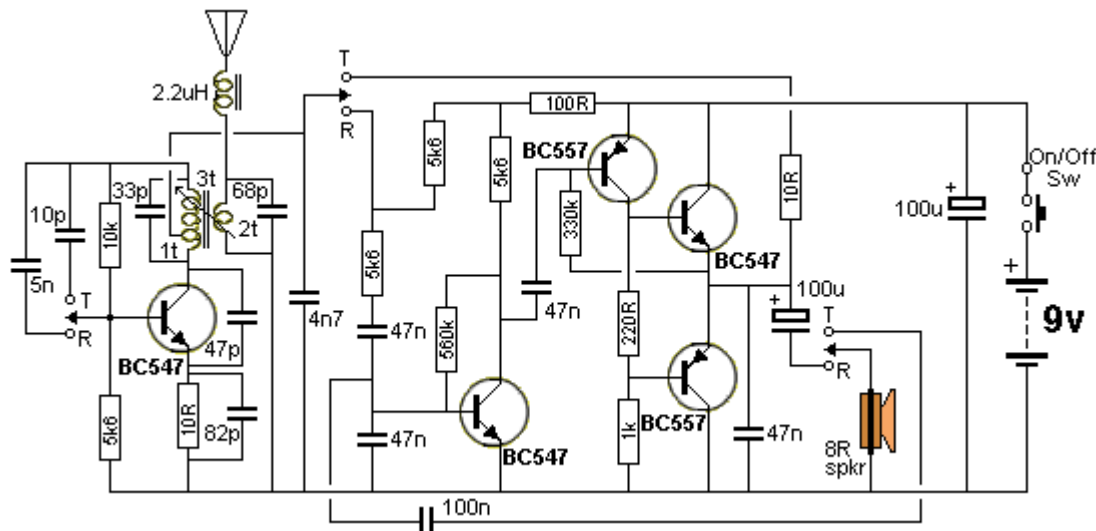
The 1/10th watt resistors used in this circuit, compared with 0.25watt resistors.



5 TRANSISTOR WALKIE TALKIE - 1

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

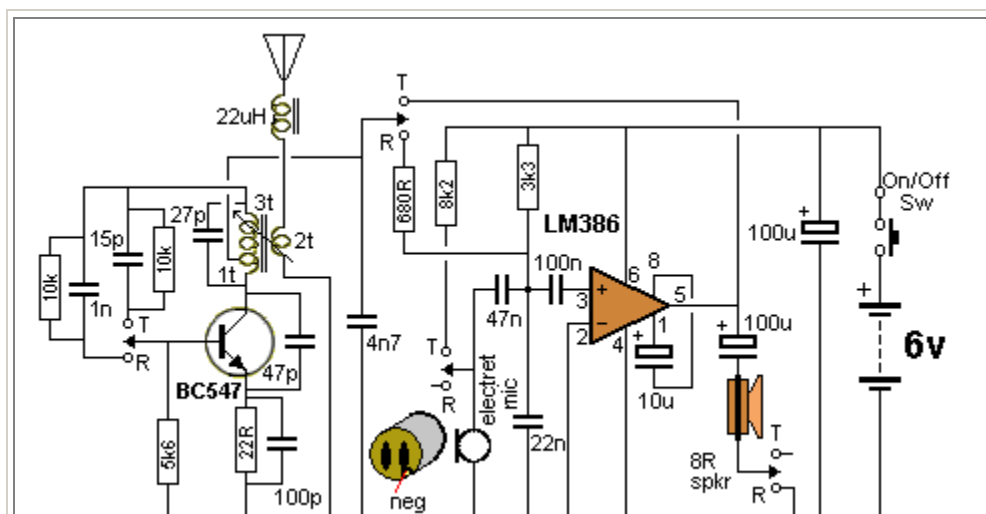
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5 TRANSISTOR WALKIE TALKIE - 2

Here is another walkie talkie circuit, using slightly different values for some of the components. See the article: [27MHz Transmitters](#) for theory on how these transmitters work.

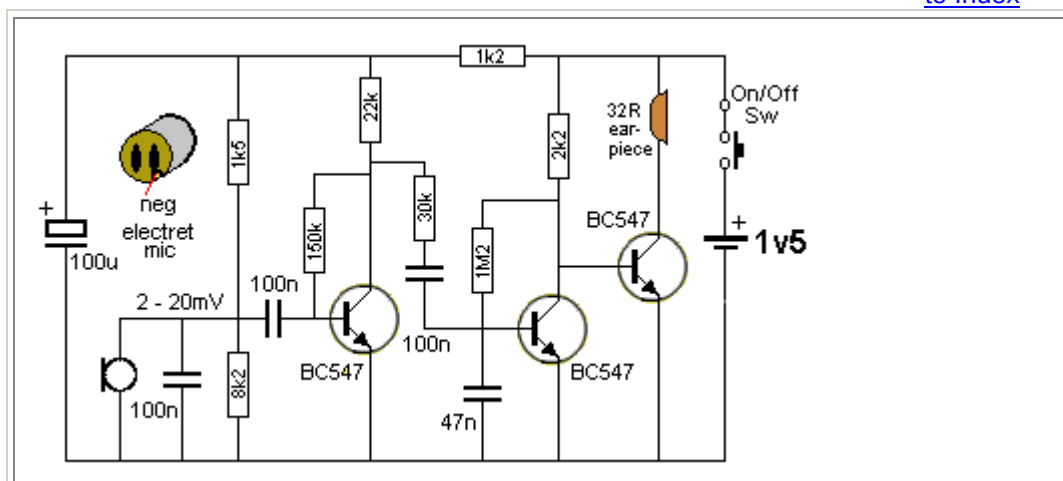
[to Index](#)

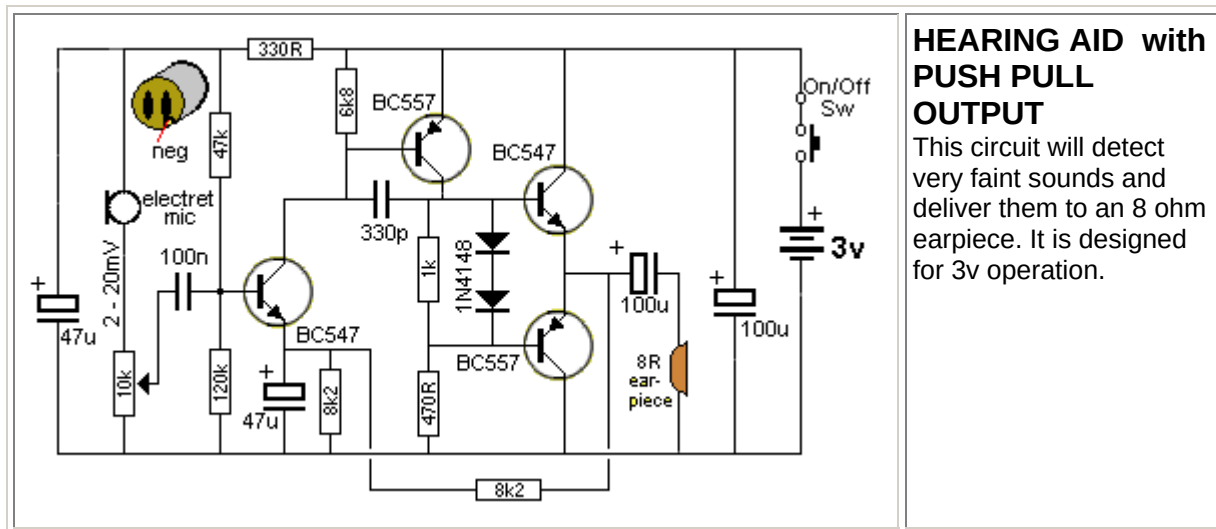


WALKIE TALKIE with LM386

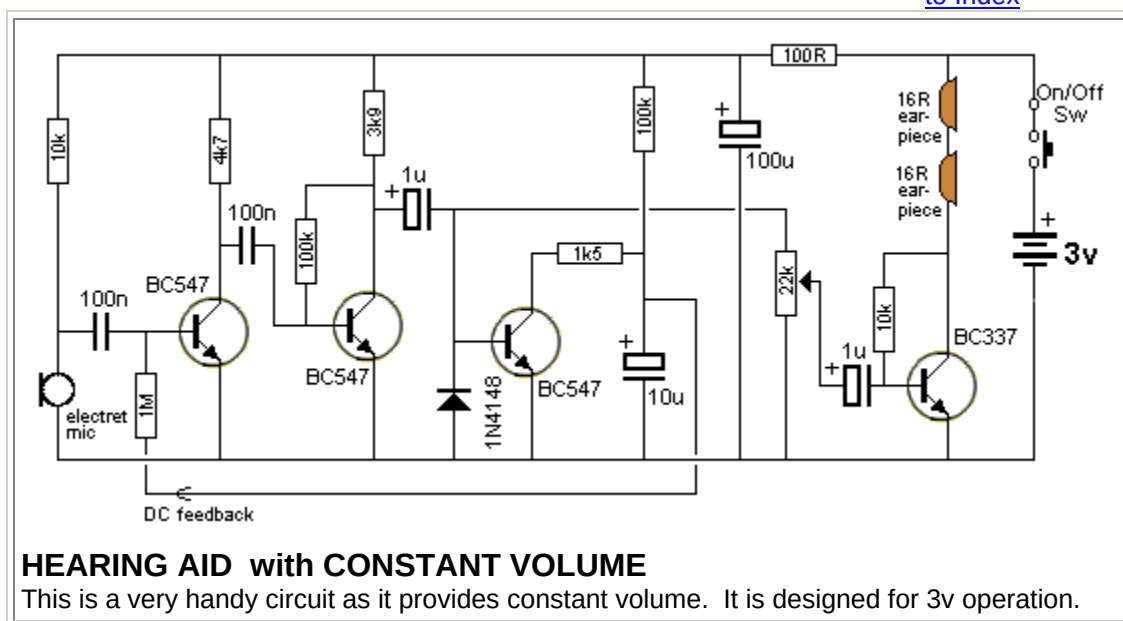
Here is a more up-to-date version of the walkie talkie, using an LM 386 amplifier IC to take the place of 4 transistors.

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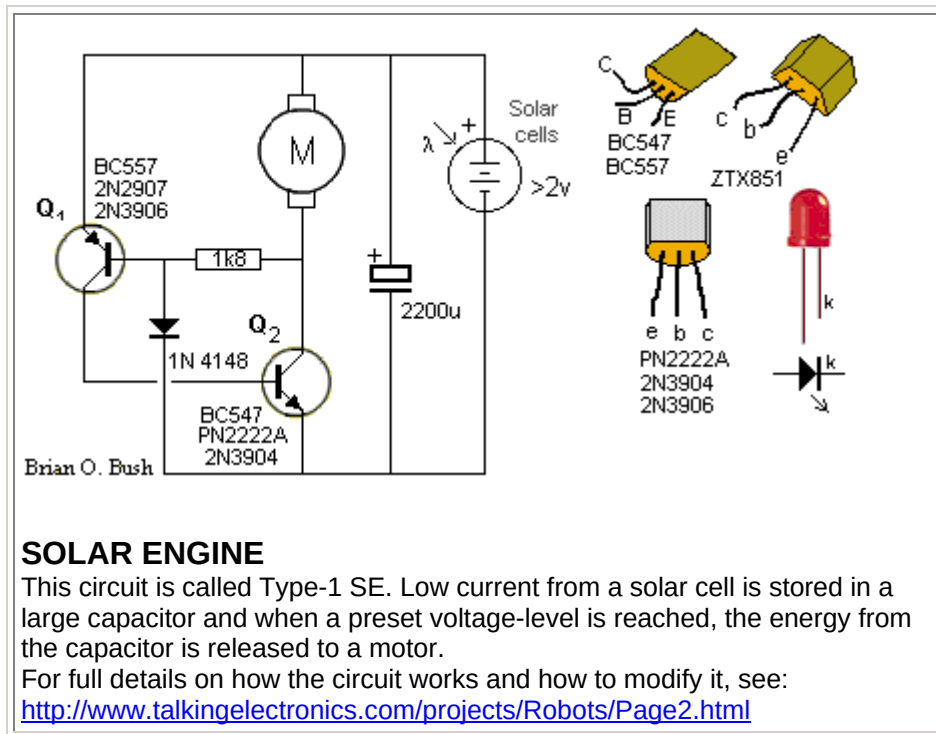




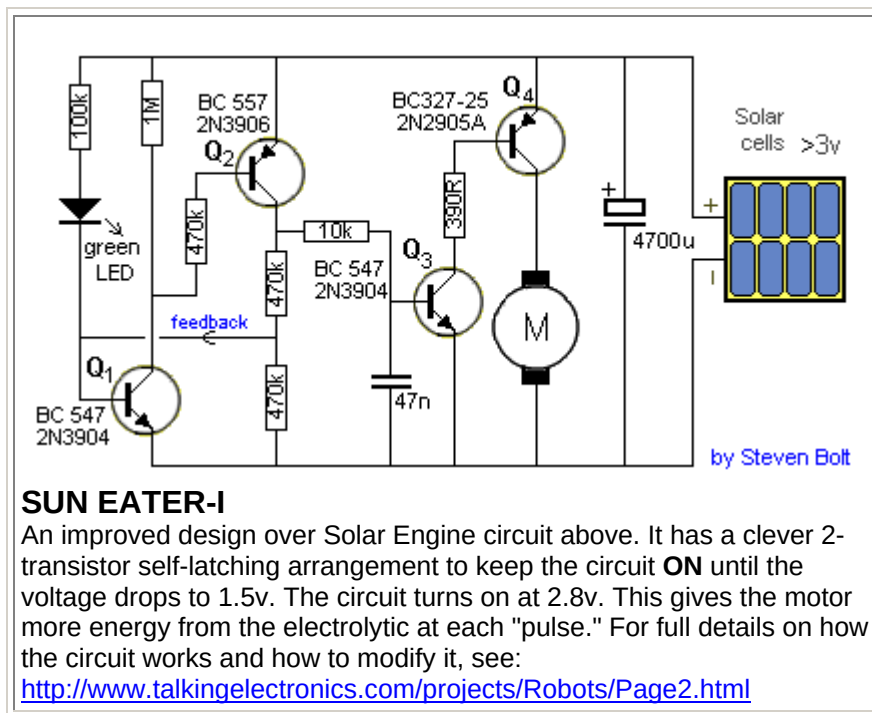
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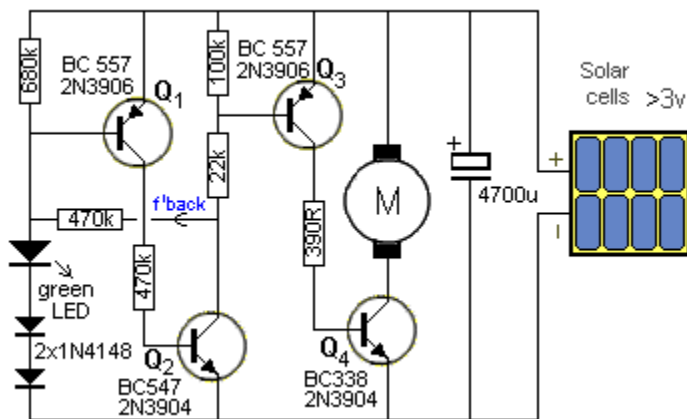
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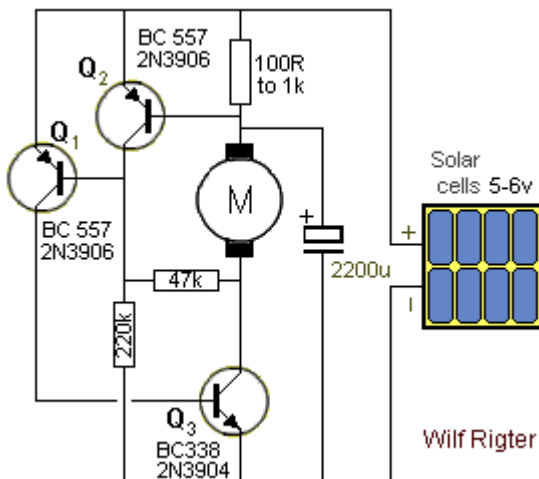
SUN EATER-1A

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

For full details on how the circuit works and how to modify it, see:

<http://www.talkingelectronics.com/projects/Robots/Page2.html>

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SOLAR ENGINE Type-3

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

At the beginning of the charge-cycle for an electrolytic, the charging current is a maximum. As the electrolytic becomes charged, the current drops. In the type-3 circuit, the charging current passes

through a 100R resistor and creates a voltage drop. This voltage is detected by a transistor (Q2) and the transistor is turned ON.

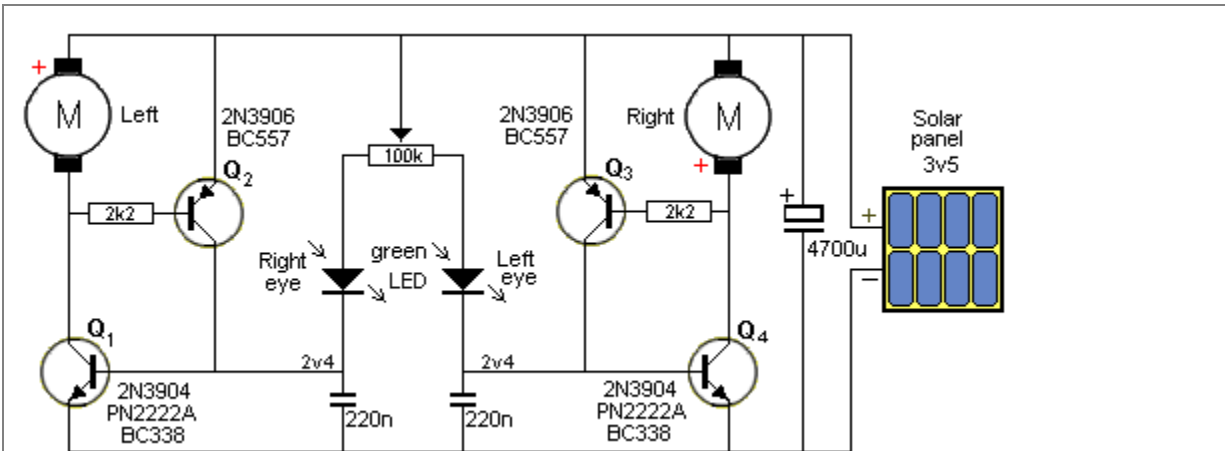
This action robs transistor (Q1) from turn-on voltage and the rest of the circuit is not activated. As the

charging current drops, Q2 is gradually turned off and Q1 becomes turned on via the 220k resistor on the base.

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

<http://www.talkingelectronics.com/projects/Robots/Page2.html>

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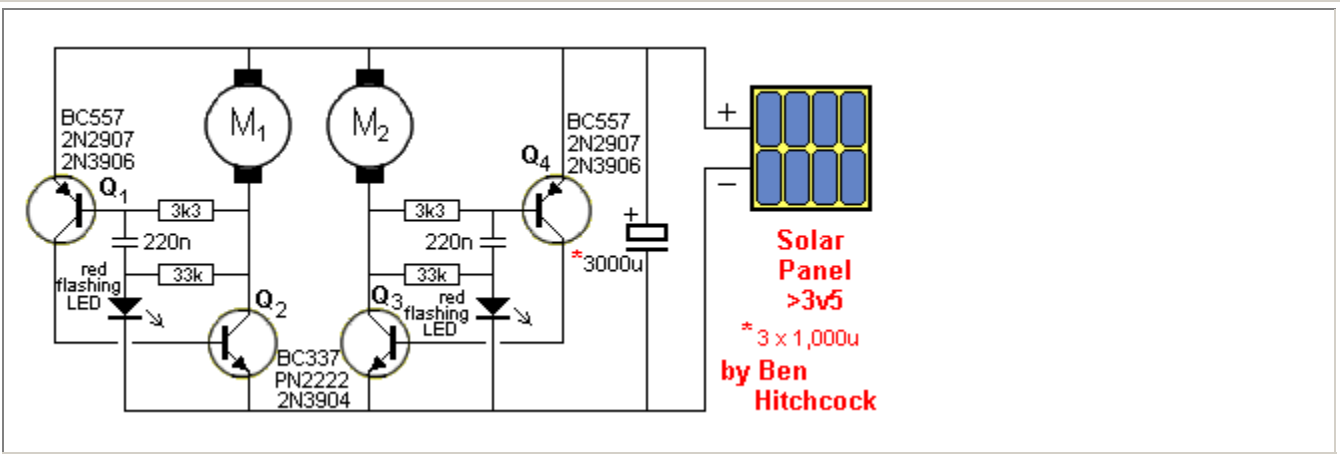


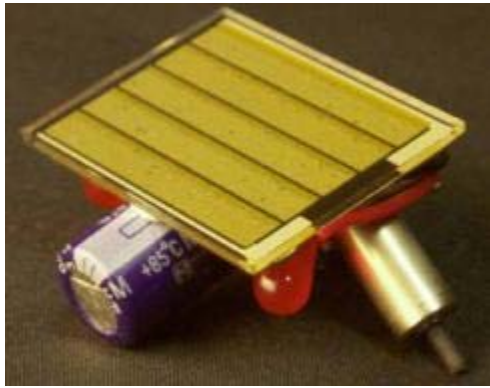
SOLAR PHOTOVORE

The green LEDs cause the Solar Engine on the opposite side to fire and the **Solar Photovore** turns toward the light source. The motors are two pager "vibe" motors with the weights removed. The 100k pot on the "head" balances the two Solar Engines. If you cannot get the circuit to work with green LEDs, use photo-transistors. For full details on how the circuit works and how to modify it, see:

<http://www.talkingelectronics.com/projects/Robots/Page4.html>

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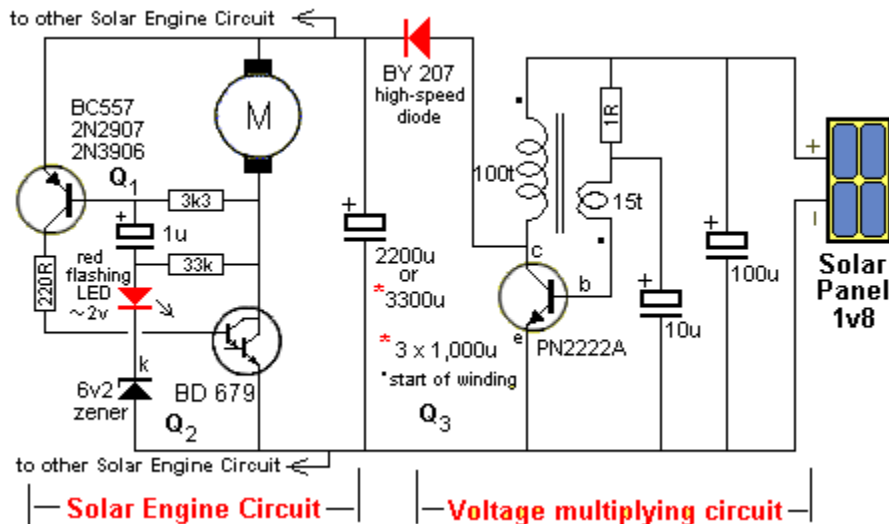
FRED Photopopper (Flashing LED)

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

For full details on how the circuit works and how to modify it, see:

<http://www.talkingelectronics.com/projects/Robots/Page6.html>

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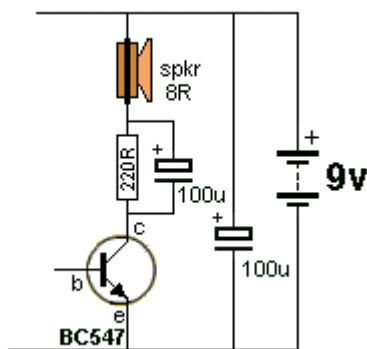
ROBO ROLLER

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

For full details on how the circuit works and how to modify it, see:

<http://www.talkingelectronics.com/projects/Robots/Page7.html>

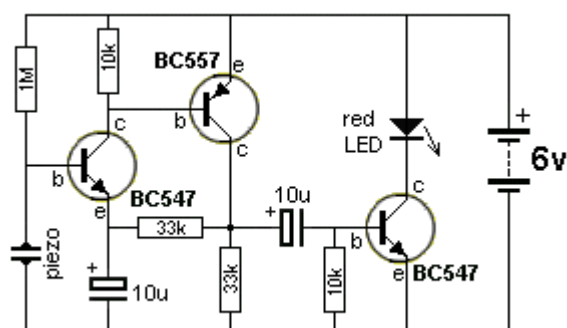
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SIGNAL BY-PASS

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

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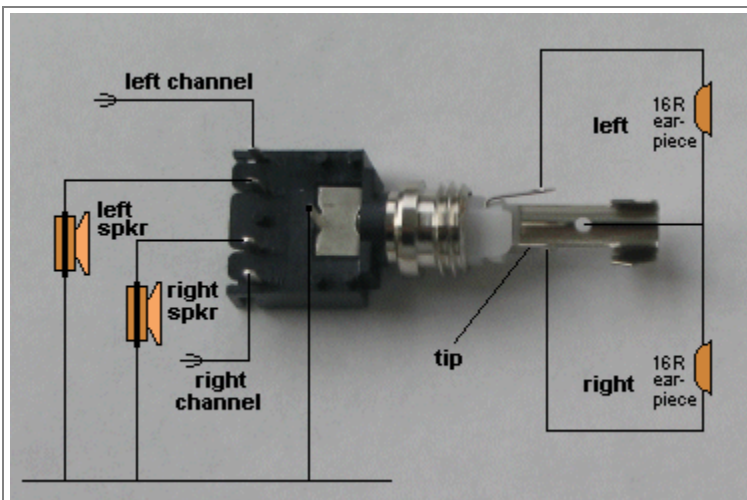


SOUND-TO-LIGHT

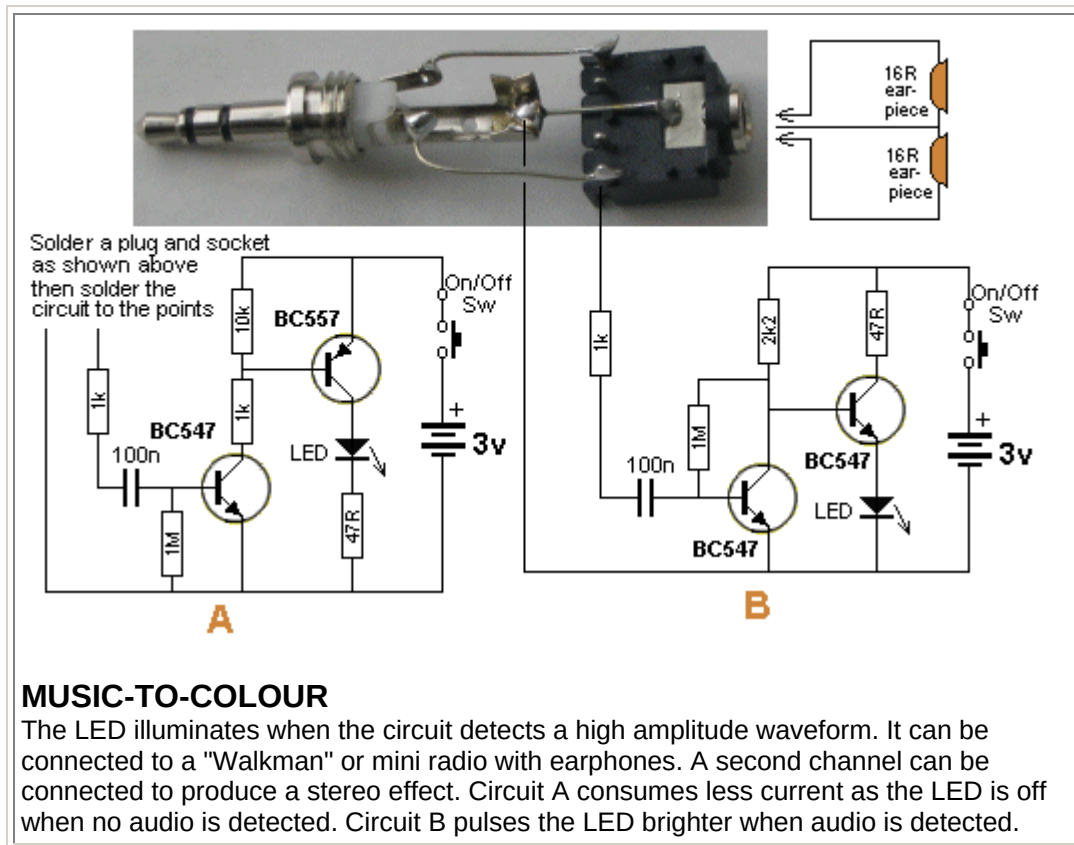
The LED illuminates when the piezo diaphragm detects sound.

Some piezo diaphragms are very sensitive and produce 100mV when whistling at 50cm. Others produce 1mV. You must test them with a CRO. The sensitivity of the diaphragm will determine the sensitivity of the circuit.

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



MUSIC-TO-COLOUR

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

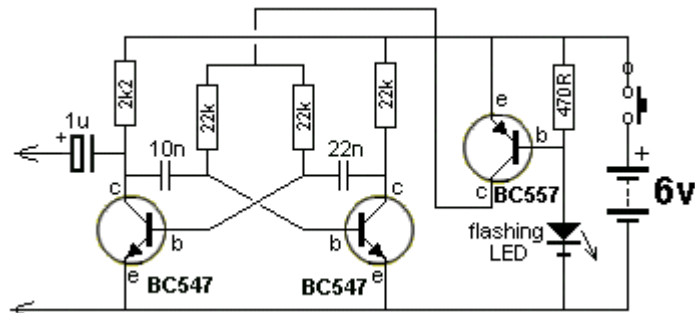
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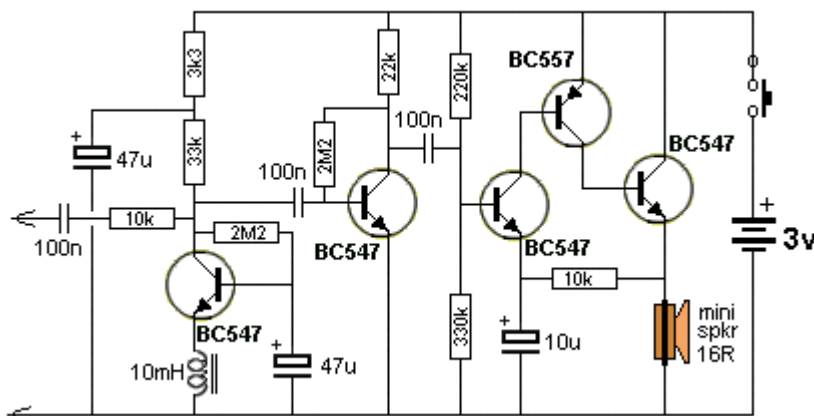
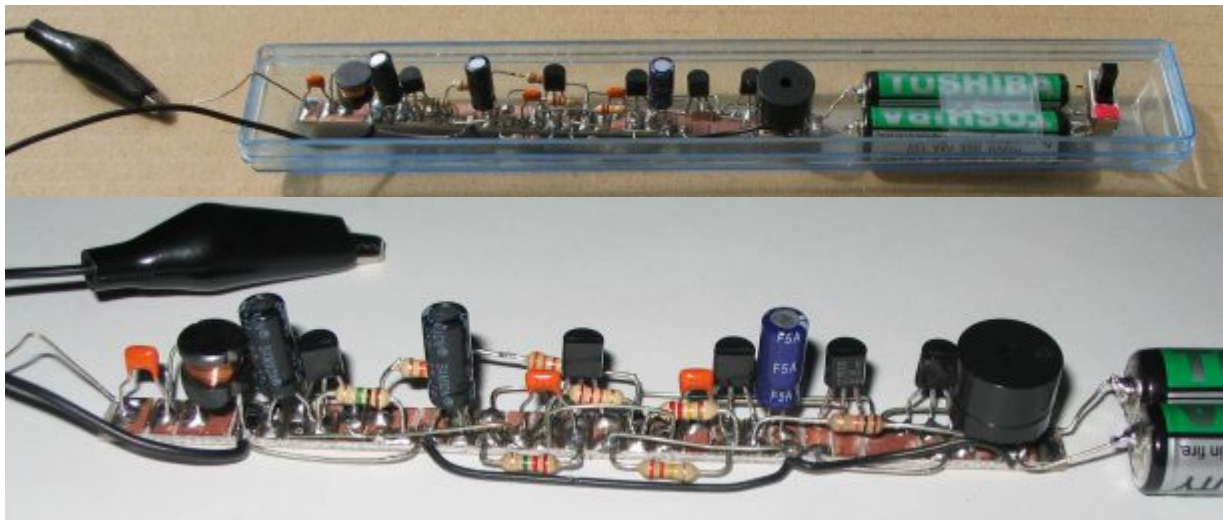


This is the professional unit

The transmitter is built on a small length of PC board, cut into lands with a file. The photo clearly shows how all the components are mounted and how the board is fitted into a toothbrush holder. The flashing LED shows the unit is ON and serves to control the beep-beep of the circuit.



TRANSMITTER CIRCUIT



RECEIVER CIRCUIT

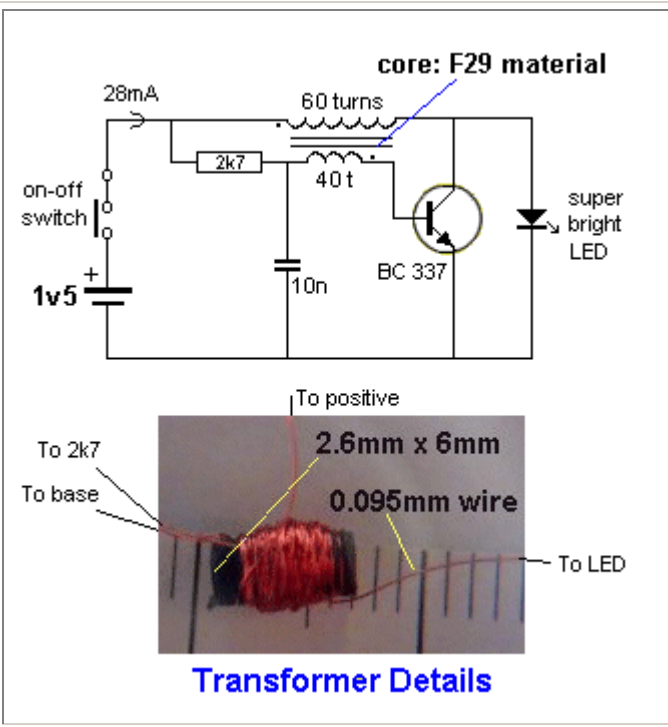
CABLE TRACER

The receiver circuit is a high-gain amplifier and produces constant background noise so the slightest magnetic field can be detected. The 10mH choke can be any value but the largest number of turns on the core is best. The mini speaker can be a 16R earpiece but these are not as loud as a mini speaker. Quiescent current is 50mA so the on-off switch can be a push-button.

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

Our cable tracer consists of two units. One unit has a multivibrator with an output of 4v p-p at approx 5kHz. This is called the transmitter. The other unit is a very sensitive amplifier with capacitive input for detecting the tone from the transmitter and a magnetic pickup for detecting magnetic lines of force from power cables carrying 240v. This is called the receiver. The circuit also has an inductive loop, made up of a length of wire, to pick up stray signals from power cables, so if one detector does not detect the signal, the other will. Our circuit is nothing like that in the professional unit shown above.

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LED TORCH with 1.5v SUPPLY

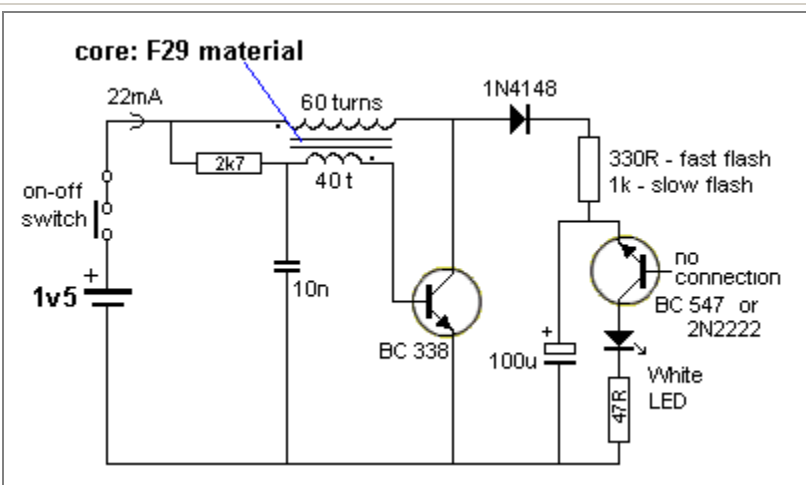
This simple circuit will illuminate a super-bright white LED to full brightness with 28mA from a 1.5v cell. The LED is 20,000mcd (20cd @ 15° viewing angle) and has an output of approx 1lumen.

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

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

BC 337 has a collector-emitter voltage of 45v. (BC338 has 25v collector-emitter voltage rating.) The voltage across the transistor is no more than 4v as the LED absorbs the spikes. Do not remove the LED as the spikes from the transformer will damage the transistor. The circuit will drive 1 or 2 while LEDs in series.

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WHITE LED FLASHER

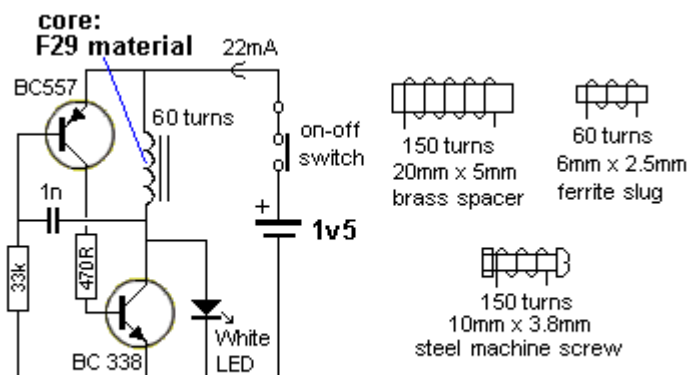
This circuit will flash a super-bright white LED from a 1.5v cell.

The transformer is wound on a small ferrite slug 2.6mm dia and 6mm long as shown in a project above.

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

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1v5 WHITE LED



DRIVER WHITE LED DRIVER

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

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

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

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

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



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

RESULTS for the same brightness:

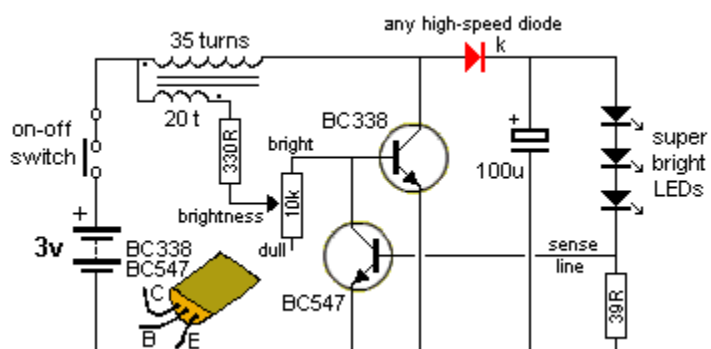
Slug: 21mA

Brass Spacer: 18mA

Machine screw: 14mA

Isn't this a SURPRISE!

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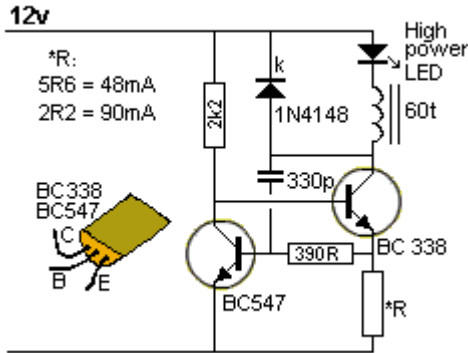
LED TORCH with ADJUSTABLE BRIGHTNESS

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

The transformer is wound on a ferrite slug 2.6mm dia and 6mm long as shown in the LED Torch with 1.5v Supply project.

This circuit is a "Boost Converter" meaning the supply is less than the voltage of the LEDs. If the supply is greater than the voltage across the LEDs, they will be damaged.

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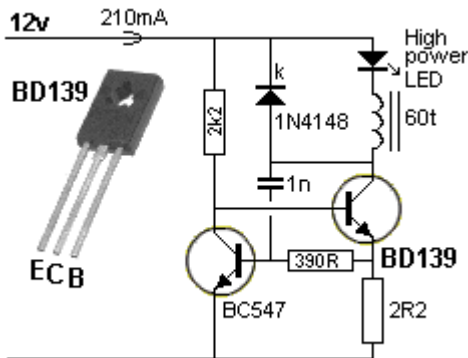


**Inductor: 60 turns
on 10mm ferrite
rod, 15mm long.**

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

This circuit is a "Buck Converter" meaning the supply is greater than the voltage of the LED. It will drive 1 high-power white LED from a 12v supply and is capable of delivering 48mA when $R = 5R6$ or 90mA when $R = 2R2$. The LED is much brighter when using this circuit, compared with a series resistor delivering the same current. But changing R from $5R6$ to $2R2$ does not double the brightness. It only increases it a small amount. The inductor consists of 60 turns of 0.25mm wire, on a 15mm length of ferrite rod, 10mm diameter. Frequency of operation: approx 1MHz. The circuit is not designed to drive one 20mA LED. This circuit draws the maximum for a BC 338.

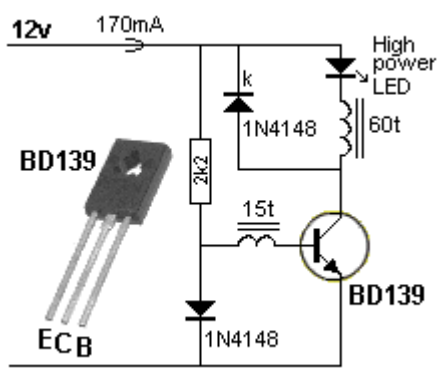
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BUCK CONVERTER for HIGH-POWER LED 210mA

This circuit will drive 1 high-power white LED from a 12v supply and is capable of delivering 210mA. The driver transistor is BD 139 and the details of the inductor are shown above. The voltage across the LED is approx 3.3v - 3.5v. The driver transistor will need a small heatsink. The $2R2$ can be increased if a lower drive-current is required.

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BUCK CONVERTER for HIGH-POWER LED 170mA

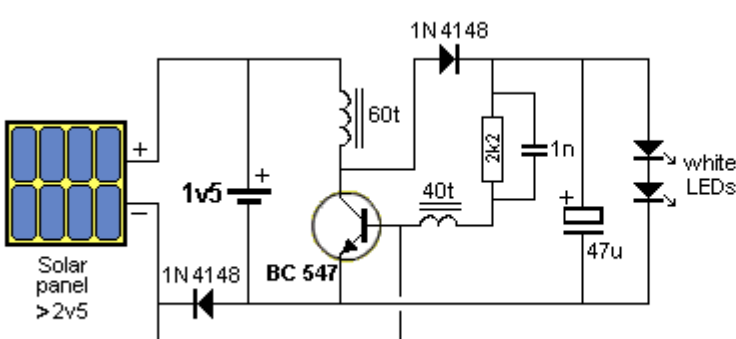
This circuit is slightly simpler than above but it does not have the feature of being able to adjust the drive-current.

The inductor is the same as the photo above but has a feedback winding of 15 turns.

Connect the circuit via a 220R resistor and if the LED does not illuminate, reverse the feedback winding.

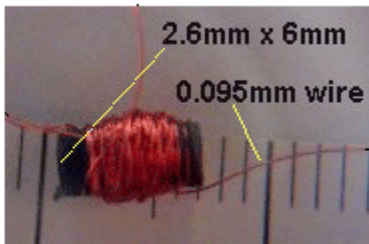
The driver transistor will need a small heatsink.

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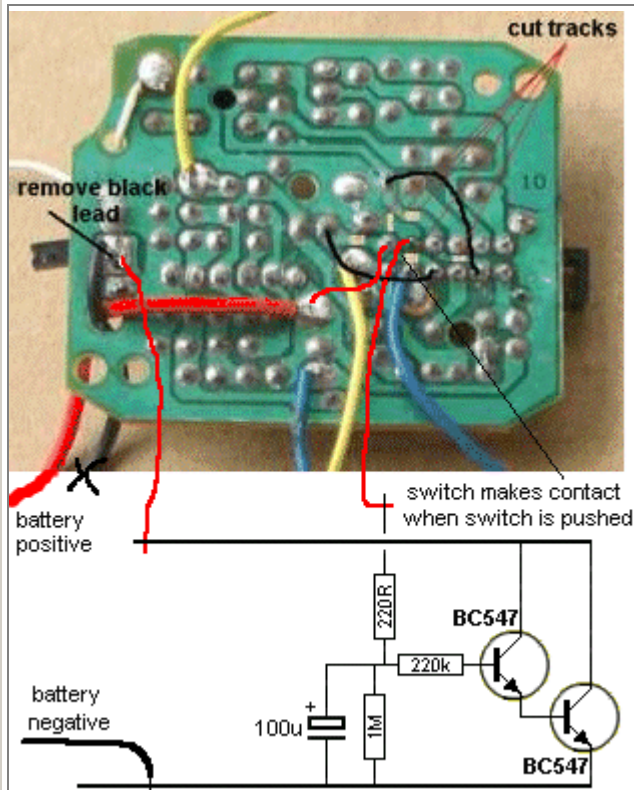
AUTOMATIC GARDEN LIGHT

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



Transformer Details
core: F29 material

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27MHz DOOR PHONE

This circuit turns a walkie talkie into a handy wireless door phone. It saves wiring and the receiver can be taken with you upstairs or outside, without losing a call from a visitor. A 5-Transistor walkie talkie can be used (see [circuit](#) above) and the modifications made to the transmitter and receiver are shown below:

THE TRANSMITTER

Only three sections of the transmit/ receive switch are used in the walkie talkie circuit and our modification uses the fourth section. Cut the tracks to the lands of the unused section so it can be used for our circuit.

There are a number of different printed circuit boards on the market, all using the same circuit and some will be physically different to that shown in the photo. But one of the sections of the switch will be unused. Build the 2-transistor delay circuit and connect it to the walkie talkie board as shown. When the "push-to-talk" switch is pressed, the PC board will be activated as the delay circuit effectively connects the negative lead of the battery to the negative rail of the board for about 30 seconds.

The 100uF gradually discharges via the 1M after the "press-to-talk" switch is released and the two transistors turn off and the current drops to less than 1 micro-amp - that's why the power switch can be left on. .

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

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

THE RECEIVER

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

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



A Schmitt Trigger is any circuit that has a fast change-over from one state to the other. In our case we have used 2 transistors to produce this effect and the third is an emitter-follower buffer. The circuit will drive a LED or relay and the purpose is to turn the LED ON quickly at a particular level of illumination and OFF at a higher level. The gap between ON and OFF is called the HYSTERESIS GAP.

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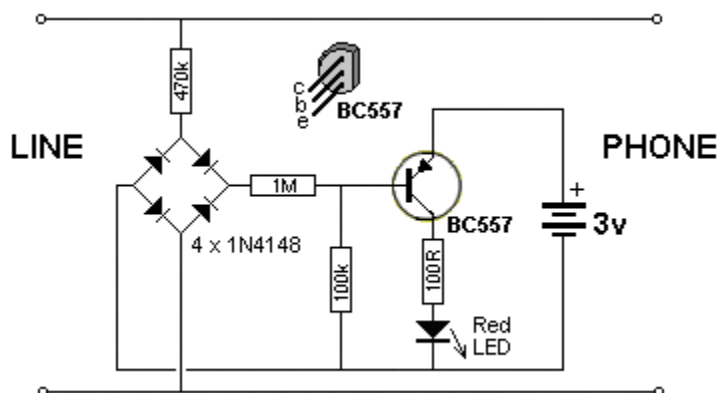
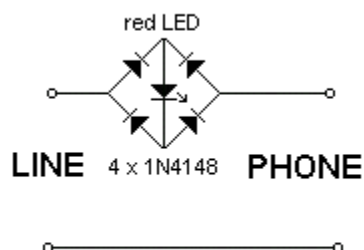


Fit two 100n capacitors to the ends of the winding for the audio. Plug the Audio into "Mic" on tape recorder. Plug the remote into "remote" on the tape recorder and push "record." The tape recorder will turn on when the phone is lifted and record the conversation.



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

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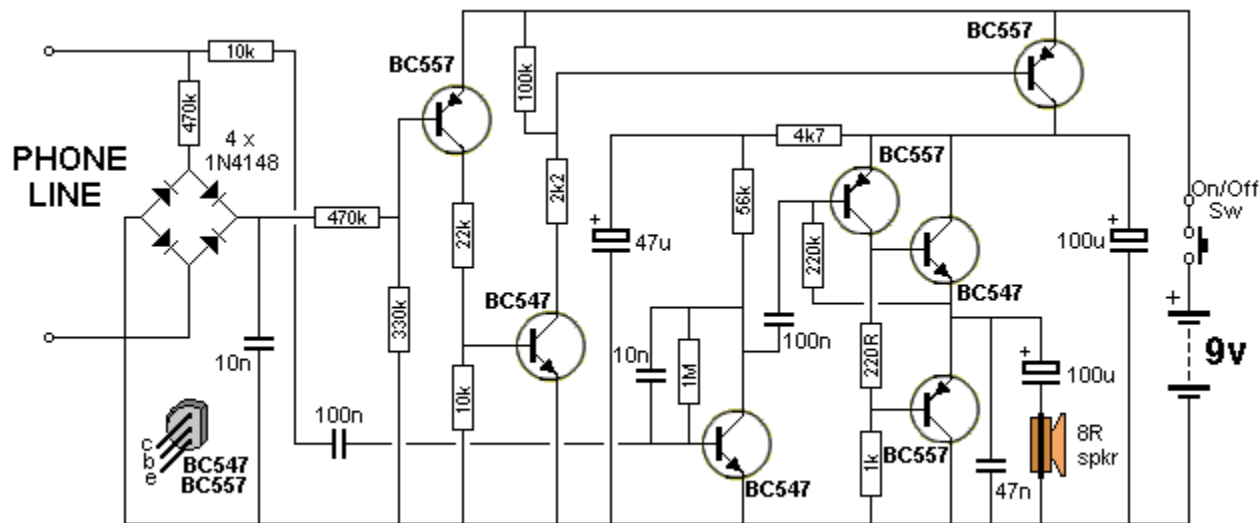


PHONE ALERT

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

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

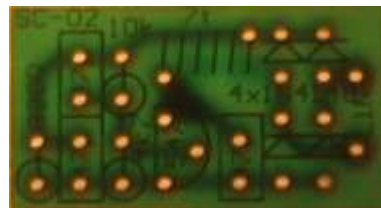
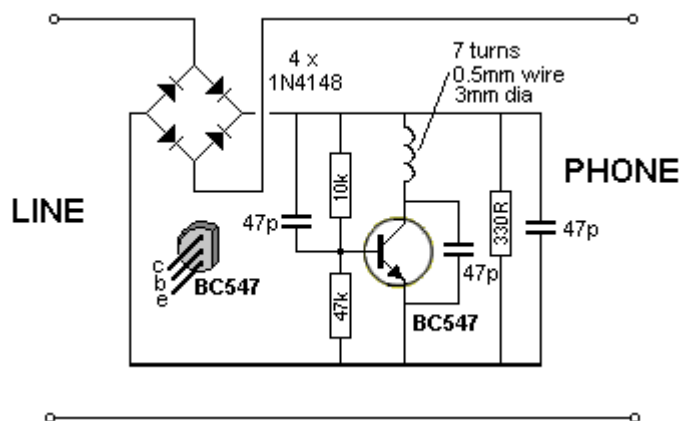
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THE LISTENER

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

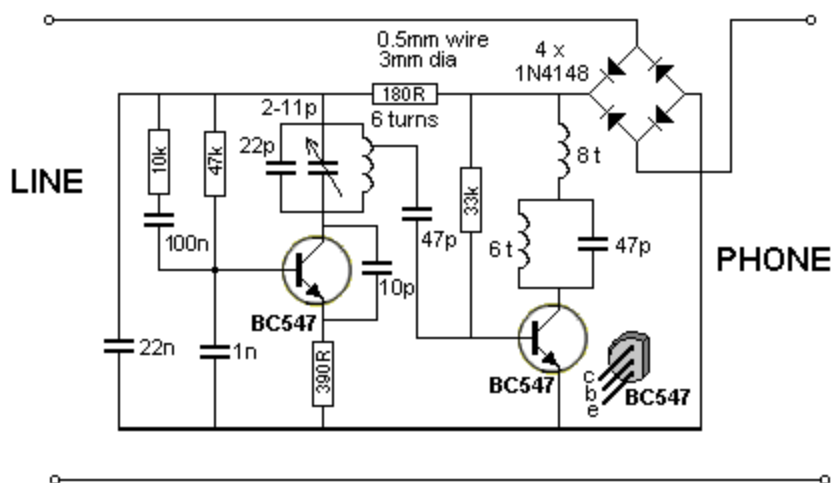
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PHONE TRANSMITTER - 1

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

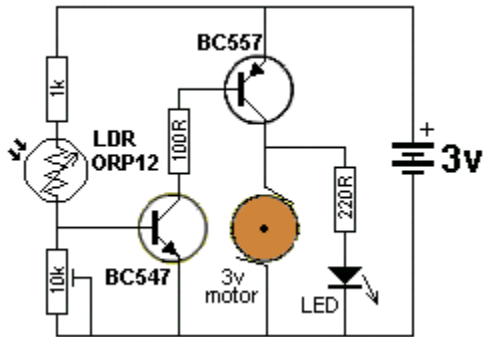
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PHONE TRANSMITTER - 2

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

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ROBOT-1

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

BIPOLAR TRANSISTORS

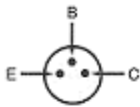
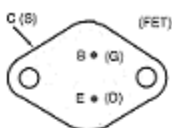
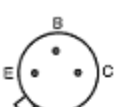
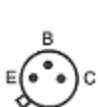
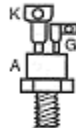
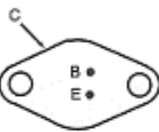
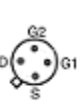
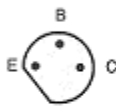
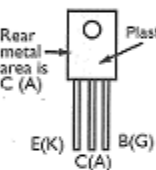
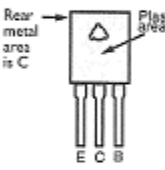
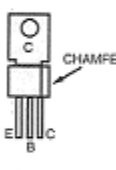
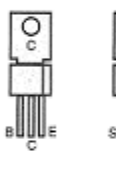
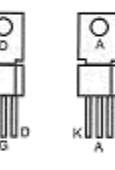
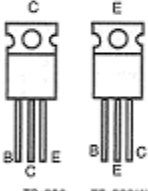
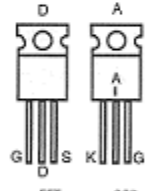
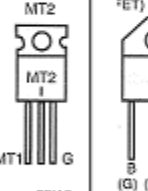
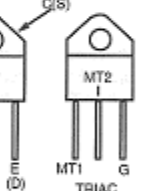
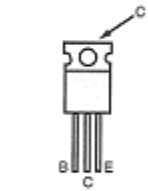
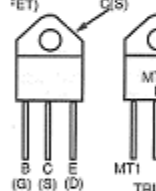
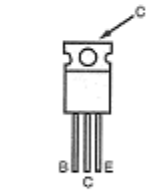
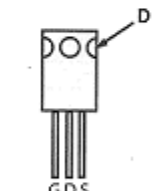
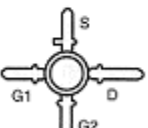
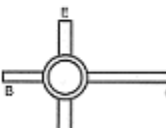
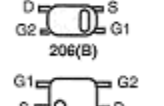
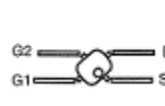
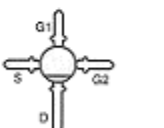
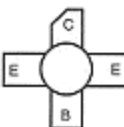
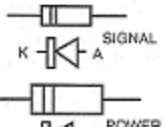
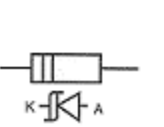
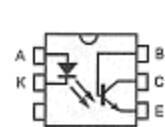
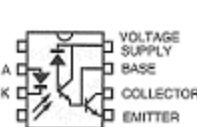
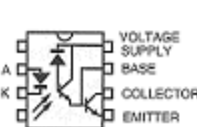
Some small signal transistors may have a TO-92 case and a "PN" prefix. The electrical specifications are the same, only the case is changed.

Type	CASE	V _{CE}	V _{CB}	I _C	V _{CEC}	@ I _C	h _{FE}	@ I _C	FT	@ I _C	P _{TOT}	USE	COMPARABLE TYPES
	Polarity	mA				mA		mA	MHz	mA	mW		
BC107	TO-18 NS	45	50	100	0.2	10	110-450	2	300	10	300	G.P. S.S. amp.	BC 207, BC147, BC182
BC108	TO-18 NS	20	30	100	0.2	10	110-800	2	300	10	300	G.P. S.S. amp.	BC 208, BC148, BC13
BC109	TO-18 NS	20	30	100	0.25	10	200-800	2	300	10	300	Low noise S.S. amp	BC 209, BC149, BC184
BC109C	TO-18 NS	20	30	100	0.25	10	420-800	2	300	10	300	Low noise high gain	BC209C BC149C
BC177	TO-18 PS	45	50	100	0.3	10	75-260	2	150	10	300	G.P. S.S. amp.	BC 157, BC307, BC212
BC178	TO-18 PS	25	30	100	0.3	10	75-500	2	150	10	300	G.P. S.S. amp.	BC158, BC308, BC213
BC179	TO-18 PS	20	25	100	0.3	10	125-500	2	150	10	300	G.P. S.S. amp.	BC 159, BC309, BC214
BC327	TO-92VAR1 PS	45	50	500	0.7	500	100-600	100	100	10	625	Output	2N3638
BC328	TO-92VAR1 PS	25	30	500	0.7	500	100-600	100	100	10	625	Output	BC 327
BC337	TO-92VAR1 NS	45	50	500	0.7	500	100-600	100	100	10	625	Output	2N3642
BC338	TO-92VAR1 NS	25	30	500	0.7	500	100-600	100	100	10	625	Output	BC337
BC546	TO-92VAR1 NS	65	80	100	0.6	100	110-450	2	300	10	500	G.P. S.S. amp.	
BC547	TO-92VAR1 NS	45	50	100	0.6	100	110-800	2	300	10	500	G.P. S.S. amp.	BC 107, BC207, BC147
BC548	TO-92VAR1 NS	30	30		0.6	100	110-800	2	300	10	500	G.P. S.S. amp.	BC 108, BC208, BC148
BC549	TO-92VAR1 NS	30	30	100	0.6	100	200-800	2	300	10	500	Low noise S.S. amp.	BC 109, BC209, BC149
BC549C	TO-92VAR1 NS	30	30	100	0.6	100	420-800	2	300	10	500	Low noise high gain	BC 109C, BC149C
BC556	TO-92VAR1 PS	65	80	100	0.65	100	75-475	2	200	10	500	G.P. S.S. amp.	
BC557	TO-92VAR1 PS	45	50	100	0.65	100	75-800	2	200	10	500	G.P. S.S. amp.	BC157
BC558	TO-92VAR1 PS	30	30	100	0.65	100	75-800	2	200	10	500	G.P. S.S. amp.	BC158
BC559	TO-92VAR1 PS	30	30	100	0.65	100	125-800	2	200	10	500	G.P. S.S. amp.	BC159
BC639	TO-92(74) NS	80	100	1A	0.5	500	40-250	150	130		1V	Audio O/P	MU9610, TT801
BC640	TO-92(74) PS	80	100	1A	0.5	500	40-250	150	50		1V	Audio O/P	MU9660, TT800
BD139	TO-126 NS	80	10	1.5A	0.5	500	40-250	150	250	50	8V	G.P. O/P	40409
BD140	TO-126 PS	80	10	1.5A	0.5	500	40-250	150	75	50	8V	G.P. O/P	40410
BD262	TO-126 PS	60	60	4A	2.5	1.5A	750	1.5A	7	1.5A	36V	High gain Darl. O/P	BD 266
BD263	TO-126 NS	60	80	4A	2.5	1.5A	750	1.5A	7	1.5A	36V	High gain Darl. O/P	BD 267
BD266A	TO-220 PS	80	80	8A	2	3A	750	3A	7		60V	High gain Darl. O/P	
BD267A	TO-220 NS	80	10	8A	2	3A	750	3A	7		60V	High gain Darl. O/P	
BD681	TO-126 NS	100	10	4A	2.5	1.5A	750	1.5A	1		40V	Darlington O/P	BD 263
BD682	TO-126 PS	100	100	4A	2.5	1.5A	750	1.5A	1		40V	Darlington O/P	BD 262
BF173	TO-72(28) NS	25	40	25			40-100	7	550	5	230	T.V. I.F. amp.	
BF199	TO-92VAR2 NS	25	40	25			37	7	550		500	H.F. amp.	BF180
BF463	TO-202 PS	250	25	500			40-180	30	20		2V	H.V. med. power.	
BF469	TO-126 NS	250	25	50			50	25	60	10	1.8V	G.P. high-V. amp.	
BF470	TO-126 PS	250	25	50			50	25	60	10	1.8V	G.P. high-V. amp.	
BFR90	SOT-37(2) NS	15	20	25			25-250	14	5GHz	14	180	Wideband amp..	
BFR91	SOT-37(2) NS	12	15	35	0.3	30	25-250	30	5GHz	30	180	Wideband amp.	
BFY90	TO-72(25) NS	15	30	25			25-125	2	1GHz	2	200	Wideband amp.	
BUX80	TO-3 NS	400	80	10A	1.5	5A	30	1.2A	8		100V	Def'n, high current	
MJ802	TO-3 NS	90	10	30A	0.8	7.5A	25-100	7.5A	2	1A	200V	High power output	
MJ2955	TO-3 PS	60	70	15A	1.1	4A	20-70	4A	2.5	500	115V	G.P. power	
MJ4502	TO-3 PS	90	10	30A	0.8	7.5A	25-100	7.5A	2	1A	200V	High power output	
MJ10012	TO-3 NS	400	60	10A	2	6A	100-2K	6A			175V	Power Darlington	
MJ15003	TO-3 NS	140	14	20A	1	5A	25-150	5A	2	500	250V	High power output	
MJ15004	TO-3 PS	140	140	20A	1	5A	25-150	5A	2	500	250V	High power output	
MJE 340	TO-126 NS	300		500	0.75	100	30-240	50			20V	G.P. H.V. power	

Type	CASE	Polarity	V _{CE} mA	V _{CE}	I _C	V _{CEC}	@ I _C	h _{FE}	@ I _C	FT	@ I _C	P _{TO T} mW	USE	COMPARABLE TYPES
MJE350T	TO-126	PS	300		500	0.77	100	30-240	50			20W	G.P. H.V. power	
MJE2955	TO-220	PS	60	70	10A	1.1	4A	20-100	4A	2	500	79W	G.P. power	TIP 2955
MJE3055T	TO-220	NS	60	70	10A	1.1	4A	20-100	4A	2	500	79W	G.P. power	TIP 3055
MPSA14	TO-92(72)	NS	30	30	500	1.5	100	20000	100	125	10	625	G.P. Darlington	
MPSA65	TO-92(72)	PS	30	30	500	1.5	100	20000	100	100	10	625	G.P. Darlington	
MRF629	TO-39A	NS	16	36	400			20-200	100			9W	UHF power	
MRF660	TO-220A	NS	16	36	2.4A			20-160	250			29W	UHF power	
PN100	TO-92(72)	NS	35	60	500	0.5	100	60-240	150	350	50	600	G.P. amp/switch	PN2222, 2N3643
PN2907	TO-92(72)	PS	40	60	600	0.4	150	100-300	150	200	50	625	High S. switch	
PN200	TO-92(72)	PS	35	60	500	0.5	150	50-400	150	200	50	600	G.P. amp/switch	2N3638, BC214
TIP31B	TOP-66	NS	80	80	3A	1.2	3A	25	1A	3	500	40W	Power output	
TIP32B	TOP-66	PS	80	80	3A	1.2	3A	25	1A	3	500	40W	Power output	
TIP142	TOP-3	NS	100	100	10A	2	5A	>1000	5A			125W	Audio output	TIP140, TIP141
TIP147	TOP-3	PS	100	100	10A	2	5A	>1000	5A			125W	Audio output	TIP145, TIP146
TIP2955	TOP-3	PS	70	100	15A	1.1	4A	20	4A	3	500	90W	Power output	MJE2955
TIP3055	TOP-3	NS	70	100	15A	1.1	4A	20	4A	3	500	90W	Power output	MJE3055
2N2222A	TO-18	NS	40	75	800	1.6	500	00-300	150	300	20	500	High S. switch	
2N3019	TO-39	NS	80	140	1A	0.5	500	50-100	500	100	50	800	H.F. amp	
2N3053	TO-39	NS	40	60	700	1.4	150	50-250	150	100	50	2.86W	G.R. switch	BD137
2N3054	TO-66	NS	60	90	4A	0.1	200	25-100	500	0.8	200	29W	Audio outout	TIP31B
2N3055	TO-3	NS	60	70	15A	1.1	4A	20-70	4A	2.5	500	115W	G.P. power	BDY20
2N3563	TO-106	NS	15	30	50			0-200	8	600	8	200	RF-IF amp	BF173
2N3564	TO-106	NS	15	30	100	0.3	20	20-500	15	400	15	200	RF-IF amp	BF167
2N3565	TO-106	NS	25	30	50	0.35	1	150-600	1	400	1	200	Lowlevel amp	BC108, BC208
2N3566	TO-105	NS	30	40	200	1	100	50-600	10	40	30	300	G.R. amp & switch	BC183
2N3567	TO-105	NS	40	80	500	0.25	150	40-120	150	60	50	300	G.P. amp & switch	BC337
2N3568	TO-105	NS	60	80	500	0.25	150	40-120	150	60	50	300	G.P. amp & switch	
2N3569	TO-105	NS	40	80	500	0.25	150	00-300	150	60	50	300	G.P. amp & switch	
2N3638A	TO-105	PS	25	25	500	0.25	50	100	50	150	50	300	G.P. amp & switch	BC328
2N3641	TO-105	NS	30	60	500	0.22	150	40-120		250	50	350	G.P. amp & switch	BC337
2N3642	TO-105	NS	45	60	500	0.22	150	40-120		250	50	350	G.R. amp & switch	BC337
2N3643	TO-105	NS	30	60	500	0.22	150	100-300	150	250	50	350	G.P. amp & switch	BC337
2N3644	TO-105	PS	45	45	500	1	300	100-300	150	200	20	300	G.P. amp & switch	BC327
2N3645	TO-105	PS	60	60	500	1	300	100-300	150	200	20	300	G.P. amp & switch	
2N3771	TO-3	NS	40	50	30A	2	15A	15-60	15A	0.2	1A	150W	Power output	
2N3866	TO-39	NS	30	55	400			0-200	50	500	50	1W	VHF amp	
2N3904	TO-92(72)	NS	40	60	200	0.2	10	00-300	10	300	10	310	Lowlevel amp	BC167A, BF194
2N3905	TO-92(72)	PS	40	40	200	0.4	50	50-200	10	200	20	310	G.P. amp & switch	
2N3948	TO-39	NS	20	36	400			15	50	700	50	1W	VHF amp	
2N4030	TO-39	PS	60	60	1A	0.5	500	25	500	260	100	800	G.P. amp & switch	
2N4250	TO-106	PS	40	40	100	0.25	10	50-700	0.1	50		200	Lowlevel amp	BC559
2N4258	TO-106	PS	12	12	50	0.5	50	30-120	10	700	10	200	Saturated switch	
2N4427	TO-39	NS	20	40	400	0.4	100	10-200	100	500	50	1W	VHF/UHF driver	2N3866
2N5401	TO-92(72)	PS	150	160	6000	0.5	50	60-250	10	100	10	625	H.V. switch	MP SL51
2N6557	TO-202	NS	250	250	500			> 40	50	45		2W	H.V. med power	
2SC710	TO-92/76	NS	25	30	30			90		100		200	G.P. RF amp	BFS18
2SC1306	TOP-66	NS	65	65	3A			0-200	500	300		12W	H.F. output	2SC2166
2SC1307	TOP-66	NS	70	70	8A			0-150	2A	150		29W	H.F. output	2SC1969
2SC1674	TO-92(74)	NS	20	30	20	0.3	10	40-180	1	600	1	250	VHP amp	
2SC1969	TOP-66	NS	30	60	6A			0-180	10	150		20W	H.F. output	2SC1307
2SC2166	TOP-66	NS	75	75	4A			5-180	100					
2SC2694	T40	NS	17	35	20A			0-180	1A	800		140W	VHF output	MRF247
2SC3355	TO-92(74)	NS	12	20	100			0-300	20	6.5GHz	20	600	UHFSS	MRF573
2SC3358	MX	NS	12	20	100			0-300	20	7 GHz	20	250	UHFSS	MRF573

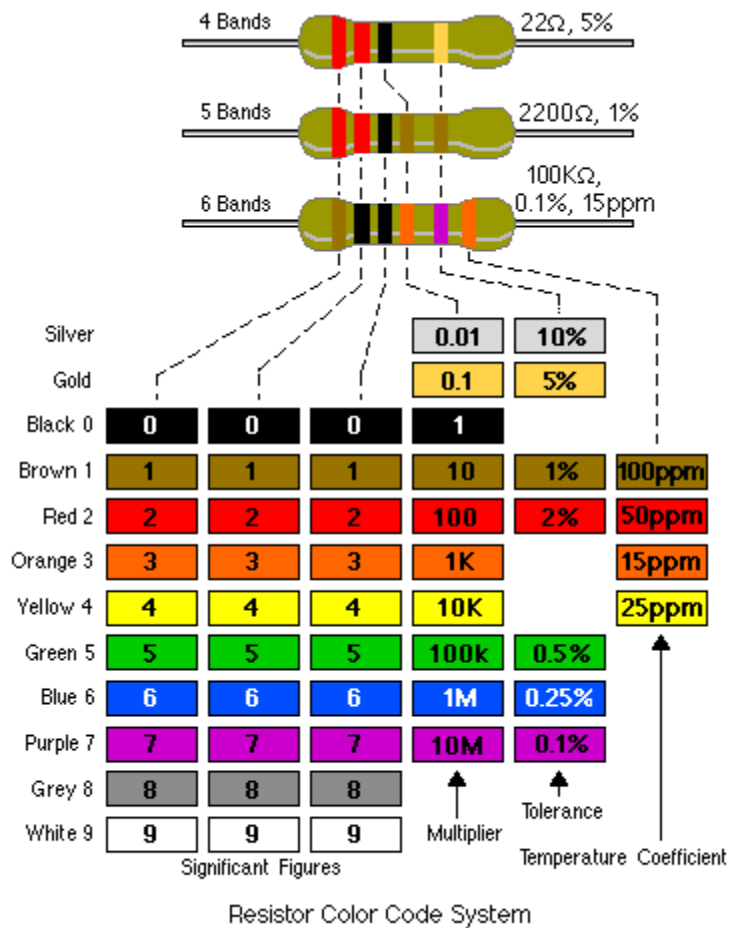
SEMICONDUCTOR OUTLINES

BOTTOM VIEW UNLESS OTHERWISE STATED

SEMICONDUCTOR OUTLINES						BOTTOM VIEW UNLESS OTHERWISE STATED																							
 TO-1	 TO-3	 TO-5	 TO-18	 TO-39	 79-03 TO-39(A)	 TO-39(mod)																							
 TO-48 SIDE VIEW	 TO-66	<table border="1"><thead><tr><th></th><th>PIN</th><th>T(25)</th><th>T(28)</th><th>FET N(25)</th></tr></thead><tbody><tr><td>TO-72</td><td>1 2 3 4</td><td>E B C CASE</td><td>B C B CASE</td><td>S D G CASE</td></tr></tbody></table> TO-72			PIN	T(25)	T(28)	FET N(25)	TO-72	1 2 3 4	E B C CASE	B C B CASE	S D G CASE	 TO-72(2)	<table border="1"><thead><tr><th></th><th>PIN</th><th>71</th><th>72 (SOT)</th><th>74</th><th>76</th><th>77</th></tr></thead><tbody><tr><td>TO-92</td><td>1 2 3</td><td>C B C</td><td>C B C</td><td>B C B</td><td>B C B</td><td>C B C</td></tr></tbody></table> TO-92 VAR.1 TO-92 VAR.2 TO-92 SCR TO-92 A SCR		PIN	71	72 (SOT)	74	76	77	TO-92	1 2 3	C B C	C B C	B C B	B C B	C B C
	PIN	T(25)	T(28)	FET N(25)																									
TO-72	1 2 3 4	E B C CASE	B C B CASE	S D G CASE																									
	PIN	71	72 (SOT)	74	76	77																							
TO-92	1 2 3	C B C	C B C	B C B	B C B	C B C																							
 TO-105	 TO-106	 TO-126 FRONT VIEW		 TO-127 FRONT VIEW																									
 TO-202		 TO-202R		 TO-202FET		 TO-202SCR																							
 TO-220 FRONT VIEW		 TO-220(A)		 FET		 SCR																							
 TRIAC		 TO-3 FRONT VIEW		 TO-66 FRONT VIEW		 TO-247 FRONT VIEW																							
 SOT-30																													
 SOT-37(2) TOP VIEW		 SOT-103 TOP VIEW		 MX TOP VIEW		 206 TOP VIEW																							
 262 TOP VIEW		 2-6F1A TOP VIEW																											
 MT-72C FRONT VIEW		 T-40 TOP VIEW		 DIODES		 ZENER DIODES																							
 D6 TOP VIEW		 D8 TOP VIEW		 VOLTAGE SUPPLY BASE COLLECTOR EMITTER																									

All the resistor colours:

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



See [101-200 Circuits](#) for resistors in parallel and series and capacitors in parallel and series. You can make ANY VALUE by simply connecting resistors in parallel or series. And the same with capacitors.

20-7-2010

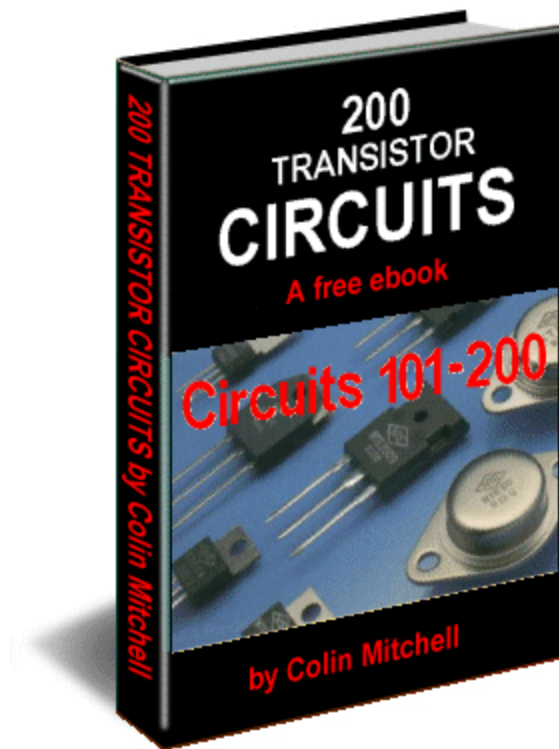
200 TRANSISTOR CIRCUITS

A free ebook

Circuits 101-200

by Colin Mitchell

200 TRANSISTOR CIRCUITS by Colin Mitchell



Go to: [1 - 100 Transistor Circuits](#)

61 CIRCUITS as of 4-8-2010

Talking Electronics

See [TALKING ELECTRONICS](#) WEBSITE

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 twofold.

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 to 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.

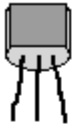
In most other cases, the layout is not critical.

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.

You can use almost any type of transistor to replace them and here is a list of the equivalents and pinouts:

NPN



c b e
BC 547
BC 337/8

PNP



c b e
BC 557
BC 327/8

NPN

TO-126



BD 139
BD 679 (darlington)

NPN



e b c
2N 3904
2N 2222

PNP



e b c
2N 3906

PNP

TO-126



BD 140

NPN



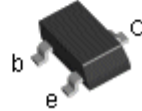
e c b
BC 639

PNP



e c b
BC 640

SOT23

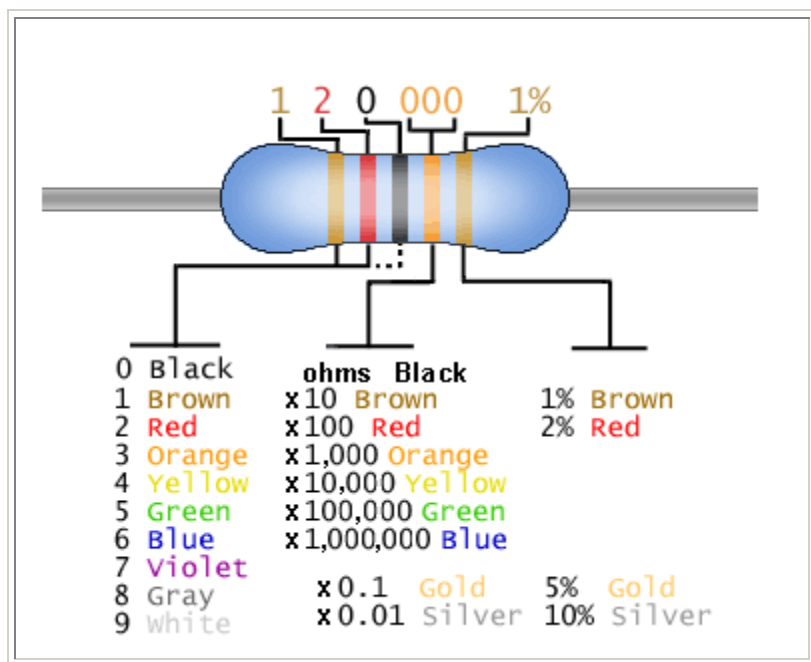


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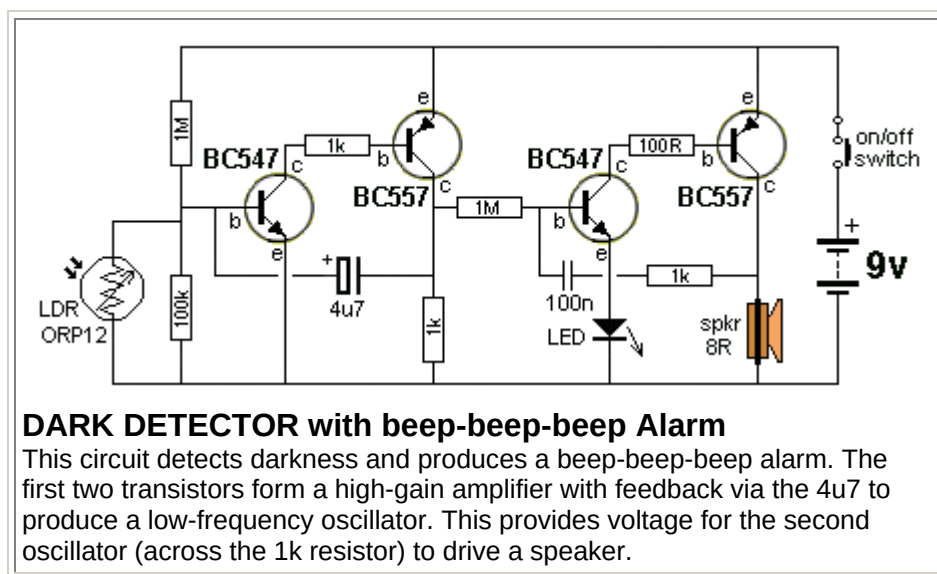
[Adjustable High Current Power Supply](#)
[Alarm Using 4 buttons](#)
[Audio Amplifier \(mini\)](#)
[Battery Monitor Mkl](#)
[Battery Monitor MkII](#)
[Bike Turning Signal](#)
[Beacon](#) (Warning Beacon 12v)
[Beeper Bug](#)
[Blocking Oscillator](#)
[Book Light](#)
[Buck Regulator](#) 12v to 5v
[Camera Activator](#)
[Capacitor Discharge Unit MkII](#) (CDU2) Trains
[Car Detector](#) (loop Detector)
[Charger](#) - NiCd
[Circuit Symbols](#) Complete list of Symbols
[Clap Switch](#)
[Code Lock](#)
[Colour Code for Resistors](#) - all resistors
[Constant Current](#)
[Crystal Tester](#)
[Dark Detector with beep Alarm](#)
[Decaying Flasher](#)
[Driving a LED](#)
[Fading LED](#)
[Flasher \(simple\)](#)
[Flashing Beacon](#) (12v Warning Beacon)
[Hex Bug](#)
[H-Bridge](#)
[High Current Power Supply](#)
[Increasing the output current](#)
[Inductively Coupled Power Supply](#)
[Intercom](#)
[Latching A Push Button](#)
[Latching Relay](#)
[LED Detects light](#)
[LEDs Show Relay State](#)
[Limit Switches](#)
[Low fuel Indicator](#)
[Low Voltage cut-out](#)
[Low Voltage Flasher](#)
[Mains Night Light](#)
[Make any resistor value](#)
[Make any capacitor value](#)

[Model Railway time](#)
[NiCd Charger](#)
[Phase-Shift Oscillator](#) - good design
[Phone Bug](#)
[Phone Tape-3](#)
[Powering a LED](#)
[Power ON](#)
[Power Supplies - Fixed](#)
[Power Supplies - Adjustable](#) LMxx series
[Power Supplies - Adjustable](#) 78xx series
[Power Supplies - Adjustable from 0v](#)
[Power Supply - Inductively Coupled](#)
[PWM Controller](#)
[Quiz Timer](#)
[Railway time](#)
[Random Blinking LEDs](#)
[Resistor Colour Code](#)
[Resistor Colour Code](#) - 4, 5 and 6 Bands
[Reversing a Motor](#) & [2](#) & [3](#)
[Sequencer](#)
[Shake Tic Tac LED Torch](#)
[Simple Flasher](#)
[Simple Touch-ON Touch-OFF Switch](#)
[Siren](#)
[Soft Start power supply](#)
[Telephone Bug](#)
[Touch-ON Touch-OFF Switch](#)
[Tracking Transmitter](#)
[Track Polarity](#) - model railway
[Train Detectors](#)
[Transformerless Power Supply](#)
[Vehicle Detector](#) loop Detector
[Voltage Doubler](#)
[Voltage Multipliers](#)
[Wailing Siren](#)
[Xtal Tester](#)
[1-watt LED](#)
[1.5 watt LED](#)
[3-Phase Generator](#)
[5v from old cells](#) - circuit 1
[5v from old cells](#) - circuit 2
[12v Flashing Beacon](#) (Warning Beacon)
[20 LEDs on 12v supply](#)

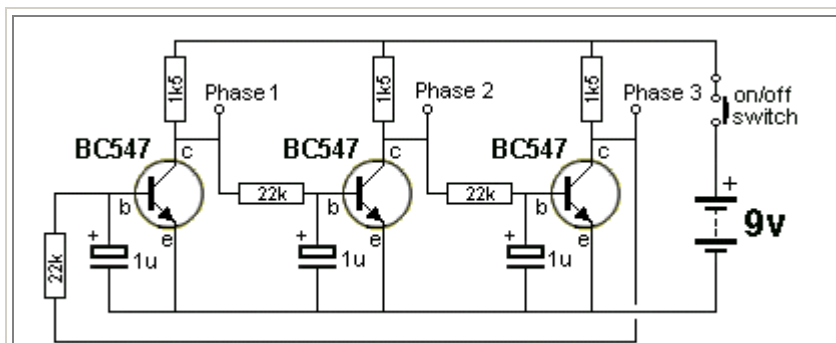
RESISTOR COLOUR CODE



See [resistors from 0.22ohm to 22M](#) in full colour at end of book and another [resistor table](#)



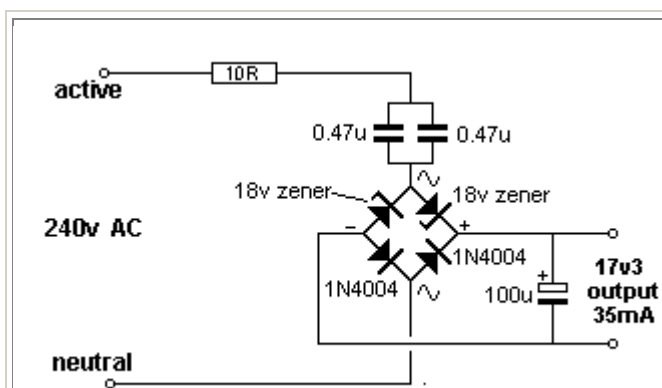
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3-PHASE SINEWAVE GENERATOR

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.

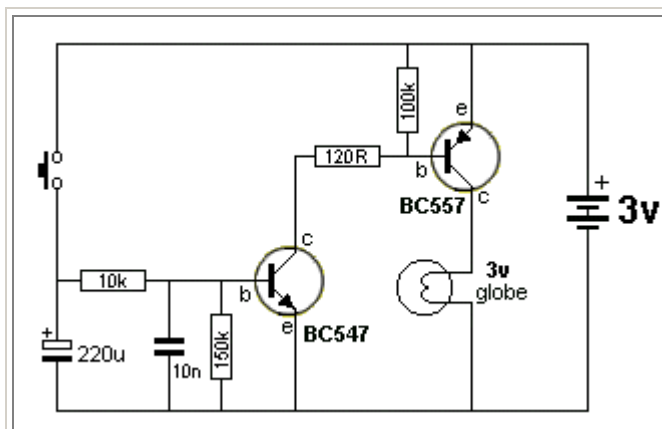
When the incoming voltage is positive at the top, the left zener provides 18v limit (and the left power-diode produces a drop of

0.6v). This allows the right zener to pass current just like a normal diode but the voltage available to it is just 18v. The output of the right zener is 17v4. The same with the other half-cycle.

The current is limited by the value of the X2 capacitor and this is 7mA for each 100n when in full-wave (as per this circuit). We have $10 \times 100n = 1u$ capacitance. Theoretically the circuit will supply 70mA but we found it will only deliver 35mA before the output drops. The capacitor 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.

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BOOK LIGHT

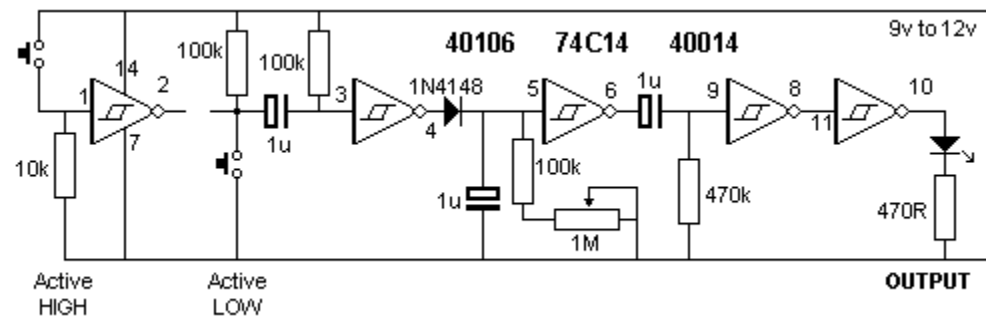
This circuit keeps the globe illuminated for a few seconds after the switch is pressed.

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

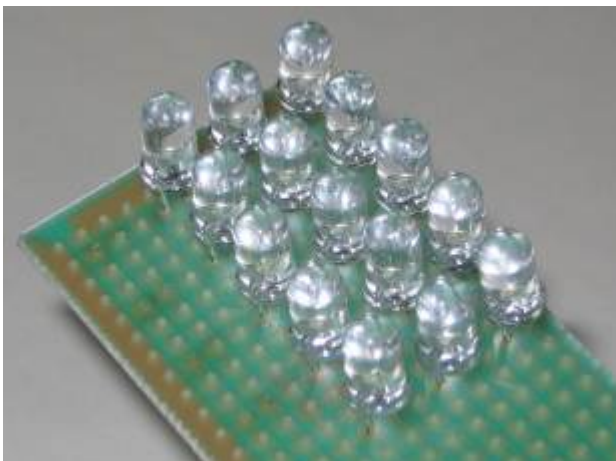
This circuit was designed for a customer who wanted to trigger a camera after a short delay.

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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MAKE YOUR OWN:



15 LEDs on Matrix board

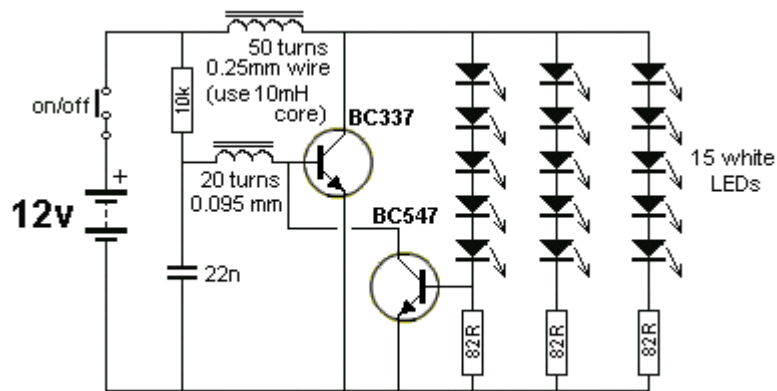


The transformer consists of 50 turns 0.25mm wire connected to the pins. The feedback winding is 20 turns 0.095mm wire with "fly-leads."

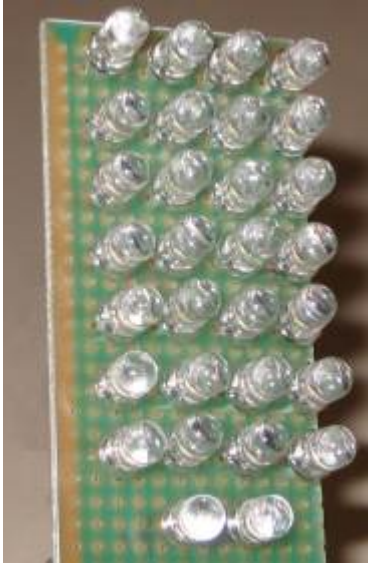
1-WATT LED

This circuit drives 15 LEDs to produce the same brightness as a 1-watt LED. The circuit

consumes 750mW but the LEDs are driven with high-frequency, high-voltage spikes, and become more-efficient and produce a brighter output than if driven by pure-DC. The LEDs are connected in 3 strings of 5 LEDs. Each LED has a characteristic voltage of 3.2v to 3.6v making each chain between 16v and 18v. By selecting the LEDs we have produced 3 chains of 17.5v. Five LEDs (in a string) has been done to allow the circuit to be powered by a 12v battery and allow the battery to be charged while the LEDs are illuminating. If only 4 LEDs are in series, the characteristic voltage may be as low as 12.8v and they may be over-driven when the battery is charging. (Even-up the characteristic voltage across each chain by checking the total voltage across them with an 19v supply and 470R dropper resistor.) The transformer is shown above. It is wound on a 10mH choke with the original winding removed. This circuit is called a **"boost circuit."** It is not designed to drive a single 1-watt LED (a buck circuit is needed). The LEDs in the circuit are 20,000mcd with a viewing angle of 30 degrees (many of the LED specifications use "half angle." You have to test a LED to make sure of the angle). This equates to approximately 4 lumens per LED. The 4-watt CREE LED claims 160 lumens (or 40 lumens per watt). Our design is between 50 - 60 lumens per watt and it is a much-cheaper design.



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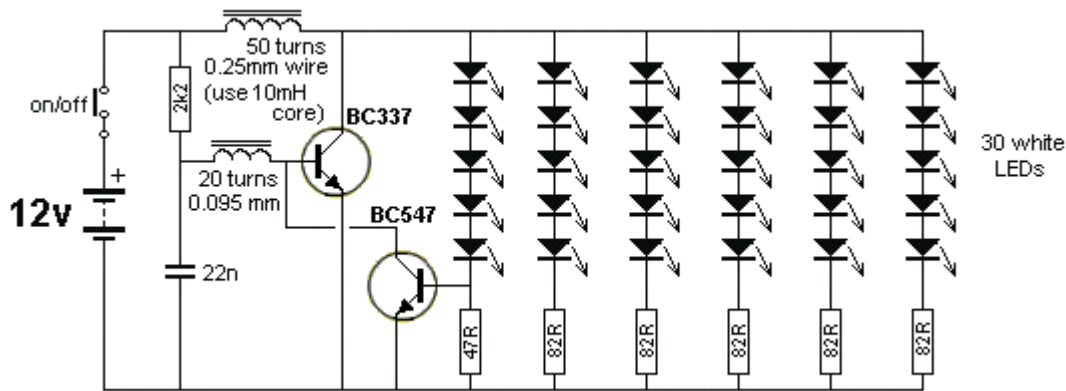


30 LEDs on Matrix board

1.5 WATT LED

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

The effectiveness of a LED array increases when they are spread out slightly and this makes them more efficient than a single 1 watt or 2 watt LED. The two modifications to the circuit make the BC337 work harder and this is the limit of the inductor. The current consumption is about 95mA. The winding details for the transformer are shown above.



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DRIVE 20 LEDs FROM 12v - approx 1watt circuit

This is another circuit that drives a number of LEDs or a single 1 watt LED. It is a "**Buck Circuit**" and drives the LEDs in parallel. They should be graded so that the characteristic voltage-drop across each of them is within 0.2v of all the other LEDs. The circuit will drive any number from 1 to 20 by changing the "sensor" resistor as shown on the circuit. The current consumption is about 95mA @ 12v and lower at 18v. The circuit can be put into dim mode by increasing the drive resistor to 2k2. The UF4004 is an ultra fast 1N4004 - similar to a high-speed diode. You can use 2 x 1N4148 signal diodes.



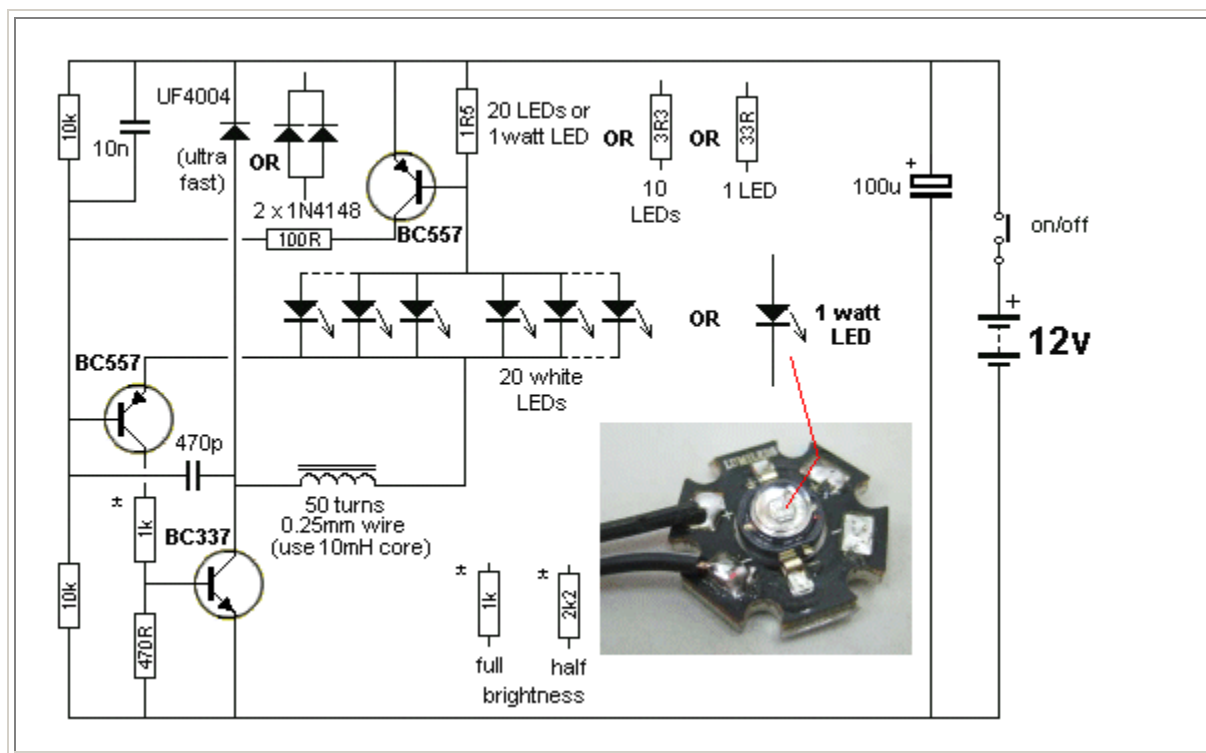
The circuit will not drive two LEDs in series - it runs out of voltage (and current) when the voltage across the load is 7v. It oscillates at approx 200kHz. Build both the 20 LED and 1 watt LED version and compare the brightness and effectiveness. The photo of the 1 watt LED on the left must be heatsinked to prevent the LED overheating. The photo on the circuit diagram shows the LED mounted on a heatsink and the connecting wires.



A 1-watt demo board showing the complex step-up circuitry.

This is a Boost circuit to illuminate the LED and is completely different to our design. It has been included to show the size of a 1 watt LED.

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

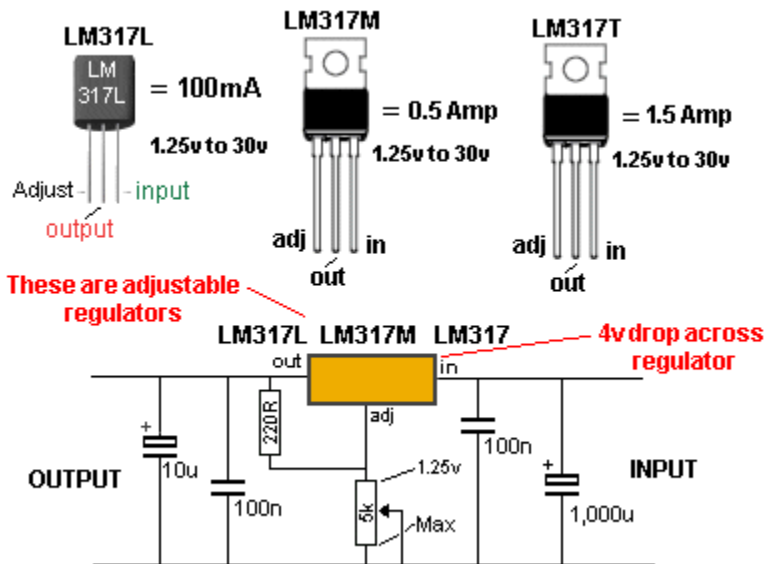


These regulators are called **linear regulators** and drop about 4v across them - minimum. If the current flow is 1 amp, 4watts of heat must be dissipated via a large heatsink. If the output is 5v and input 12v, 7volts will be dropped across the regulator and 7watts must

be dissipated.

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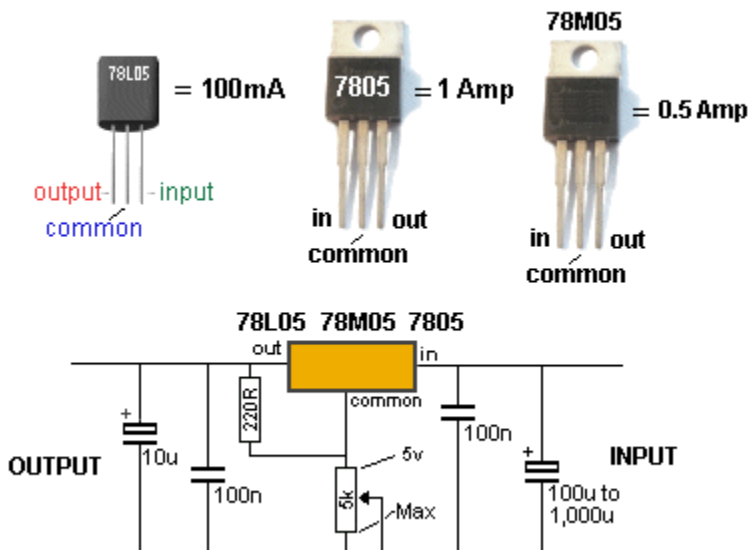
POWER SUPPLIES - ADJUSTABLE:



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

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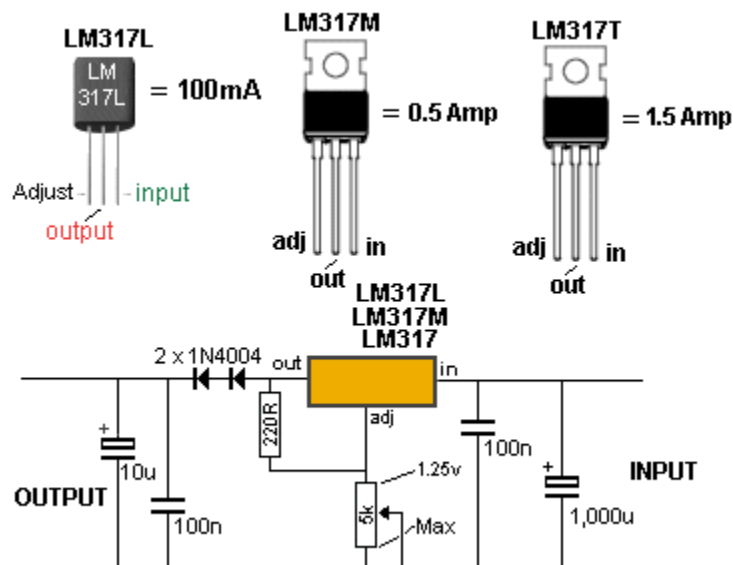
POWER SUPPLIES - ADJUSTABLE using 7805:



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.

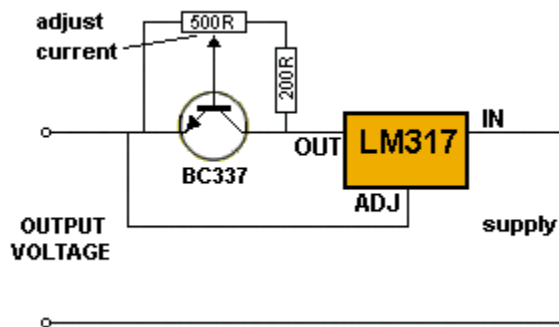
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POWER SUPPLIES - ADJUSTABLE from 0V:



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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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.

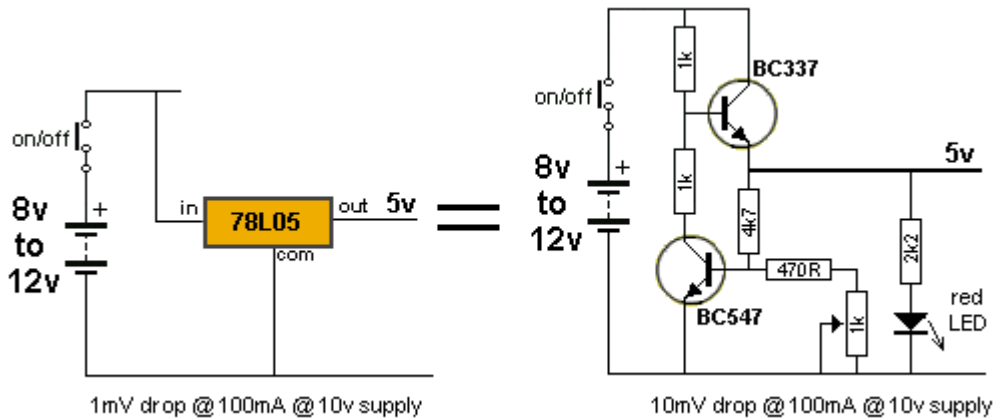
The LM 317 3-terminal regulator will need to be heatsinked.

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

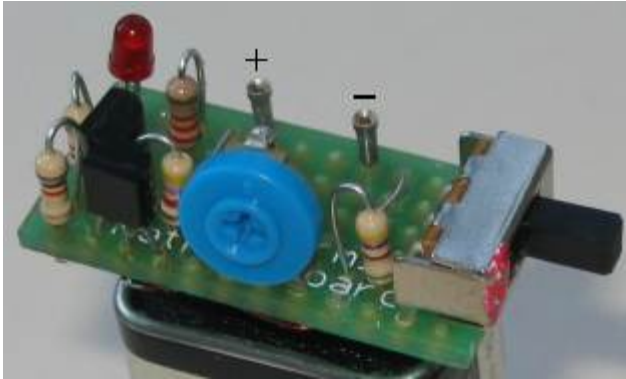


The regulator connected to a 9v battery



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.

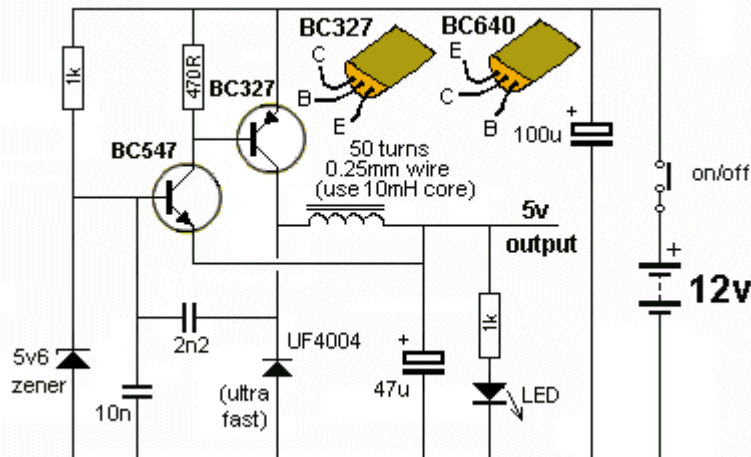
A close-up of the regulator module

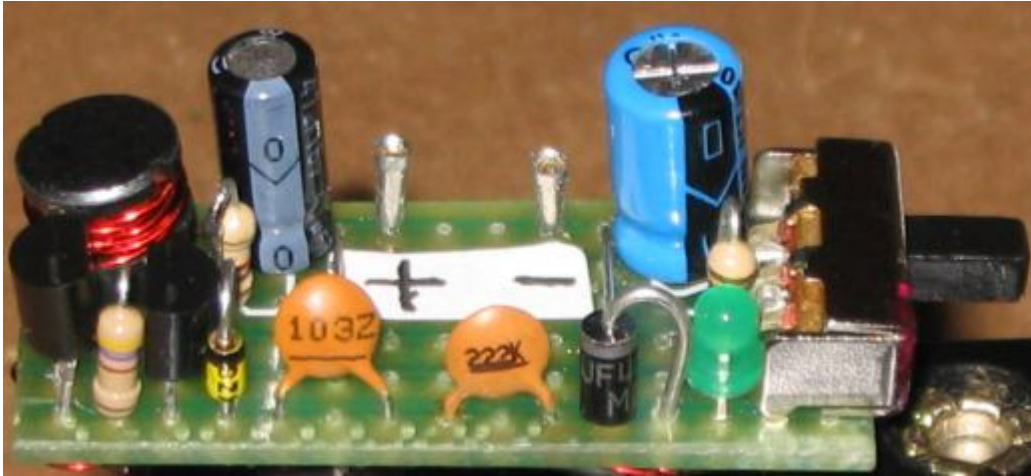


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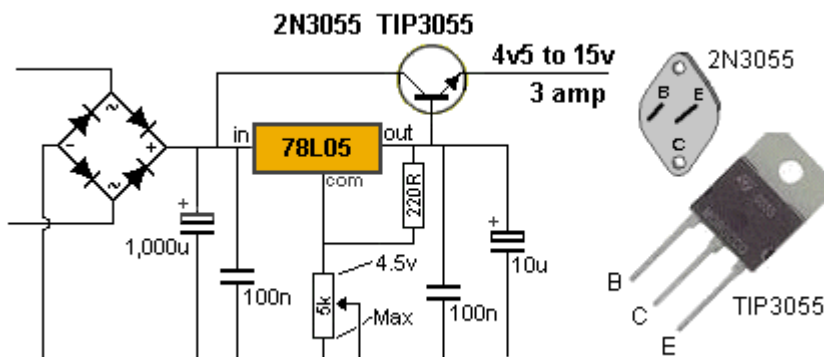
5v FROM OLD CELLS - circuit 2

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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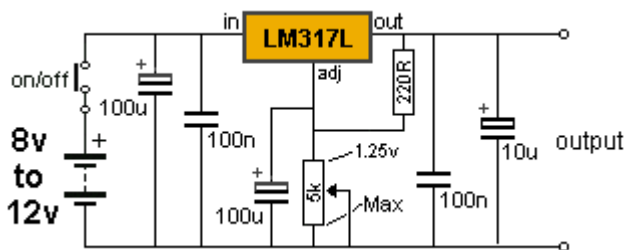
INCREASING THE OUTPUT CURRENT

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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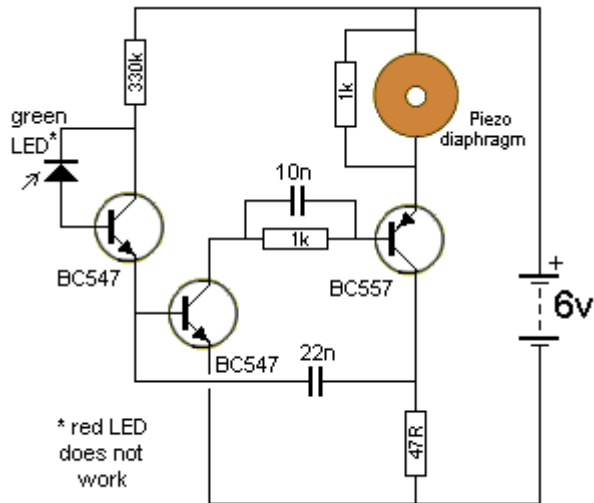


SOFT START

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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LED DETECTS LIGHT

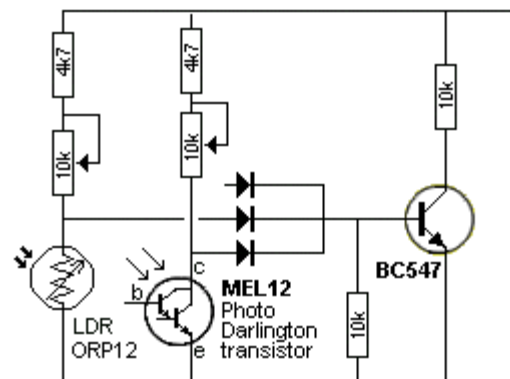
The LED in this circuit will detect light to turn on the oscillator. Ordinary red LEDs do not work. But green LEDs, yellow LEDs and high-bright white LEDs and high-bright red LEDs work very well.

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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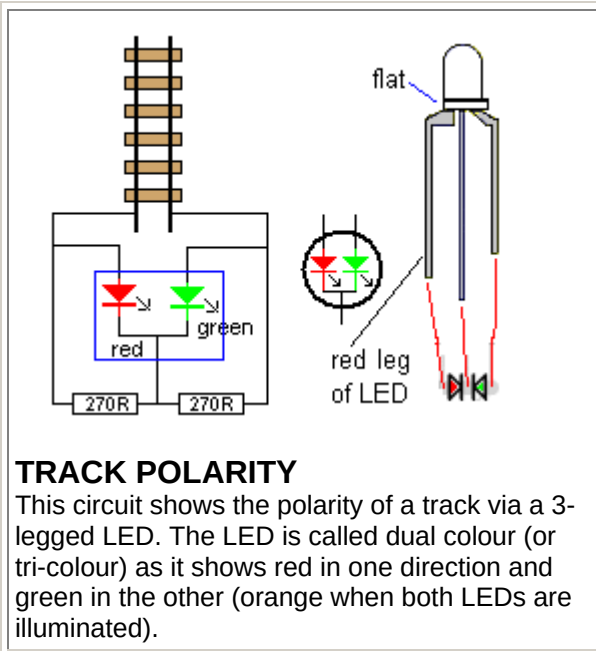


TRAIN DETECTORS

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.

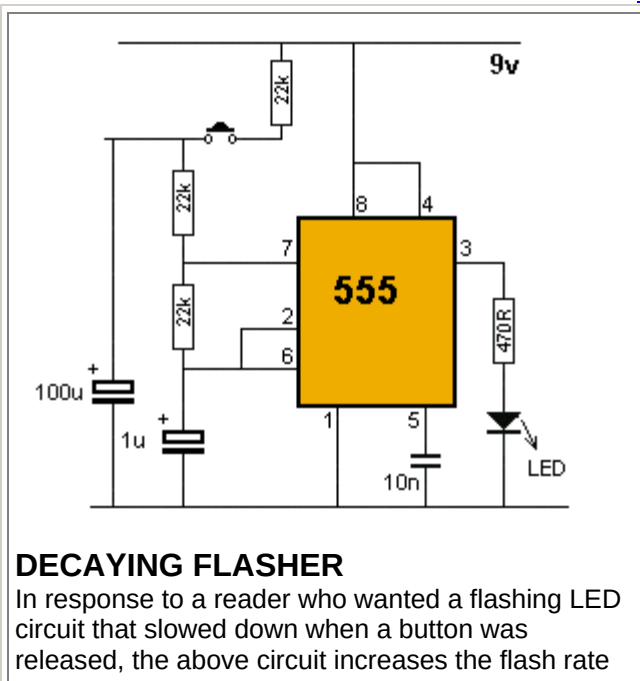
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TRACK POLARITY

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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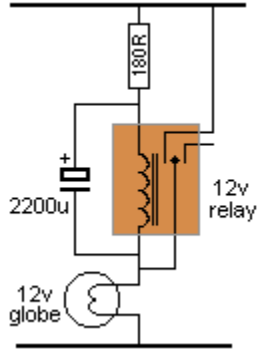
DECAYING FLASHER

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



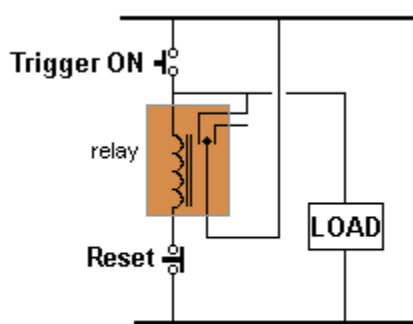
This simple circuit flashes a globe at a rate according to the value of the 180R and 2200u electrolytic.

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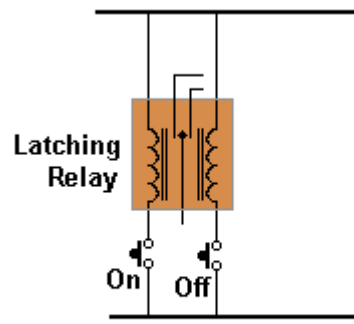
LATCHING RELAY

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.

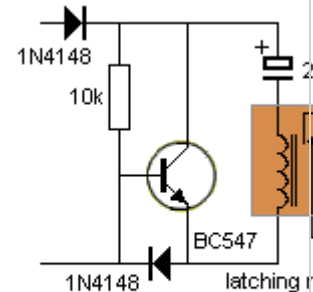
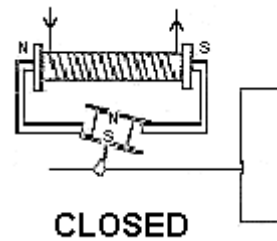
The following diagram shows how the coil makes the magnet click in the two directions.



Latching an ordinary relay



A 2-coil Latching Relay

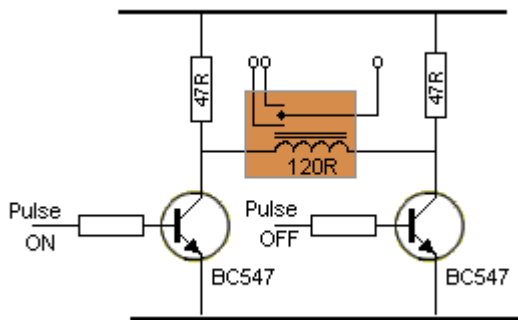
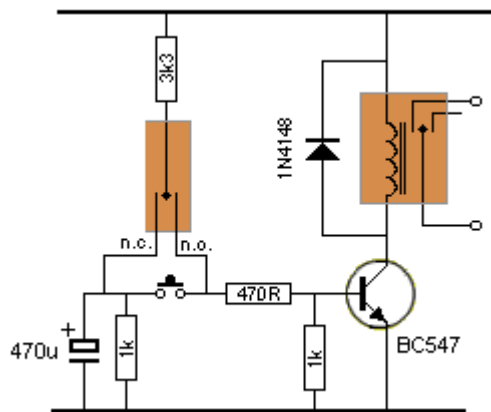


PULSE LATCHING RELAY C

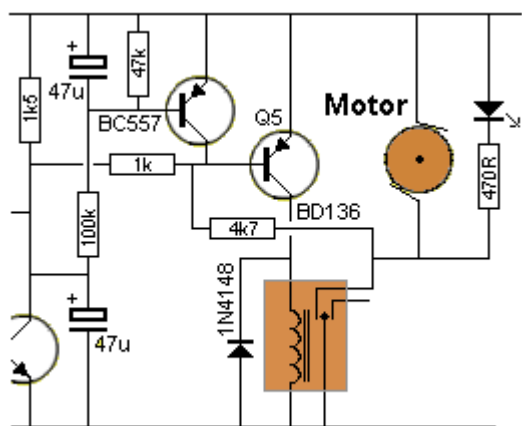
To operate this type of relay, the voltage must be reversed to unlatch it. The circuit above produces a strong pulse to latch the relay ON and the input voltage must remain HIGH. The 220uF gradually charges and the current falls to a very low level. When the input voltage is removed, the circuit produces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

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

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



connected to provide a toggle action.

The circuit comes on with the relay de-activated and the contacts connected so that the 470uF charges via the 3k3. Allow the 470uF 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 470uF 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.

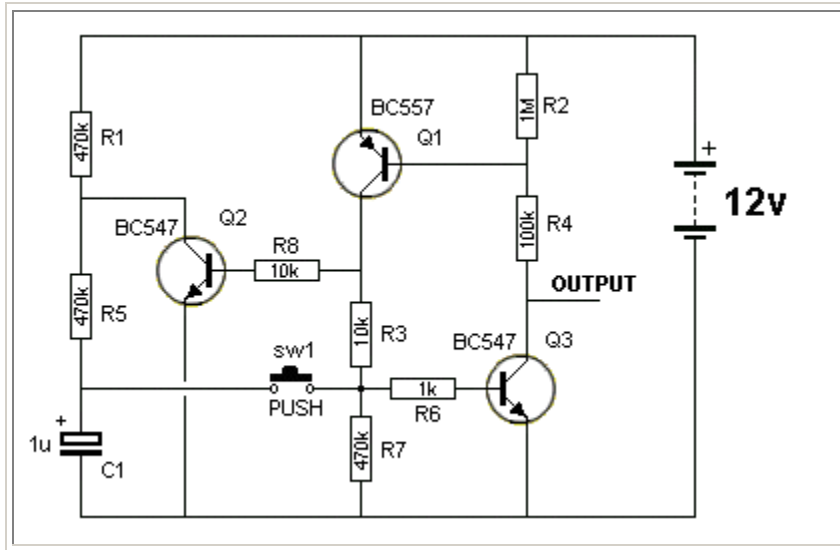
A normal relay can be activated by a short tone and de-activated by a long tone as shown via the circuit on the left. This circuit can be found in "27MHz Links" Page 2.

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LATCHING A PUSH BUTTON

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.

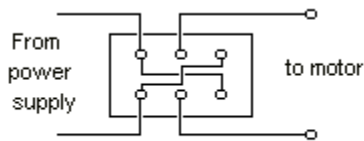
Q2 is also turned on during this time and it discharges the capacitor. When the switch is pressed again, the capacitor is in a discharged state and this zero voltage will be passed to Q3 turn it off. This turns off Q1 and Q2 and the capacitor begins to charge again to repeat the cycle.



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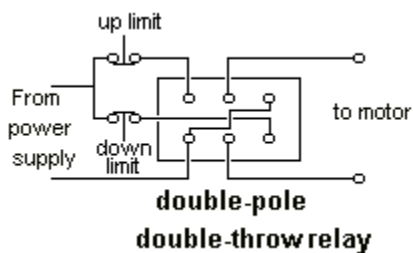
REVERSING A MOTOR-1

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.

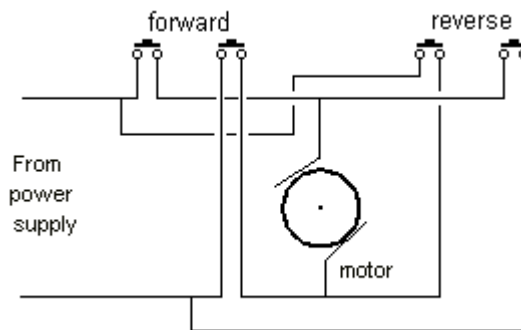


double-pole double-throw relay

Adding limit switches:



double-pole double-throw relay



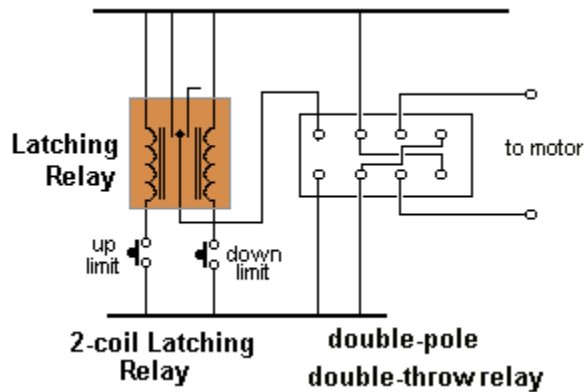
The way the dpdt relay circuit (above) works is this:

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 the "down-limit" switch and stops. The MAIN SWITCH must be used to send the motor to the "up limit" switch.

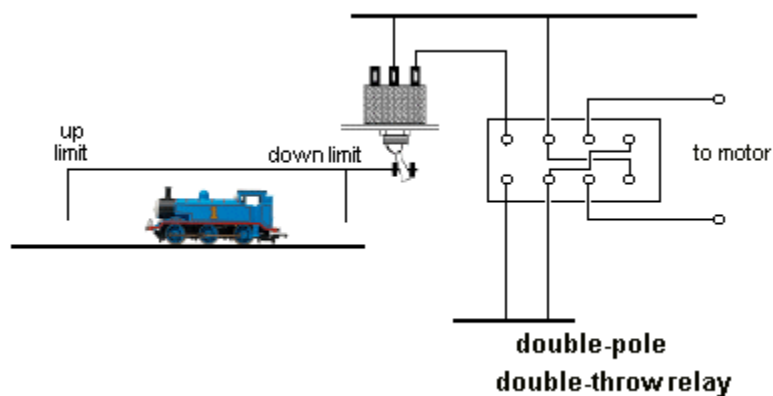
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REVERSING A MOTOR-2 AUTOMATIC FORWARD-REVERSE

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.



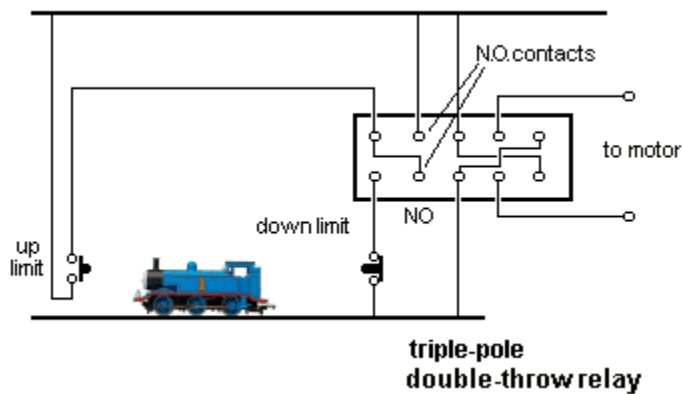
If the motor can be used to click a switch or move a slide switch, the following circuit can be used:



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REVERSING A MOTOR-3

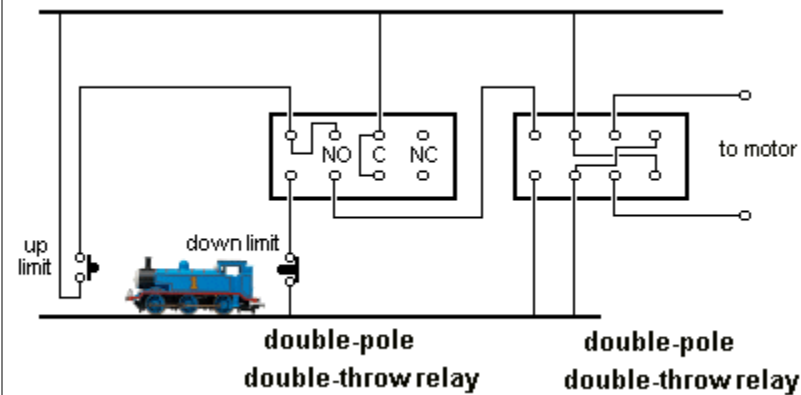
If the train cannot physically click the slide switch in both directions, via a linkage, the following circuit should be used:



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.

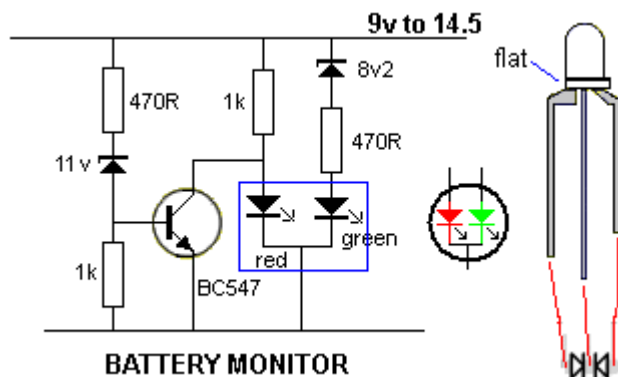
If you cannot get a triple-pole change-over relay, use the following circuit:



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BATTERY MONITOR MkI

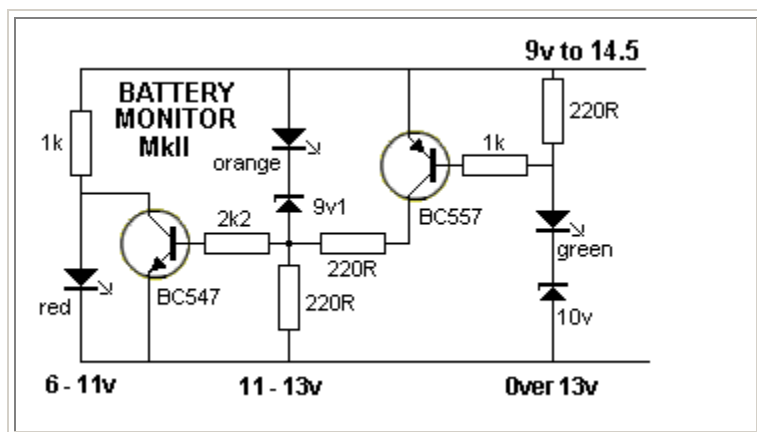
A very simple battery monitor can be made with a dual-colour LED and a few surrounding components. The LED produces orange when the red and green LEDs are illuminated. The following circuit turns on the red LED below 10.5v. The orange LED illuminates between 10.5v and 11.6v. The green LED illuminates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



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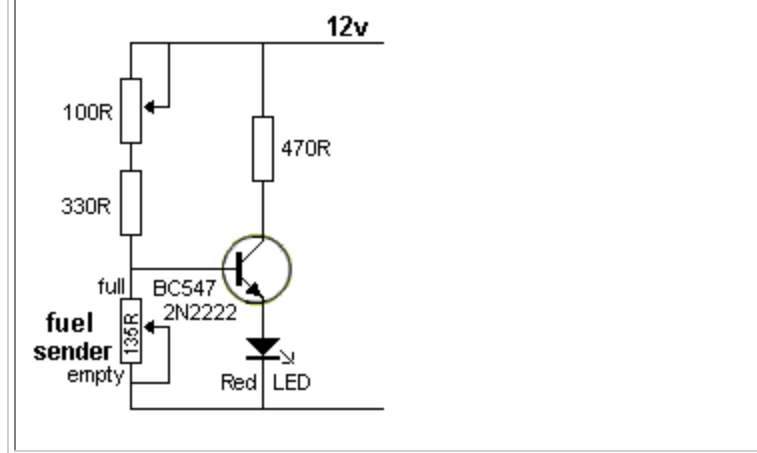
BATTERY MONITOR MkII

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.



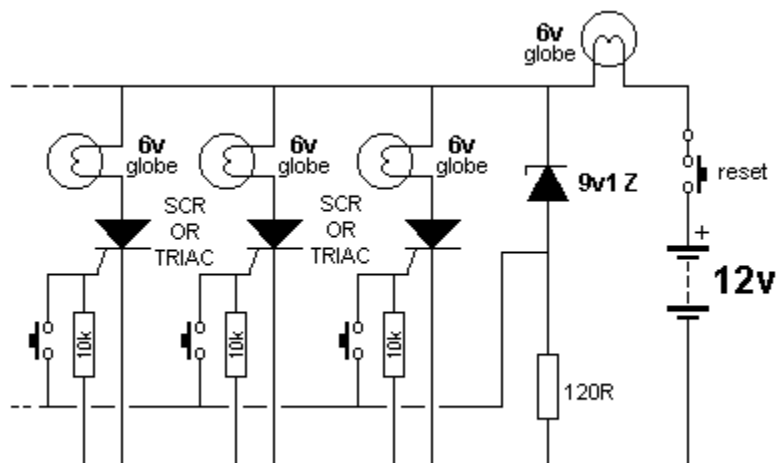
LOW FUEL INDICATOR

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 empty.)



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.

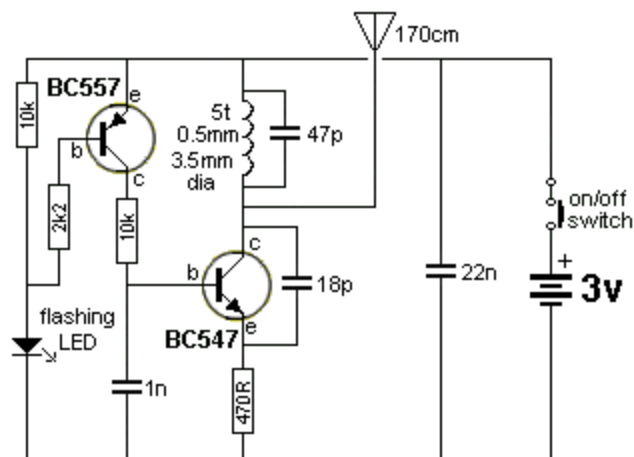


When a button is pressed the corresponding globe is illuminated. The Quiz Master globe is also illuminated and the cathode of the 9v1 zener sees approx mid-rail voltage. The zener comes out of conduction and no voltage appears across the 120R resistor. No other globes can be lit until the circuit is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

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TRACKING TRANSMITTER

This circuit can be used to track lots of items.



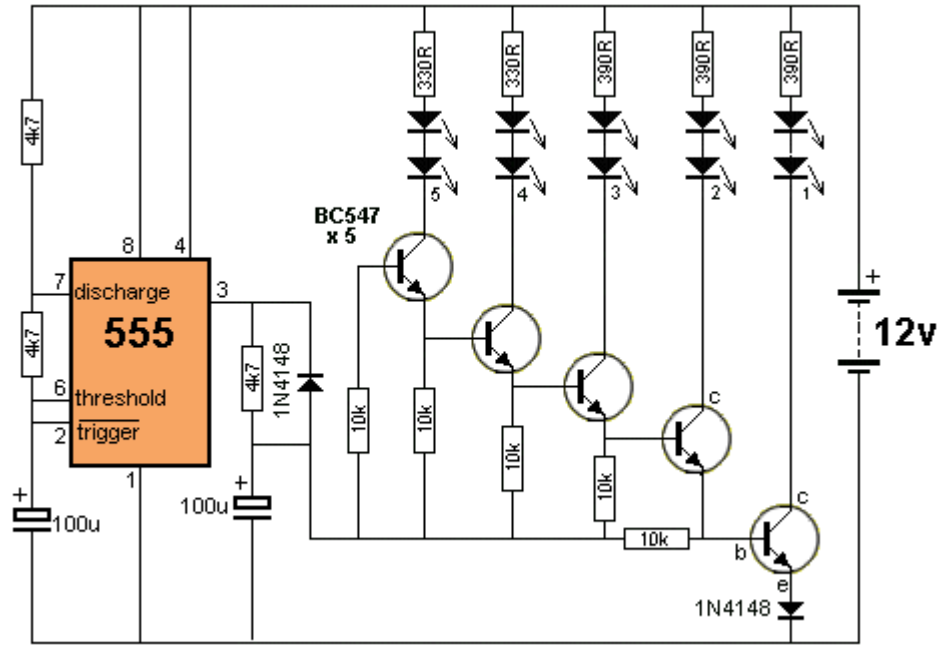
TRACKING TRANSMITTER MKI

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

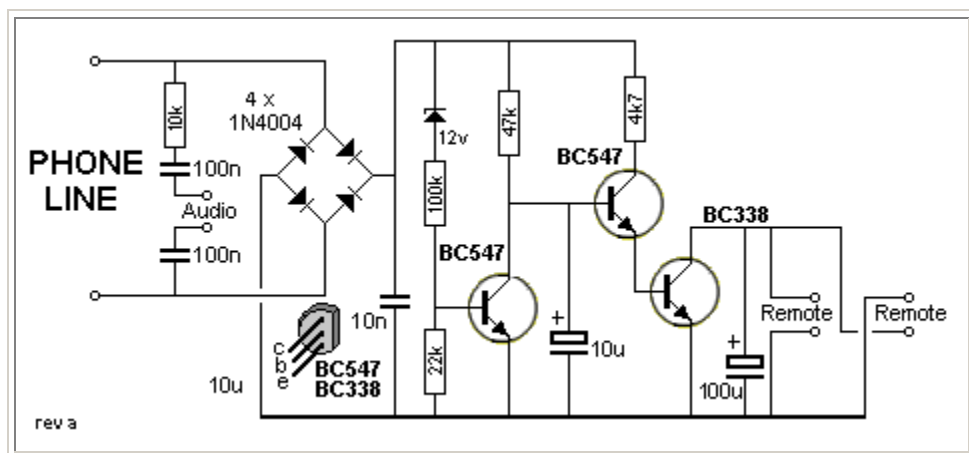
This circuit can be used to indicate left and right turn on a motor-bike. Two identical circuits will be needed, one for left and one for right.



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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 10uF 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.

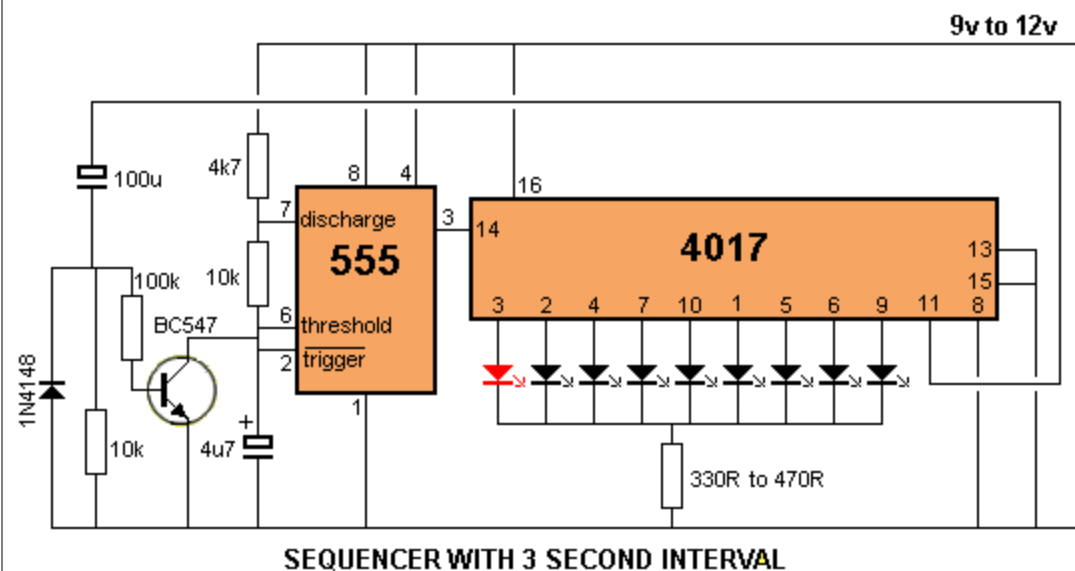


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SEQUENCER

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:

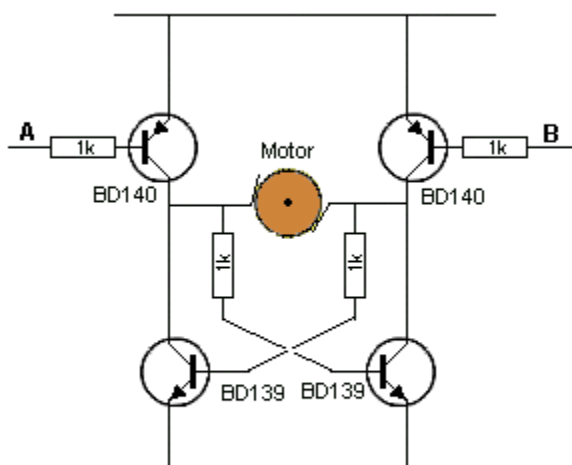


Note the delay produced by the 100u and 10k produces 3 seconds by the transistor inhibiting the 555 (taking pin 6 LOW). Learn more about the 555 - see the article: **"The 555"** on Talking Electronics website by clicking the title on the left index. See the article on CD 4017. See **"Chip Data eBook"** on TE website in the left index.

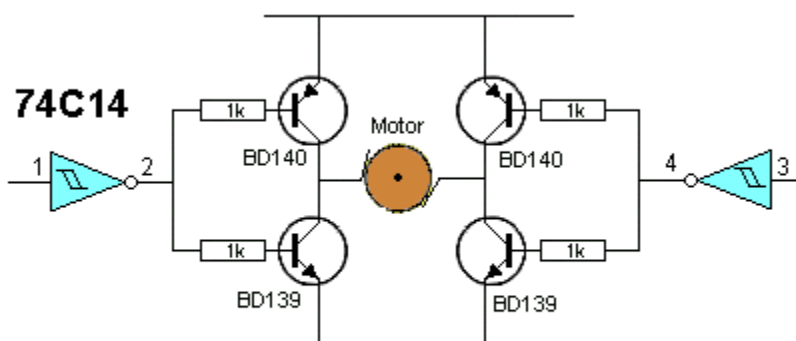
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H-BRIDGE

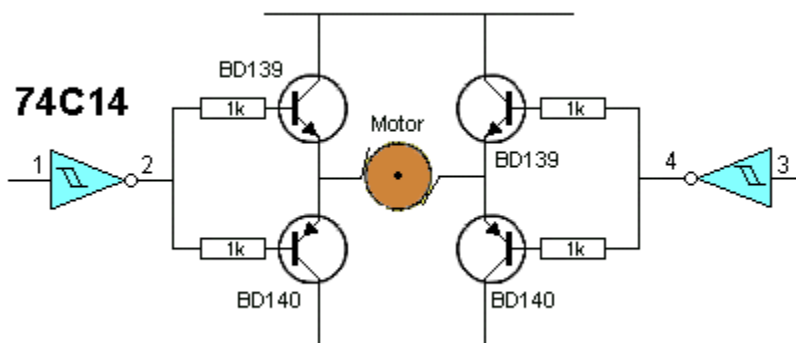
These circuits reverse a motor via two input lines. Both inputs must not be LOW with the first H-bridge circuit. If both inputs go LOW at the same time, the transistors will "short-out" the supply. This means you need to control the timing of the inputs. In addition, the current capability of some H-bridges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



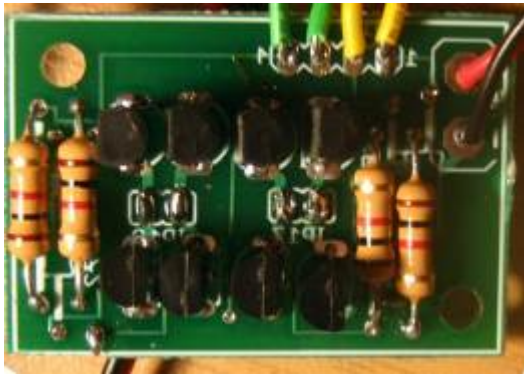
A and B must NEVER both be low



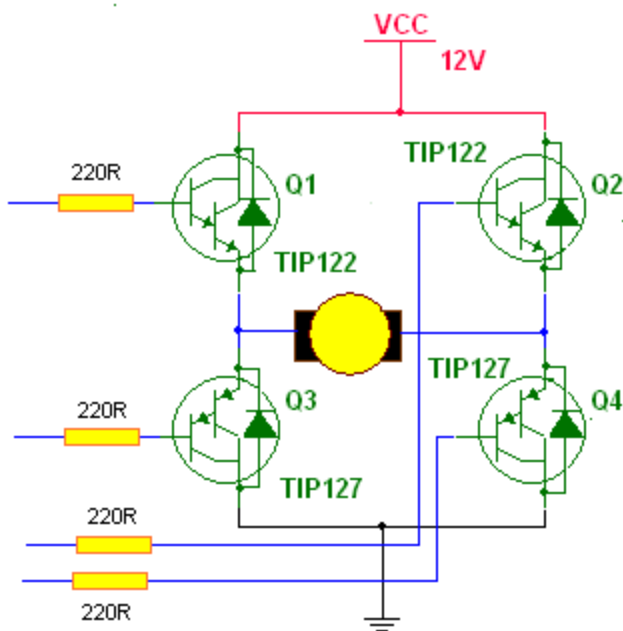
When A and B are equal, motor does not run



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



Two H-Bridges on a PC board

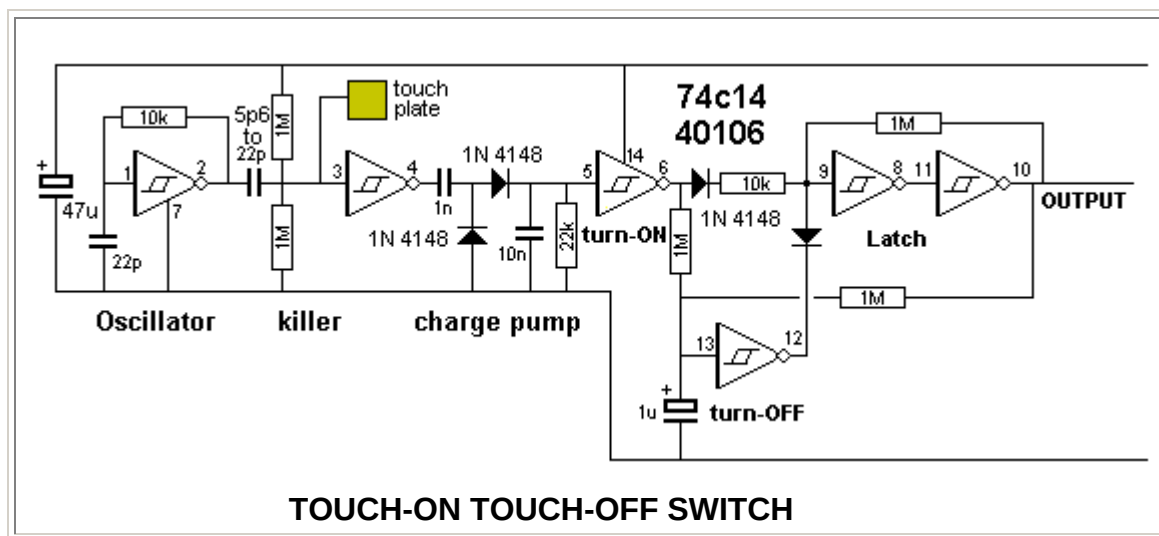


H-Bridge using Darlington transistors

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TOUCH-ON TOUCH-OFF SWITCH

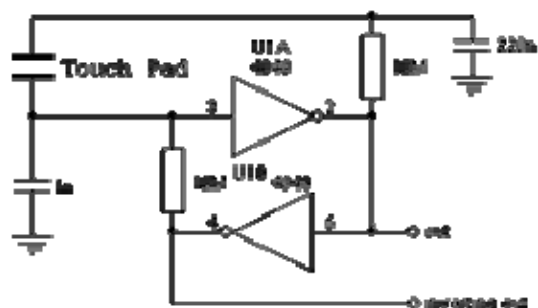
This circuit will create a HIGH on the output when the Touch Plate is touched briefly and produce a low when the plate is touched again for a slightly longer period of time. Most touch switches rely on 50Hz mains hum and do not work when the hum is not present. This circuit does not rely on "hum."



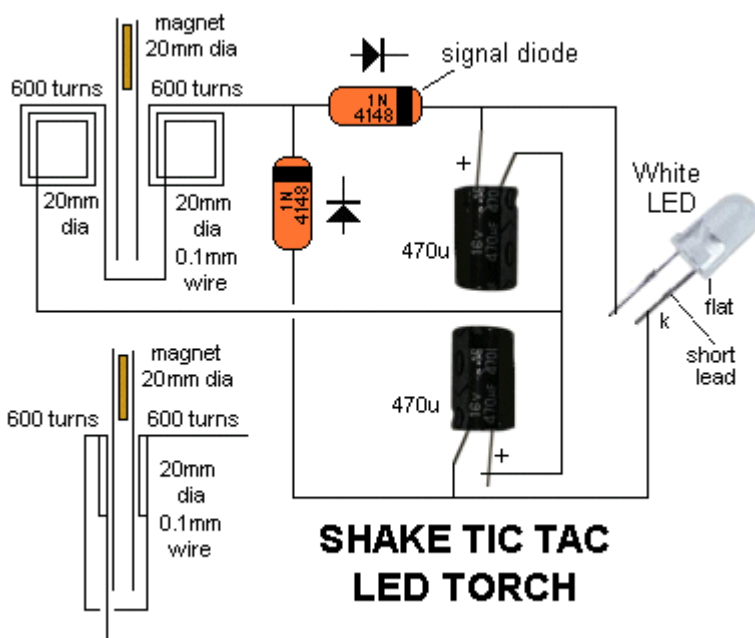
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SIMPLE TOUCH-ON TOUCH-OFF SWITCH

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 through 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.

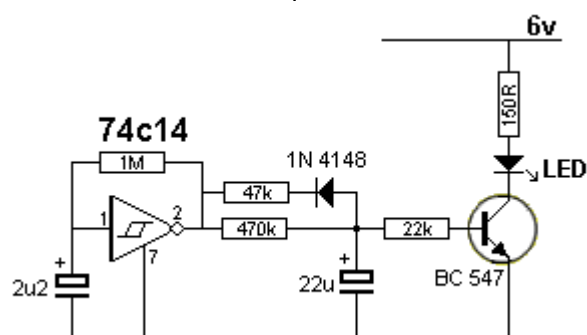
The voltage across each electrolytic is combined to produce a voltage for the white LED. When the combined voltage is greater than 3.2v, the LED illuminates. The electrolytics help to keep the LED illuminated while the magnet starts to make another pass.

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FADING LED

The circuit fades the LED ON and OFF at an equal rate.

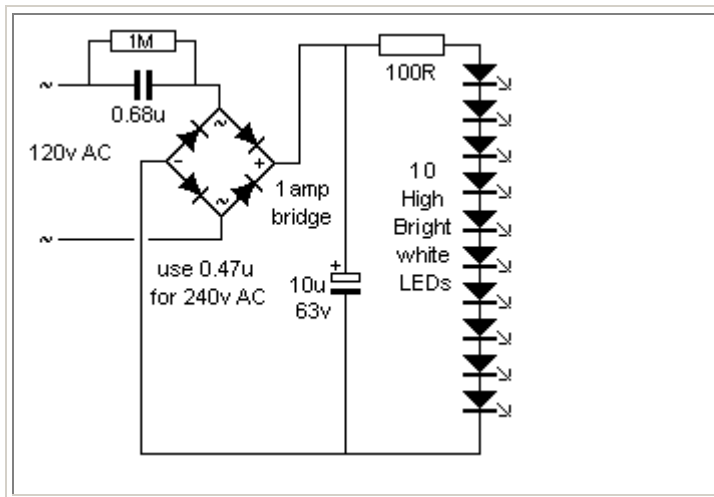
The 470k charging and 47k discharging resistors have been chosen to create equal on and off times.



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MAINS NIGHT LIGHT

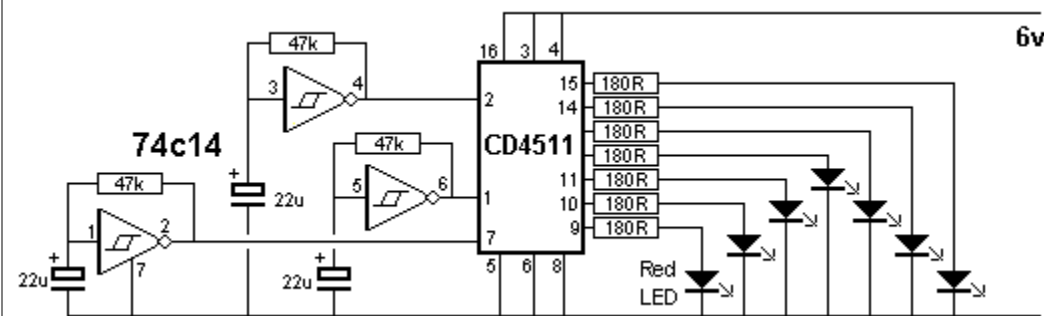
The circuit illuminates a column of 10 white LEDs. The 10u prevents flicker and the 100R also reduces flicker.



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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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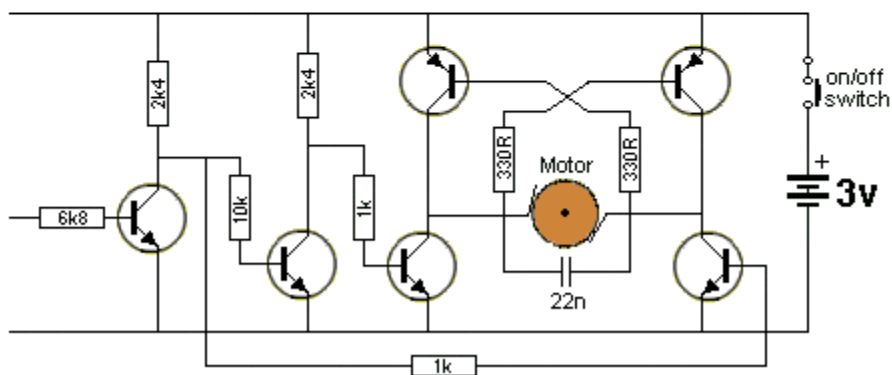
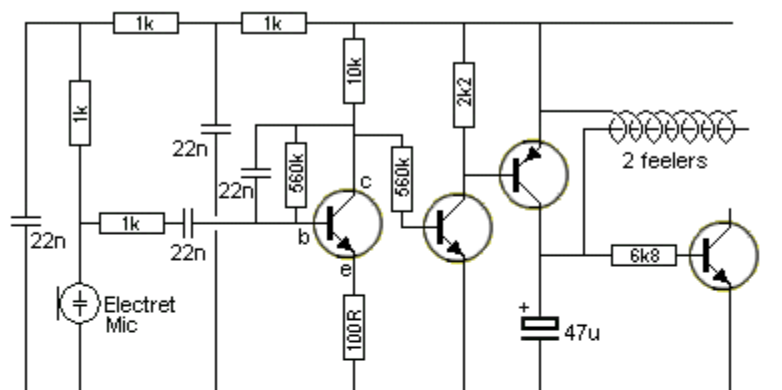
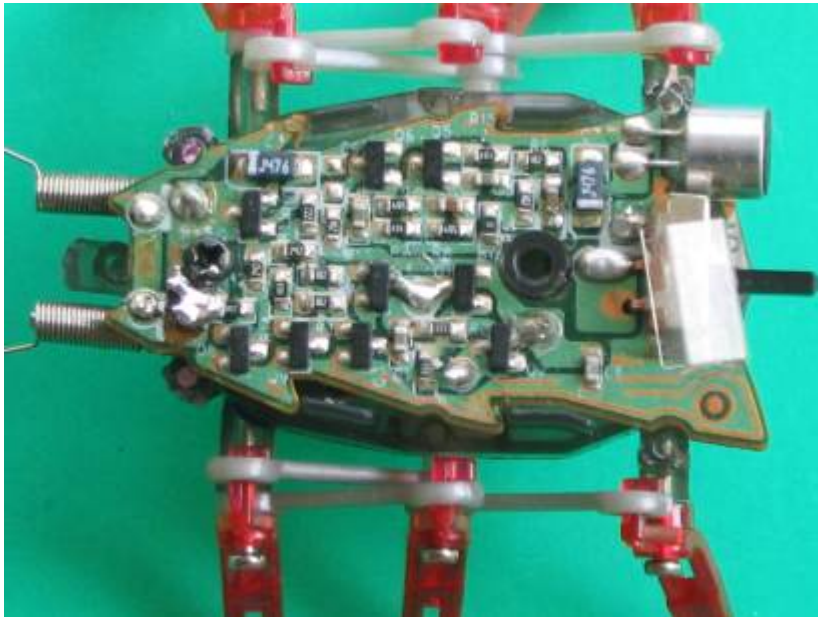
HEX BUG

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.

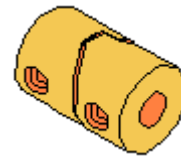
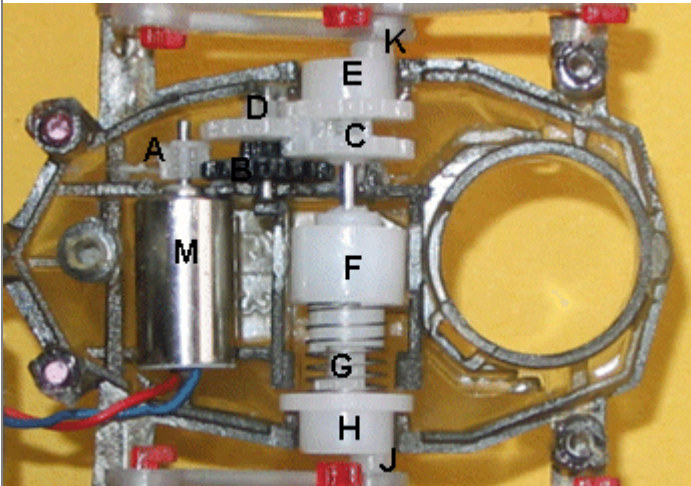
In the forward direction, both sets of legs are driven by the compound gearbox but when the motor is reversed, the left legs do not operate as they are connected by a clutch consisting of a spring-loaded inclined plane that does not operate in reverse.

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.

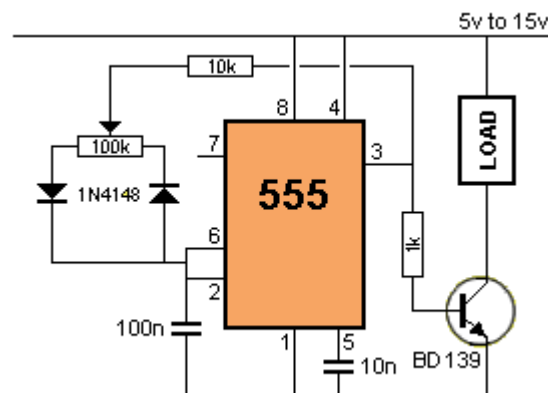
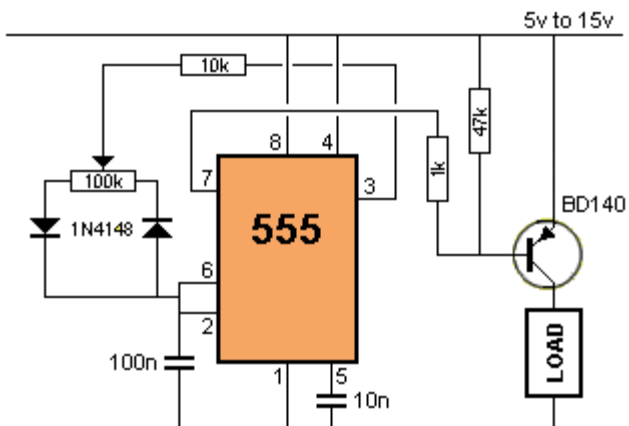
When the motor is reversed, the clutch "F" is a housing that is spring-loaded to "H" and drives "H" via a square shaft "G". Gearwheel "C" is an idler and the centre of "F" is connected to "E" via the shaft. When "E" reverses, the centre of "F" consists of a driving inclined plane and pushes "F" towards "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.

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PWM CONTROLLER

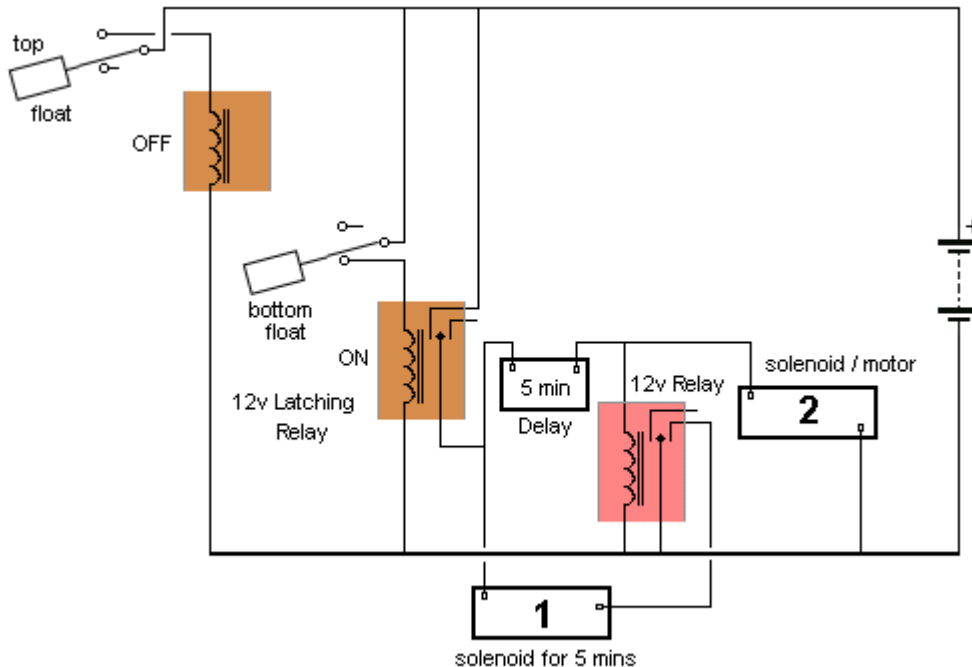
This 555 based PWM controller features almost 0% to 100% pulse width regulation using the 100k variable resistor, while keeping the oscillator frequency relatively stable. The frequency is dependent on the 100k pot and 100n to give a frequency range from about 170Hz to 200Hz.



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LIMIT SWITCHES

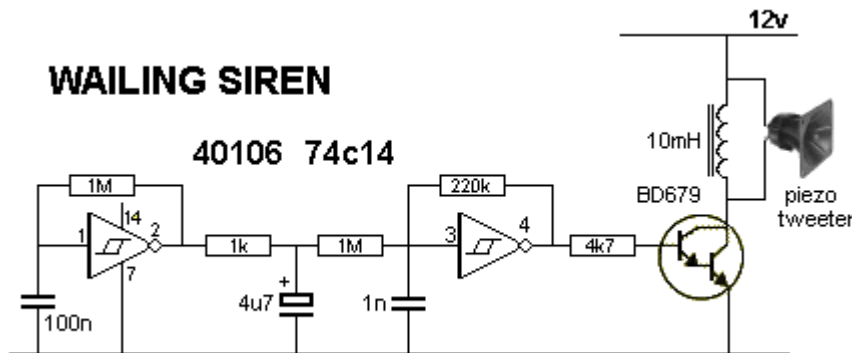
This circuit detects when the water level is low and activates solenoid (or pump) 1 for 5 minutes (adjustable) to allow dirty water to be diverted, before filling the tank via solenoid 2.



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WAILING SIREN

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

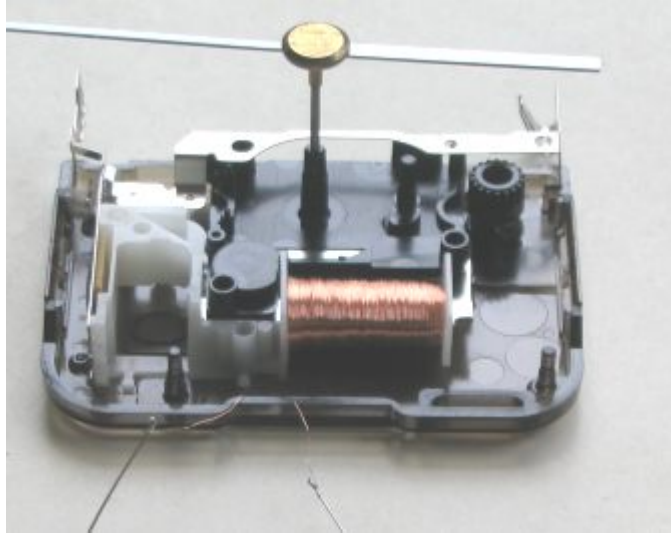
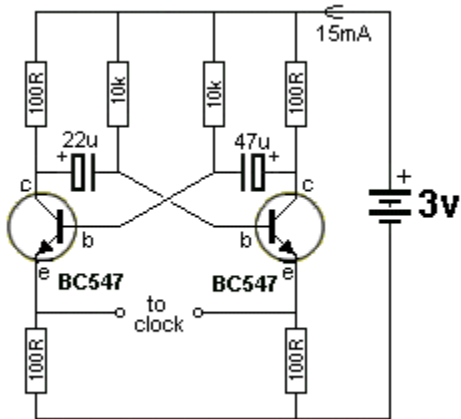


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MODEL RAILWAY TIME

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.

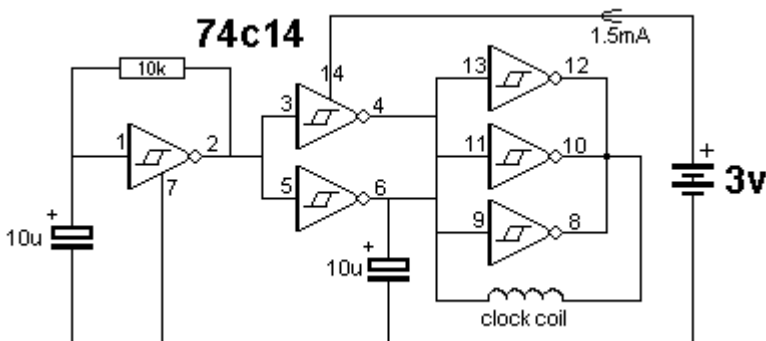
The timing can be adjusted by the electrolytics in the circuit. The electronics in the clock is disconnected from the coil and the circuit drives the coil directly. The circuit takes a lot more current than the original clock (1,000 times more) but this is the only way to do the job without a sophisticated 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:

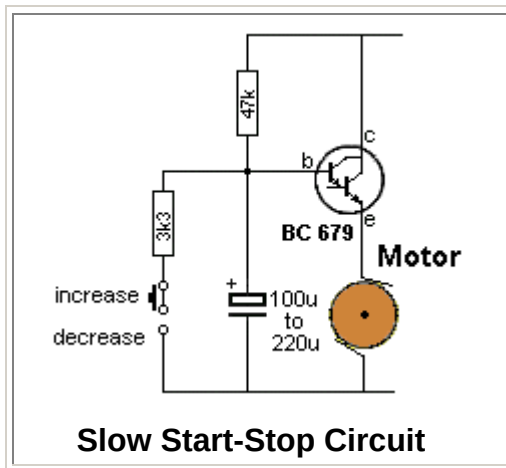


Model Railway Time Circuit using a 74c14 Hex Schmitt Chip

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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.



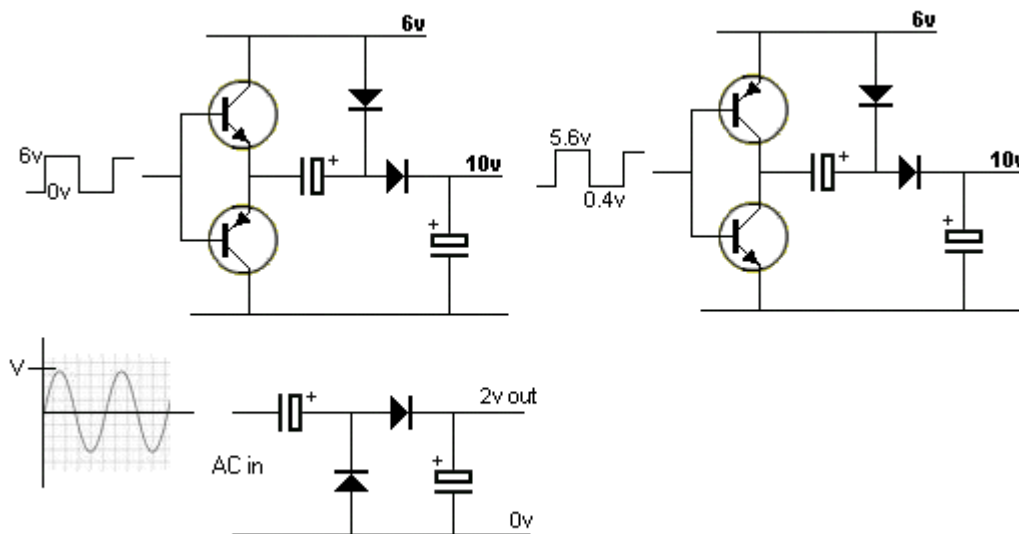
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VOLTAGE MULTIPLIERS

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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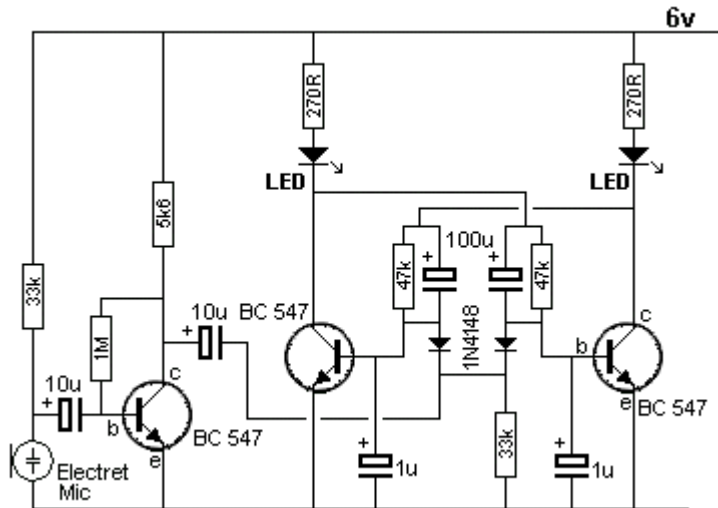
CLAP SWITCH

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.

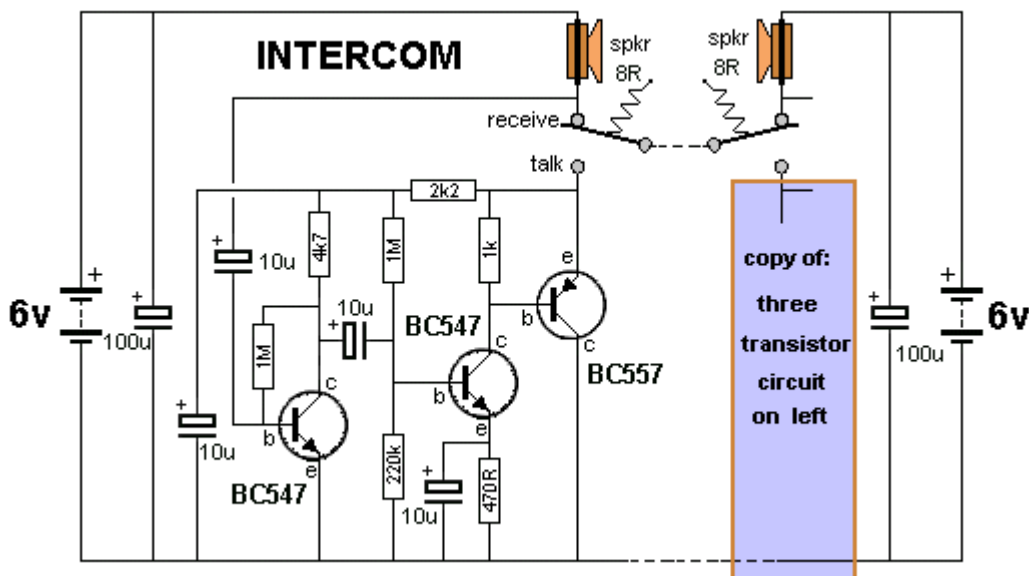
As the anodes of the two signal diode are brought lower, the transistor that is turned on, will begin to turn off and the other transistor will begin to turn on via its 100u and 47k. As it begins to turn on, the transistor that was originally turned on will get less "turn-on" from its 100u and 47k and 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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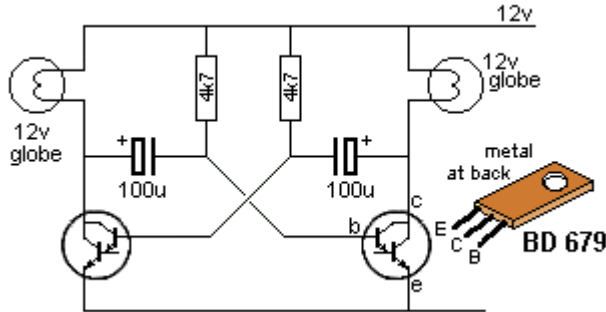
INTERCOM

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

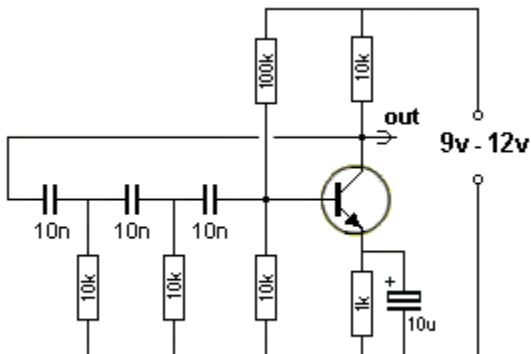


Here is a 12v Warning Beacon suitable for a car or truck break- down on the side of the road. The key to the operation of the circuit is the high gain of the Darlington transistors. The circuit must be kept "tight" (thick wires) to be sure it will oscillate.

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.

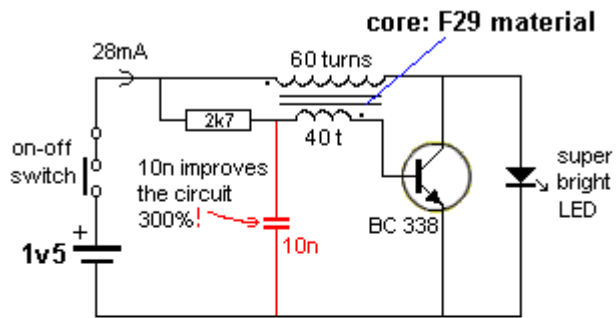
The three 10n capacitors and two 10k resistors (actually 3) determine the frequency of operation (700Hz).

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

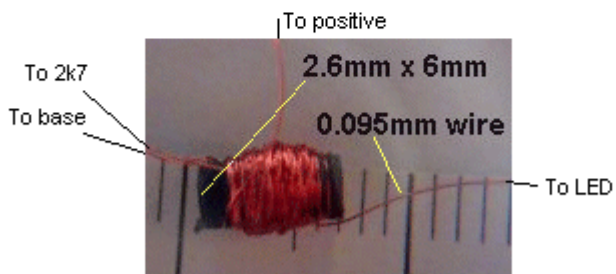
This type of circuit can be designed to operate from about 10Hz to about 200kHz.

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BLOCKING OSCILLATOR also called FLYBACK OSCILLATOR



LED TORCH CIRCUIT



Transformer Details

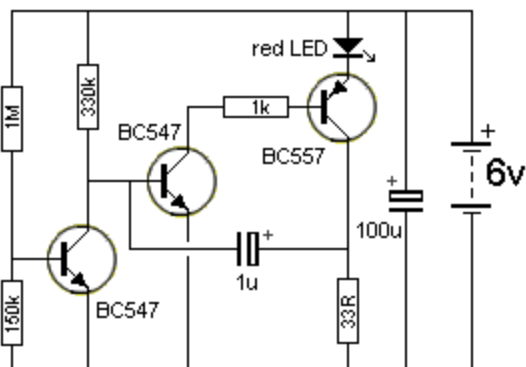
The circuit produces high voltage pulses (spikes) of about 40v p-p (when the LED is not connected), at a frequency of 200kHz. The super-bright LED on the output absorbs the pulses and uses the energy to produce illumination. The voltage across the LED will be about 3.6v

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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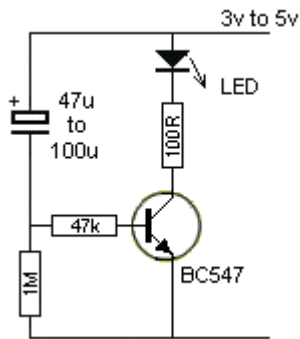
LOW VOLTAGE FLASHER



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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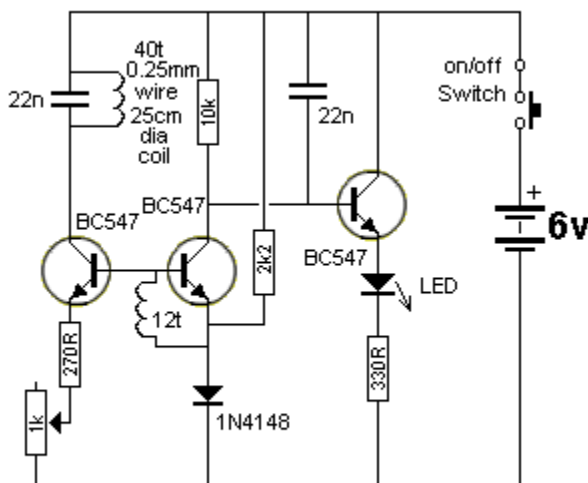
POWER ON



This LED illuminates for a few seconds when the power is turned on. The circuit relies on the 47uF capacitor 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

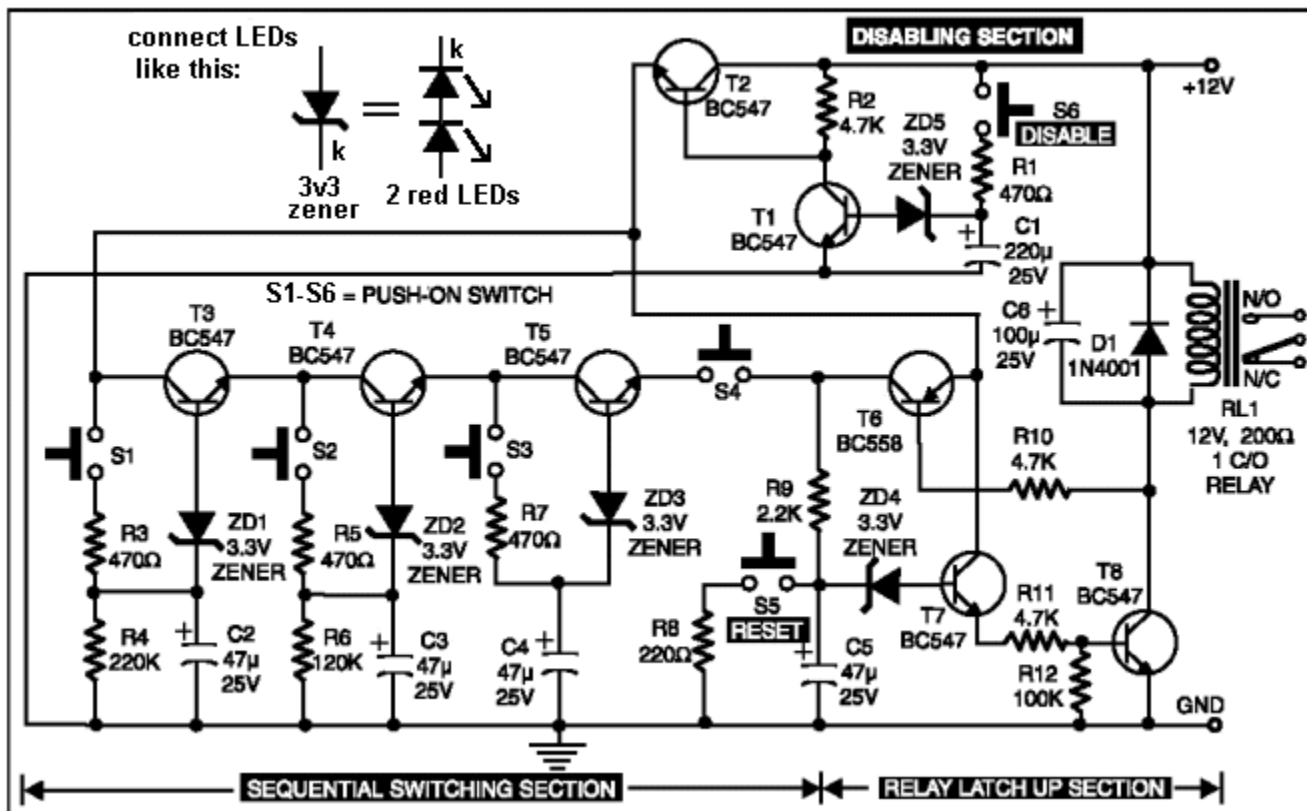


VEHICLE DETECTOR

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 collapse. The second transistor turns off and the 10k resistor pulls the base of the third transistor (an emitter-follower) to the 6V rail and turns on the LED.

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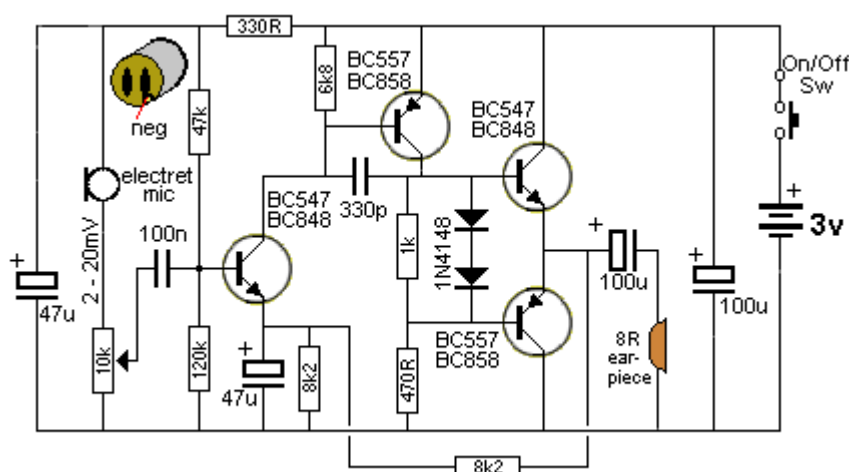
ALARM USING 4-BUTTONS



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

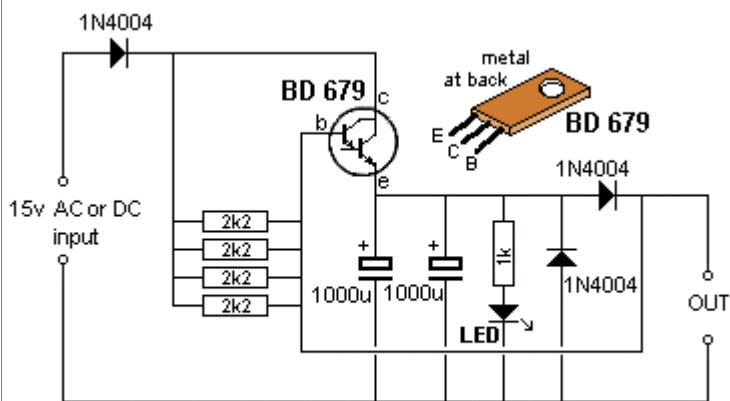
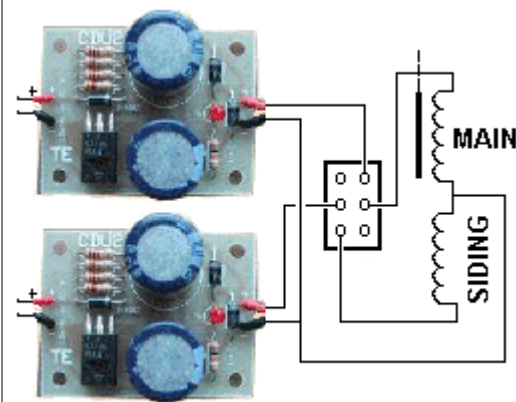
output of the BC 557 causes current to flow through the 1k and 470R resistors so that the voltage developed across each resistor turns on the two output transistors. The end result is mid-rail voltage on the join of the two emitters.

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

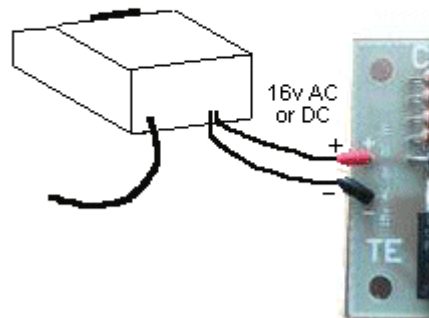
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CAPACITOR DISCHARGE UNIT MkII (CDU2)

This project is available as a kit for \$10.80 plus \$6.50 post. email [Talking Electronics](#) for details.



CAPACITOR DISCHARGE UNIT MkII

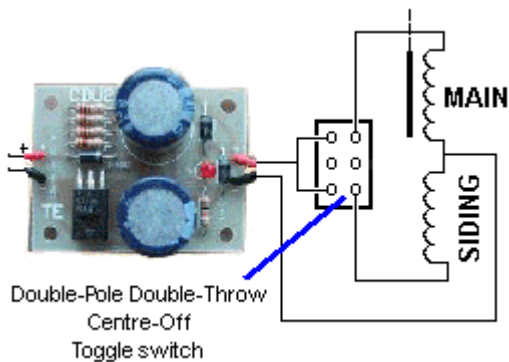


This circuit will operate a two-solenoid point-motor and prevent it overheating and causing any damage. The circuit produces energy to change the points and ceases to provide any more current. This is carried out by the switching arrangement within the circuit, by sampling the output voltage.

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



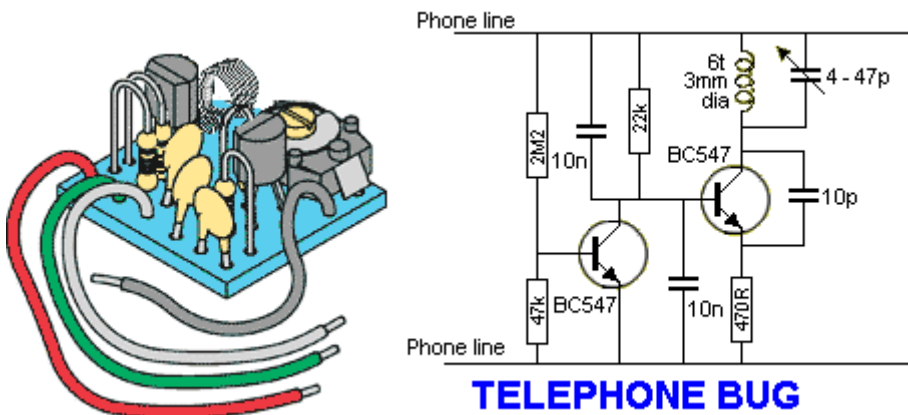
emitter follows. This is called an emitter-follower stage. The two 1,000u electrolytics charge and the indicator LED turns on. The circuit is now ready. When the Main or Siding switch is pressed, the energy from the electrolytics is passed to the point motor and the points change. As the output voltage 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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PHONE BUG

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.



TELEPHONE BUG

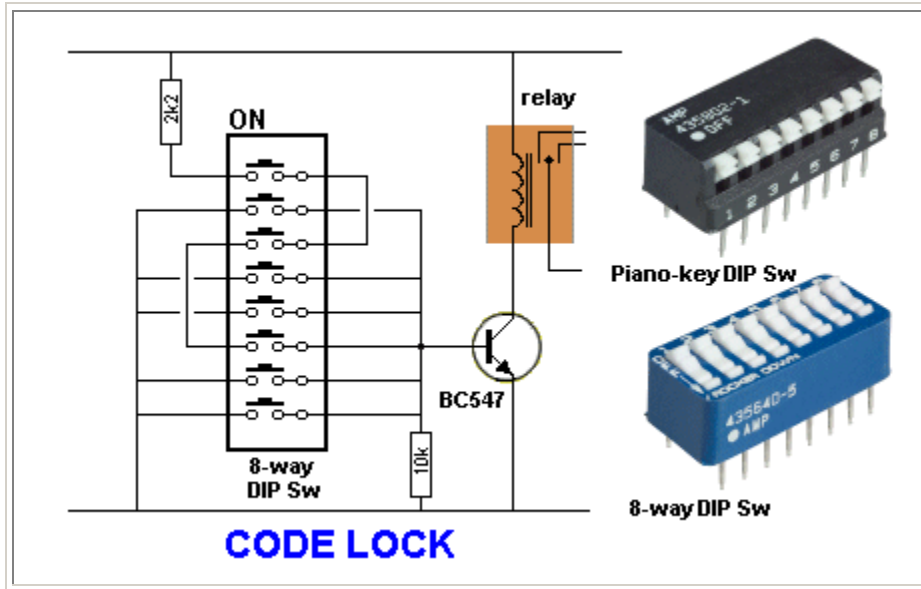
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CODE LOCK

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.

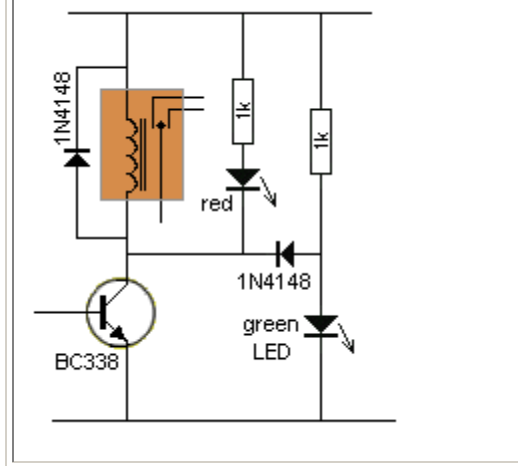
There are 256 different combinations and because the combination is in binary, it would be very difficult for a burglar to keep up with the settings of the switches.



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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.

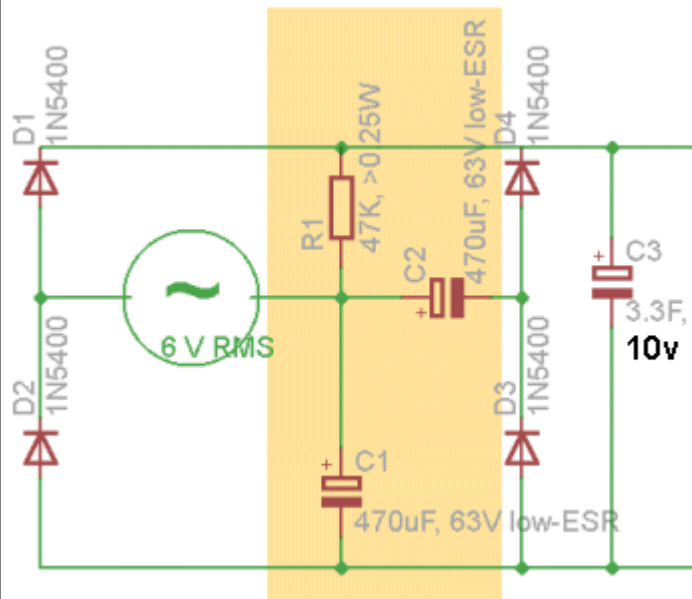
This is how the circuit works.

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



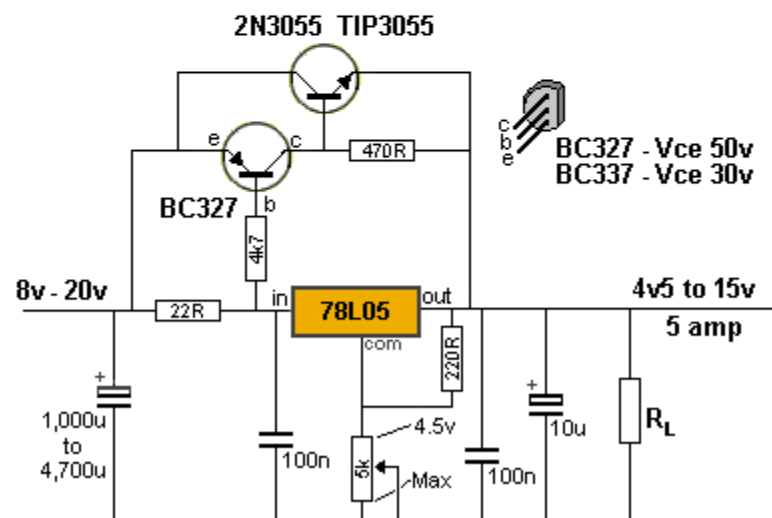
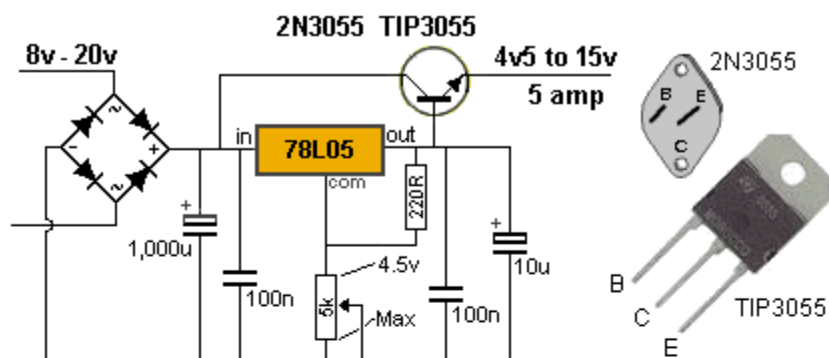
the right side is negative. The right side is already sitting at a potential of 7v (via C1) and as the left side increases, it raises the rail voltage higher by an amount that could be as high as 7v minus 0.6v.

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.



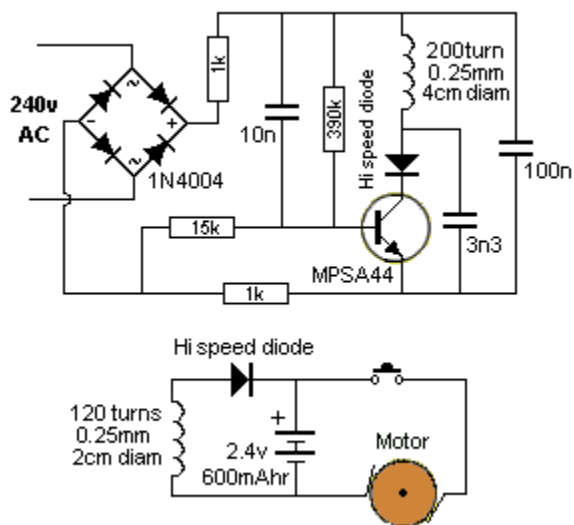
RL must be low enough to guarantee at least a 30mA. It can be a separate resistor or part of the actual load.

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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.



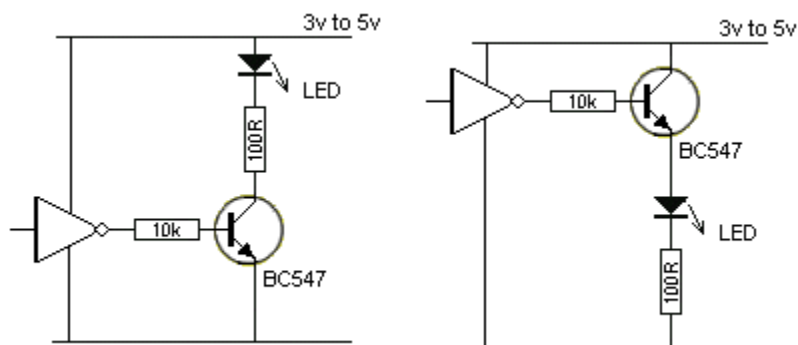
The battery charger is nothing more than a diode to rectify the signal from the 120 turn coil in the charging base. Thus the battery is in constant trickle charge as long as the hand unit is in the base. The battery pack is a pair of 600mAh AA NiCd cells.

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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.



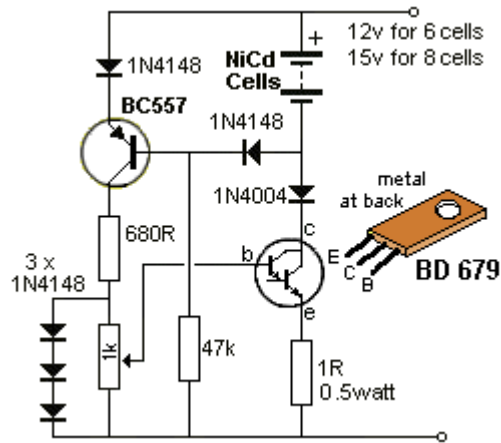
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NiCd BATTERY CHARGER

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

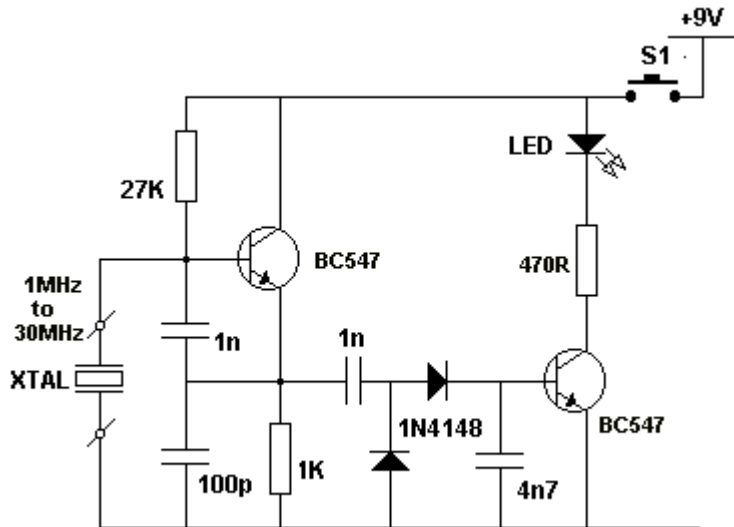
example, a 600 mAh cell is charged at 60mA for 14 hours. If the charging current is too high it will damage the cell. The level of charging current is controlled by the 1k pot from 0mA to 600mA. The BC557 is turned on when NiCd cells are connected with the right polarity. If you cannot obtain a BD679, 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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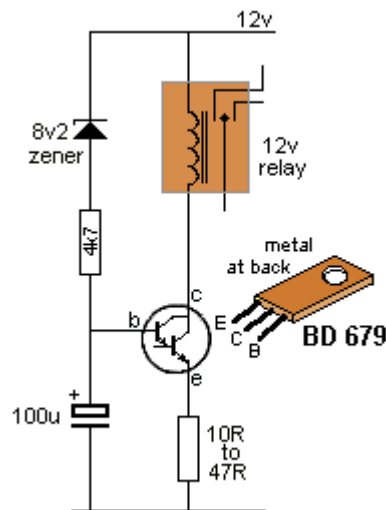
LOW VOLTAGE CUT-OUT

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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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 other 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

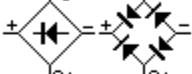
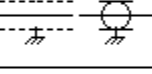
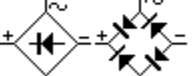
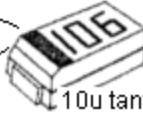
correctly.

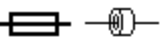
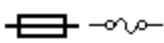
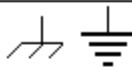
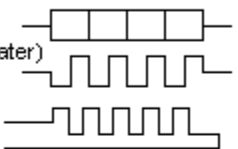
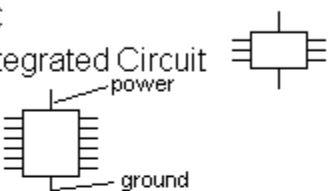
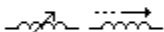
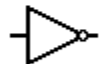
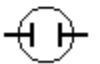
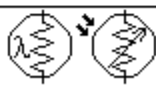
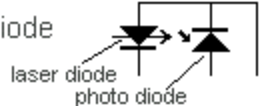
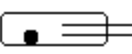
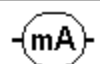
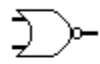
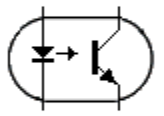
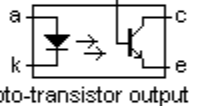
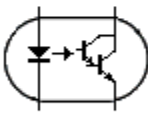
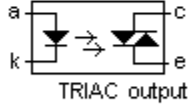
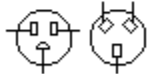
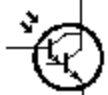
Colin Mitchell

CIRCUIT SYMBOLS

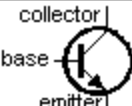
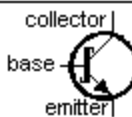
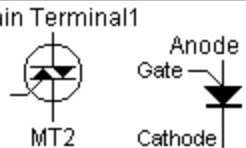
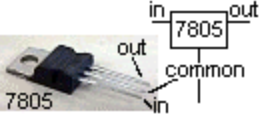
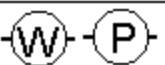
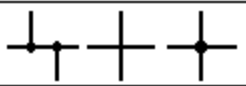
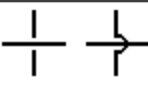
Some additional symbols have been added to the following list. See **Circuit Symbols** on the index of [Talking Electronics.com](http://TalkingElectronics.com)

CIRCUIT SYMBOLS by TALKING ELECTRONICS

AC current:  voltage: 	ALTERNISTOR TRIAC A TRIAC and 33 - 43v DIAC  Main Terminal 1 Gate Main Terminal 2	Ammeter (amp meter) 
AND Gate 	AND Gate 	Antenna balanced 
Antenna Loop, Shielded 	Antenna Loop, Unshielded 	Antenna unbalanced 
Attenuator, fixed (see Resistor) 	Attenuator, variable (see Resistor) 	Battery 
Bilateral Switch (DIAC) 	Bridge Rectifier (Diode Bridge) 	BUFFER (Amplifier Gate) 
BUFFER (Amplifier Gate) 	Buzzer 	Capacitor feedthrough 
Capacitor non-polarised 	Capacitor polarised (see electrolytic) 	Capacitor Variable 
Cavity Resonator 	Cell 	Circuit Breaker 
Coaxial Cable 	CRO - Cathode Ray Oscilloscope 	Crystal Microphone (Piezoelectric) 
Connectors → Plug (male) ↗ Jack (female) ⇨ connected  Plug (male)  (female)	Crystal Piezoelectric 	DC current:  voltage: 
	Darlington Transistor  collector base emitter	Delay Line 
	DIAC (Bilateral Switch) 	Diode 
Diode - Gunn 	Diode - Light Emitting (LED) 	Diode Photo Sensitive 
Diode Photovoltaic 	Diode Bridge (Bridge Rectifier) 	Diode - Pin 
Diode - Varactor 	Diode - Zener 	Earth Ground 
Earpiece (earphone, crystal earpiece) 	Electroluminescence  el	Electret Microphone (Condenser mic) 
Electrolytic (Polarised Capacitor)  alternate symbols: (positive on top)   	Electrolytic - Tanatulum positive end black band or chamfer  10u tantalum	Exclusive-OR Gate (XOR Gate) 
Field Effect Transistor  Drain	Field Effect Transistor  Drain	Flashing LED 

Ferrite Bead 	Fuse 	Galvanometer 
Globe 	Ground Chassis 	Ground Earth 
Heater (immersion heater) (cooker etc) 	IC Integrated Circuit 	Inductor Air Core 
Headphone 		Inductor Iron Core or ferrite core  
Inductor Tapped 	Inductor Variable 	Integrated Circuit  
Inverter (NOT Gate) 	INVERTER (NOT Gate) 	
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) 	Microphone (see Electret Mic)  
Microphone (Crystal - piezoelectric) 	Milliamp meter (milli-ammeter) 	Motor 
NAND Gate 	NAND Gate 	Nitinol wire "Muscle wire" 
Negative Voltage Connection 	NOR Gate 	NOR Gate 
NOT Gate Inverter 	NOT Gate Inverter 	Ohm meter 
Operational Amplifier (Op Amp) 	Optocoupler (Transistor output) 	Opto Coupler (Opto-isolator)  Photo-transistor output
Optocoupler (Darlington output) 	Opto Coupler (Opto-isolator)  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 (Field Effect Transistor) 	Photo Transistor 

Photovoltaic Cell (Solar Cell)		Piezo Tweeter (Piezo Speaker)		Positive Voltage Connection	
Potentiometer (variable resistor)		Programmable Unijunction Transistor PUT		Rectifier Silicon Controlled (SCR)	
Rectifier Semiconductor		Reed Switch		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 Schottky) Low forward voltage 0.3v Fast switching also called Schottky Barrier Diode		Shielding		Shockley Diode 4-layer PNP device Remains off until forward current reaches the forward break-over voltage.	
Silicon Bilateral Switch (SBS)		Silicon Unilateral Switch (SUS)		Silicon Controlled Rectifier (SCR)	
Surface Mount		Switch - spst		Solar Cell	
		Switch - spdt		Switch - process activated normally open: normally closed:	
		Switch - dpst		Flow	
		Switch - dpdt		Level	
		Switch - mercury tilt switch		Pressure	
		Spark Gap		Temperature	
Switch - push (Push Button)		Switch - push off (used in alarms etc)		Speaker	
Test Point		Thyristors: Main Terminal1		Switch - Rotary	
Thermal Probe		Thyristors: Bilateral Switch		Thermocouple	
Transformer		Thyristors: SCR		Tilt switch mercury	
		Thyristors: TRIAC		Touch Sensor	
		Thyristors: TRIAC		Transformer	

Transistor Bipolar - NPN		Transistor Bipolar - PNP		Transistor n-channel Field Effect	
Transistor p-channel Field Effect		Transistor Metal Oxide Single Gate		Transistor Metal Oxide Dual Gate	
Transistor Photosensitive		Transistor Schottky - NPN		Transistor Unijunction - UJT Unijunction Transistor (UJT) N-type	
TRIAC		Transistor Unijunction - UJT Unijunction Transistor (UJT) P-type		Tunnel Diode	
Varactor varactor diode		Voltage Regulator (7805 etc)		Voltmeter	
Wattmeter		Wires		Wires Connected	
Wires Not Connected		XOR Gate (exclusive OR)		XOR Gate (exclusive OR)	
Zener Diode		Learn BASIC ELECTRONICS Go to: http://www.talkingelectronics.com			

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IC PINOUTS

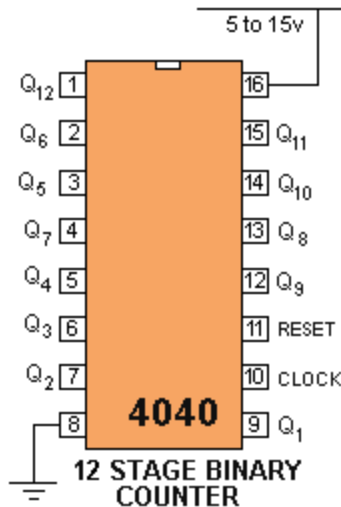
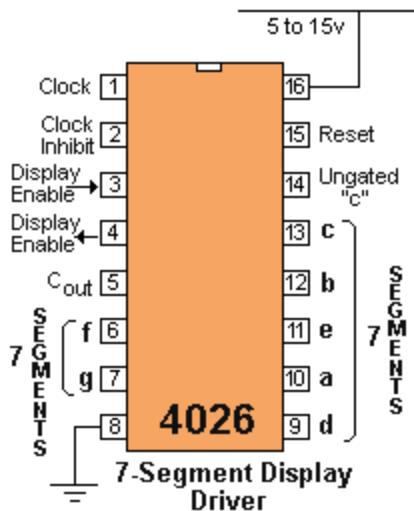
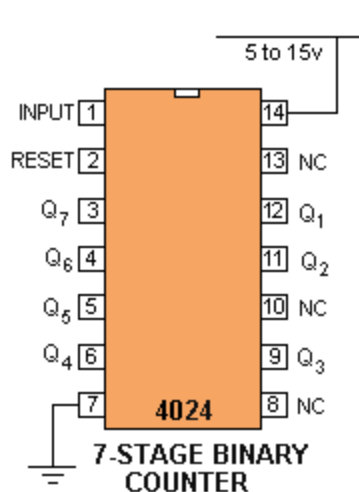
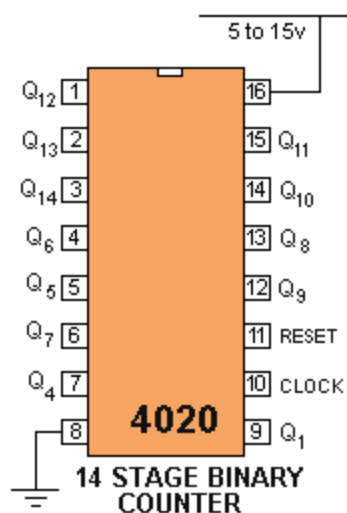
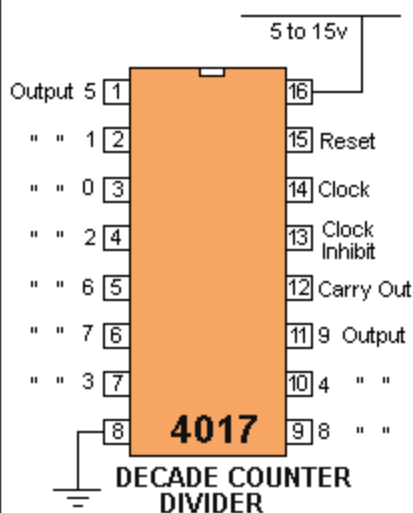
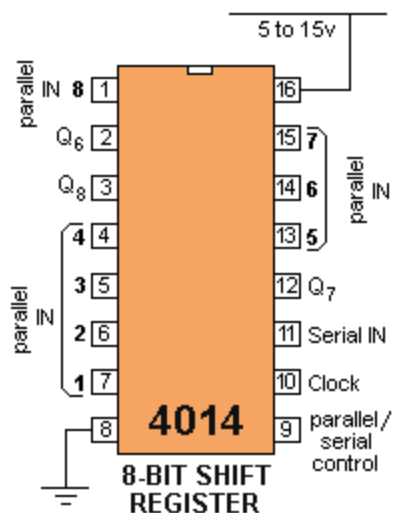
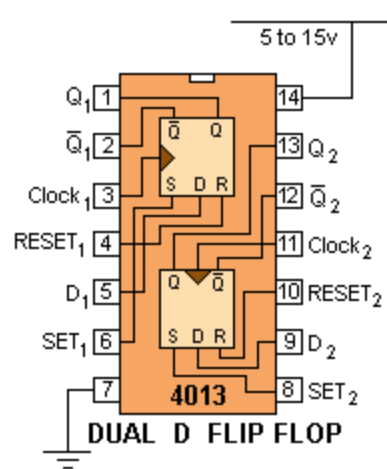
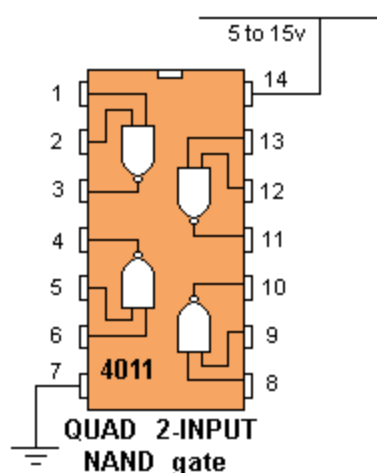
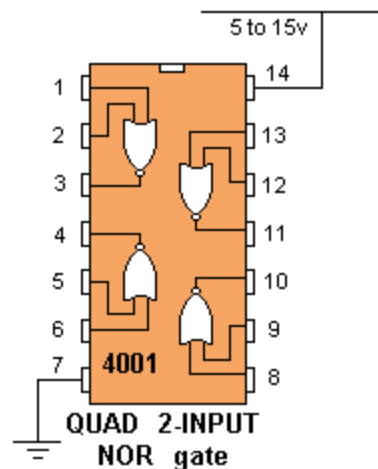
The following list covers just a few of the IC's on the market and these are the "simple" or "basic" or "digital" or "op-amp" IC's suitable for experimenting.

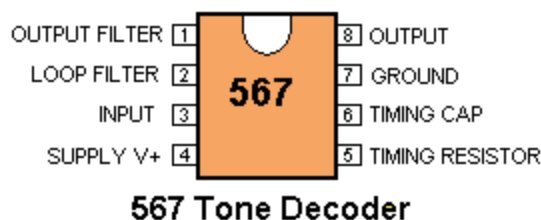
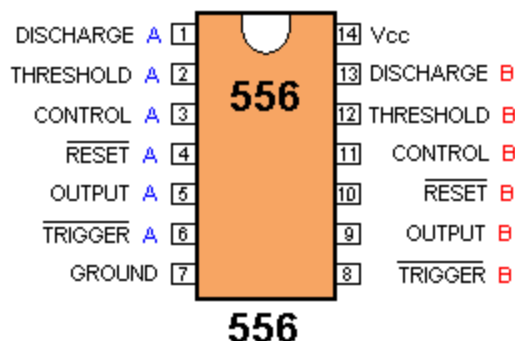
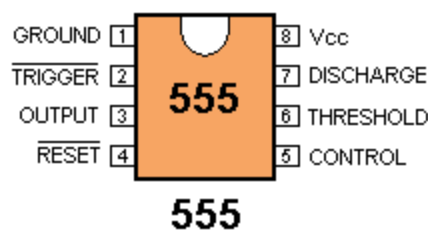
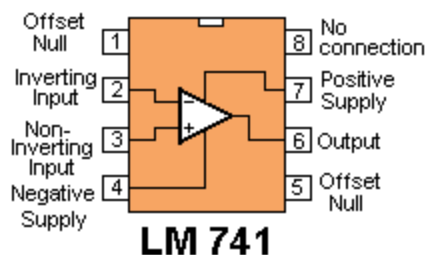
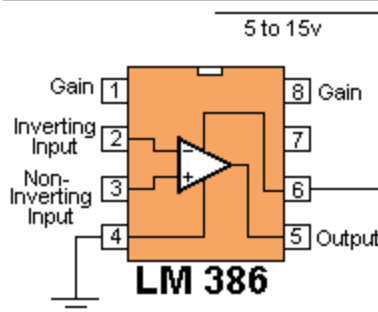
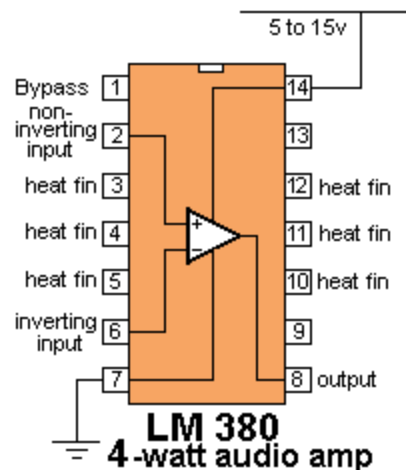
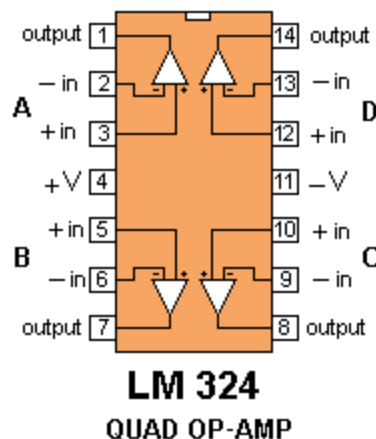
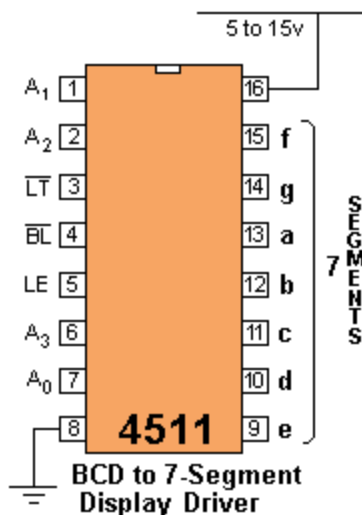
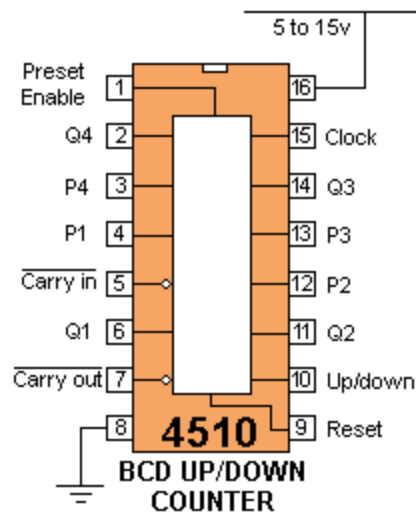
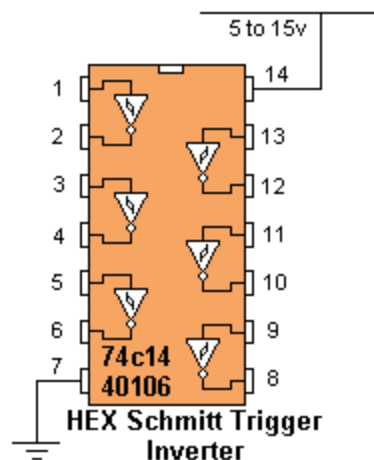
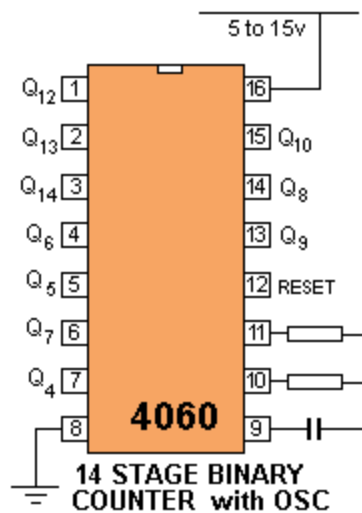
When designing a circuit around an IC, you have to remember two things:

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 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.

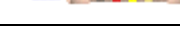


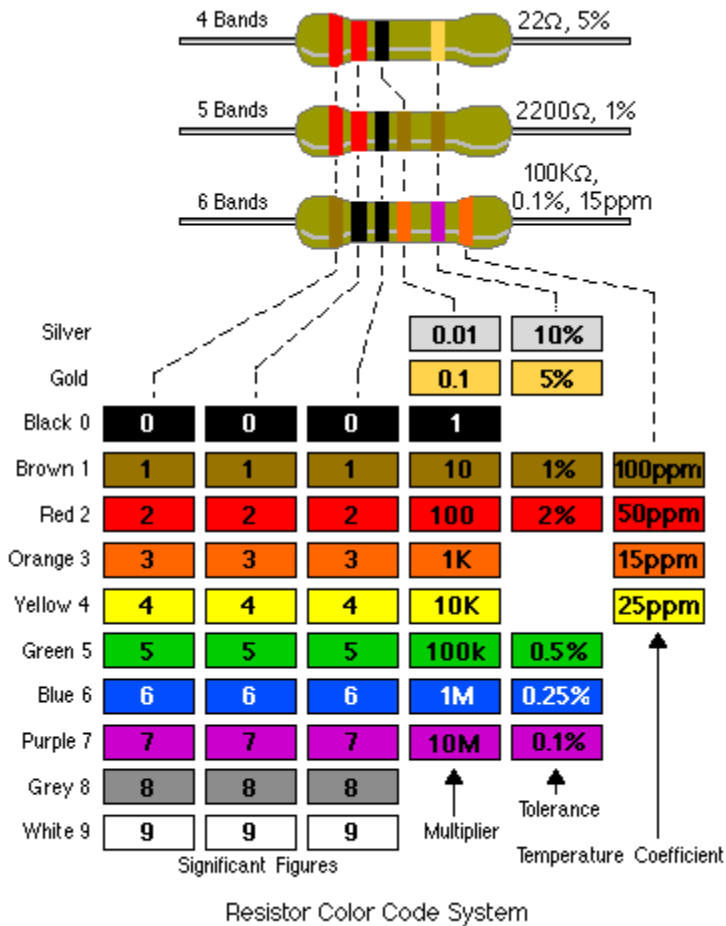


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All the resistor colours:

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.

			
			
			
			
			
			
			
			
			
			
			
			
			
			
			
			
			
			
			zero ohm (link)
			
			$\frac{1}{10}$ th watt
			and
			0.25 watt
			



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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

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.

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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