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Go to: [101 - 200 Transistor Circuits](#)

Go to: [50 - 555 Circuits](#)

# Talking Electronics

See [TALKING ELECTRONICS WEBSITE](#)

email Colin Mitchell: [talking@tpg.com.au](mailto:talking@tpg.com.au)

## INTRODUCTION

This is the third part of our **Circuits** e-book series. It contains a further 100 circuits. This time we have concentrated on circuits containing one or more IC's. It's amazing what you can do with transistors but when Integrated Circuits came along, the whole field of electronics exploded.

IC's can handle both analogue as well as digital signals but before their arrival, nearly all circuits were analogue or very simple "digital" switching circuits.

Let's explain what we mean.

The word analogue is a waveform or signal that is changing (increasing and decreasing) at a constant or non constant rate. Examples are voice, music, tones, sounds and frequencies. Equipment such as radios, TV's and amplifiers process analogue signals.

Then digital came along.

Digital is similar to a switch turning something on and off.

The advantage of digital is two-fold.

Firstly it is a very reliable and accurate way to send a signal. The signal is either HIGH or LOW (ON or OFF). It cannot be half-on or one quarter-off.

And secondly, a circuit that is ON, consumes the least amount of energy in the controlling device. In other words, a transistor that is fully turned ON and driving a motor, dissipates the least amount of heat. If it is slightly turned ON or nearly fully turned ON, it gets very hot.

And obviously a transistor that is not turned on at all will consume no energy.

A transistor that turns ON fully and OFF fully is called a SWITCH.

When two transistors are cross-coupled in the form of a flip flop, any pulses entering the circuit cause it to flip and flop and the output goes HIGH on every second pulse. This means the circuit halves the input pulses and is the basis of counting or dividing. It is also the basis of a "Memory Cell" as will hold a piece of information.

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" (Boolean logic) and "gates."

Integrated Circuits started with a few transistors in each "chip" and increased to 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).

In this **IC Circuits ebook**, we have presented about 100 interesting circuits using Integrated Circuits.

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 or the components they replace.

In all, they are a fantastic way to get something working with the least componentry.

A list of some of the most common 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](mailto: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

We have said this before but we will say it again: **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 very little practical experience. The other is to "learn on the job."

I am not saying one approach is better than the other but most electronics enthusiasts are not "book worms" and many have been dissuaded from entering electronics due to the complex mathematics surrounding University-type courses.

Our method is to get around this by advocating designing, building, constructions and even more assembly with lots of experimenting and when you get stuck with a mathematical problem, get some advice or read about it via the thousands of free test books on the web.

Anyone can succeed in this field by applying themselves to constructing projects. You actually learn 10 times faster by doing it yourself and we have had lots of examples of designs from students in the early stages of their career.

And don't think the experts get it right the first time. Look at all the recalled electronics equipment from the early days.

The most amazing inventions have come from almost "newcomers" as evidenced by looking through the "New Inventions" website.

All you have to do is see a path for your ideas and have a goal that you can add your ideas to the "Word of Invention" and you succeed.

Nothing succeeds like success. And if you have a flair for designing things, electronics will provide you a comfortable living for the rest of your life.

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" 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.

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.

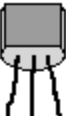
If you just follow these ideas, you will succeed.

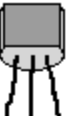
A few of the basics are also provided in this eBook, the first is transistor outlines:

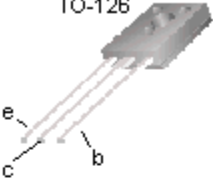
## TRANSISTORS


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:

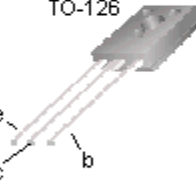
**NPN**  
  
 c b e  
 BC 547  
 BC 337/8


**PNP**  
  
 c b e  
 BC 557  
 BC 327/8


**NPN**  
 TO-126  
  
 e c b  
 BD 139  
 BD 679 (darlington)

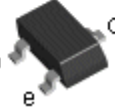
**NPN**  
  
 e b c  
 2N 3904  
 2N 2222

**PNP**  
  
 e b c  
 2N 3906

**PNP**  
 TO-126  
  
 e c b  
 BD 140

**NPN**  
  
 e c b  
 BC 639

**PNP**  
  
 e c b  
 BC 640

**SOT23**  
  
 b e c

## CONTENTS

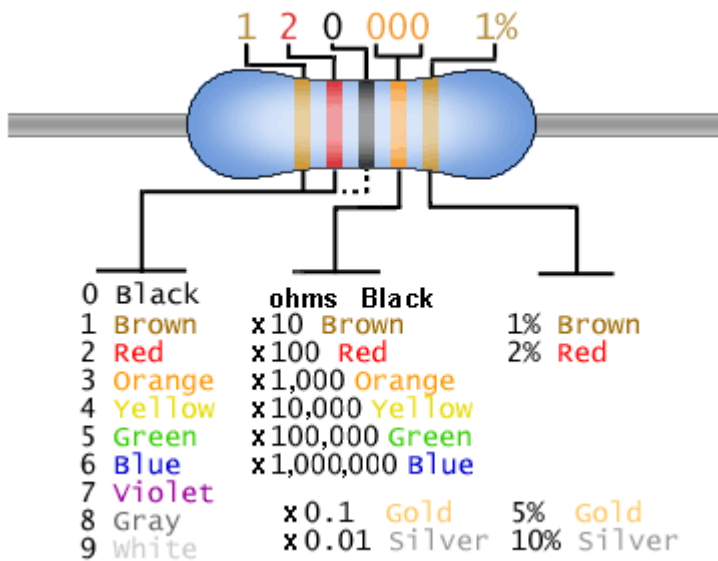
[Activate after 3 rings](#)  
[Active for 1 second](#)  
[Adjustable Voltage Supply](#)  
[Alarm 4-Zone](#)  
[AND Gate](#)  
[Any Capacitor Value](#)  
[Any Resistor Value](#)  
[Battery Charger](#) - Gell Cell  
[Battery-Low Beeper](#)  
[BFO Metal Locator](#)  
[Brake Lights](#) (flash 3 times)  
[Burglar Alarm](#)  
[Burglar Alarm 4-Zone](#)  
[Clap Switch](#)  
[Constant Current 20mA](#)  
[CRO](#) - 100 LED CRO  
[Current Limiting](#)  
[Dice](#)  
[Domino Effect](#)  
[Flash LEDs for 20 Seconds](#)  
[Gates](#)  
[Gell Cell Battery Charger](#)  
[Home Alarm](#)  
[Intercom](#)  
[Knight Rider](#) - Kitt Scanner  
[Knight Rider for High-power LEDs](#)  
[Knock Knock Doorbell](#)  
[Ladybug Robot](#)

[Logic Gates](#)  
[Logic Probe](#) - Simple  
[Logic Probe with pulse](#)  
[Long Duration Timer](#)  
[Low-Battery Beeper](#)  
[Mains Detector](#)  
[Metal Detector](#) - BFO  
[Phone Charger](#)  
[Phone ring detector](#)  
[Phone Ringer](#)  
[Police Lights](#)  
[Resistor Colour Code](#)  
[Simple BFO Metal Locator](#)  
[Simple Logic Probe](#)  
[Solar Tracker](#)  
[Timer](#) - Long Duration  
[Transistor Tester](#) - Combo-2  
[Water Level Pump Controller](#)  
[Wheel Of Fortune](#)  
[1.5v to 5v Phone Charger](#)  
[2-Sector Burglar Alarm](#)  
[4 Pumps](#)  
[4-Zone Burglar Alarm](#)  
[10 LED Chaser](#)  
[10 Minute & 30 Minute Timer](#)  
[10 Second Alarm](#)  
[20mA Constant Current](#)  
[100 LED CRO](#)

[LED CRO](#)  
[LED Dice](#)  
[LED Zeppelin](#) - a game of skill

[555](#)  
[74c14](#)

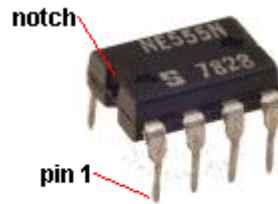
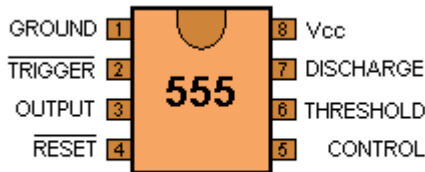
## RESISTOR COLOUR CODE



## THE 555

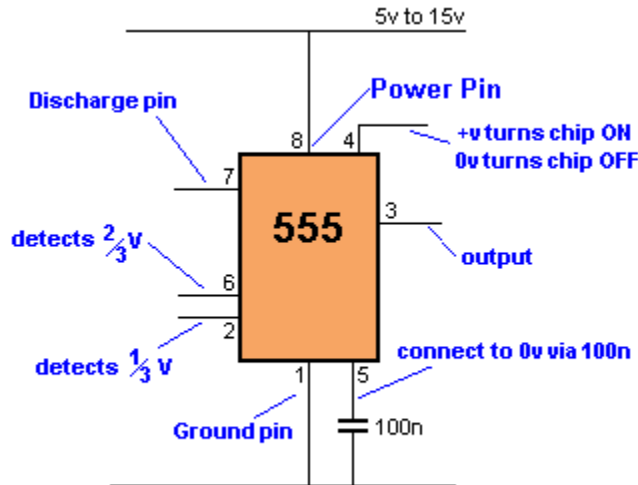
The 555 is everywhere. It is possibly the most-frequency used chip and is easy to use. But if you want to use it in a "one-shot" or similar circuit, you need to know how the chip will "sit." For this you need to know about the UPPER THRESHOLD (pin 6) and LOWER THRESHOLD (pin 2):  
The 555 is fully covered in a 3 page article on Talking Electronics website (see left index: 555 P1 P2 P3)

Here is the pin identification for each pin:

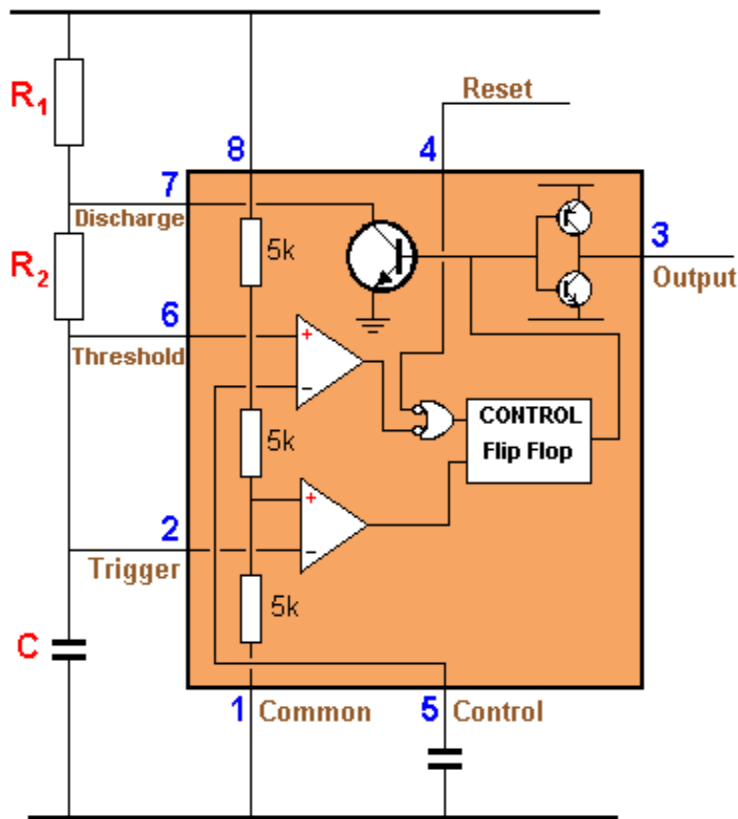


## 555 PINOUT

When drawing a circuit diagram, always draw the 555 as a building block with the pins in the following locations. This will help you instantly recognise the function of each pin:



## The Function of each PIN



## INSIDE THE 555 CHIP

Note: Pin 7 is "in phase" with output Pin 3 (both are low at the same time).

Pin 7 "shorts" to 0v via the transistor. It is pulled HIGH via R1.

Maximum supply voltage 16v - 18v

Current consumption approx 10mA

Output Current sink @5v = 5 - 50mA @15v = 50mA

Output Current source @5v = 100mA @15v = 200mA

Maximum operating frequency 300kHz - 500kHz

### Faults with Chip:

Consumes about 10mA when sitting in circuit

Output voltage up to 2.5v **less than rail voltage**

**Output is 0.5v to 1.5v above ground**

Sources up to 200mA but sinks only 50mA

## HOW TO USE THE 555

There are many ways to use the 55.

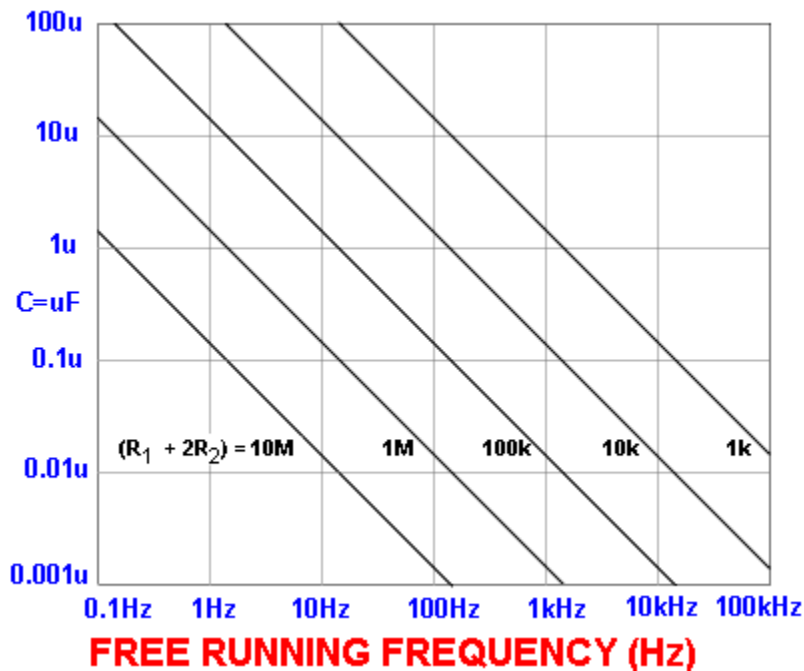
(a) Astable Multivibrator - constantly oscillates

(b) Monostable - changes state only once per trigger pulse - also called a ONE SHOT

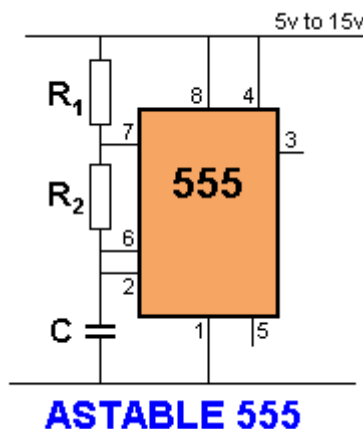
(c) Voltage Controlled Oscillator

## ASTABLE MULTIVIBRATOR

The output frequency of a 555 can be worked out from the following graph:



The graph applies to the following Astable circuit:



**ASTABLE 555**

The capacitor C charges via R1 and R2 and when the voltage on the capacitor reaches 2/3 of the supply, pin 6 detects this and pin 7 connects to 0v. The capacitor discharges through R2 until its voltage is 1/3 of the supply and pin 2 detects this and turns off pin 7 to repeat the cycle.

The top resistor is included to prevent pin 7 being damaged as it shorts to 0v when pin 6 detects 2/3 rail voltage. Its resistance is small compared to R2 and does not come into the timing of the oscillator.

### Using the graph:

Suppose  $R_1 = 1k$ ,  $R_2 = 10k$  and  $C = 0.1$  (100n).

Using the formula on the graph, the total resistance  $= 1 + 10 + 10 = 21k$

The scales on the graph are logarithmic so that 21k is approximately near the "1" on the 10k.

Draw a line parallel to the lines on the graph and where it crosses the 0.1u line, is the answer.

The result is approx 900Hz.

Suppose  $R_1 = 10k$ ,  $R_2 = 100k$  and  $C = 1u$

Using the formula on the graph, the total resistance  $= 10 + 100 + 100 = 210k$

The scales on the graph are logarithmic so that 210k is approximately near the first "0" on the 100k.

Draw a line parallel to the lines on the graph and where it crosses the 1u line, is the answer.

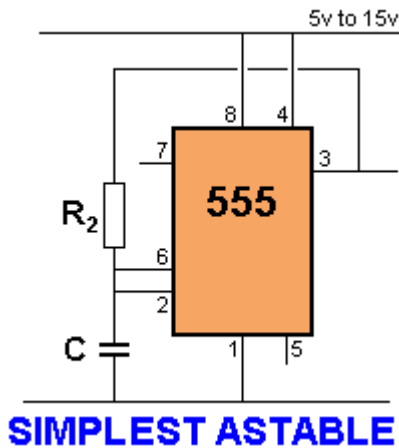
The result is approx 9Hz.

The frequency of an astable circuit can also be worked out from the following formula:

$$\text{frequency} = \frac{1.4}{(R_1 + 2R_2) \times C}$$

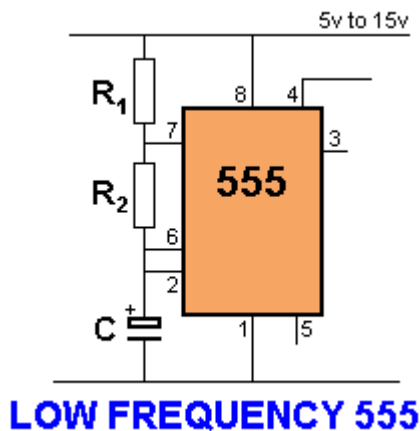
### 555 astable frequencies

C	R <sub>1</sub> = 1k R <sub>2</sub> = 6k8	R <sub>1</sub> = 10k R <sub>2</sub> = 68k	R <sub>1</sub> = 100k R <sub>2</sub> = 680k
0.001μ	100kHz	10kHz	1kHz
0.01μ	10kHz	1kHz	100Hz
0.1μ	1kHz	100Hz	10Hz
1μ	100Hz	10Hz	1Hz
10μ	10Hz	1Hz	0.1Hz



The simplest Astable uses one resistor and one capacitor. Output pin 3 is used to charge and discharge the capacitor.

### LOW FREQUENCY OSCILLATORS



If the capacitor is replaced with an electrolytic, the frequency of oscillation will reduce. When the frequency is less than 1Hz, the oscillator circuit is called a timer or "delay circuit." The 555 will produce delays as long as 30 minutes but with long delays, the timing is not accurate.

### 555 Delay Times:

C	R <sub>1</sub> = 100k R <sub>2</sub> = 100k	R <sub>1</sub> = 470k R <sub>2</sub> = 470k	R <sub>1</sub> = 1M R <sub>2</sub> = 1M
10μ	2.2sec	10sec	22sec
100μ	22sec	100sec	220sec
470μ	100sec	500sec	1000sec

### 555 ASTABLE OSCILLATORS

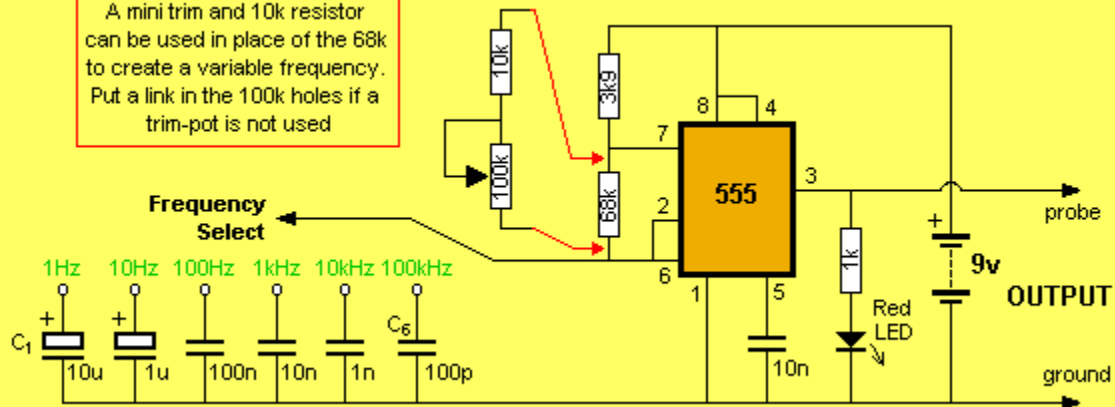
Here are circuits that operate from 300kHz to 30 minutes:

(300kHz is the absolute maximum as the 555 starts to malfunction with irregular bursts of pulses at this high frequency and 30 minutes is about the longest you can guarantee the cycle will repeat.)



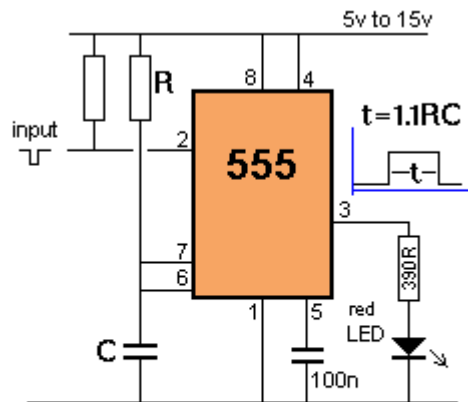


A mini trim and 10k resistor can be used in place of the 68k to create a variable frequency. Put a link in the 100k holes if a trim-pot is not used



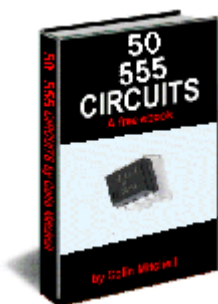
A square wave oscillator kit can be purchased from Talking Electronics for approx \$10.00  
See website: **Square Wave Oscillator**  
It has adjustable (and settable) frequencies from 1Hz to 100kHz and is an ideal piece of Test Equipment.

## 555 Monostable or "one Shot"



## MONOSTABLE OR "ONE-SHOT"

### 50 - 555 CIRCUITS

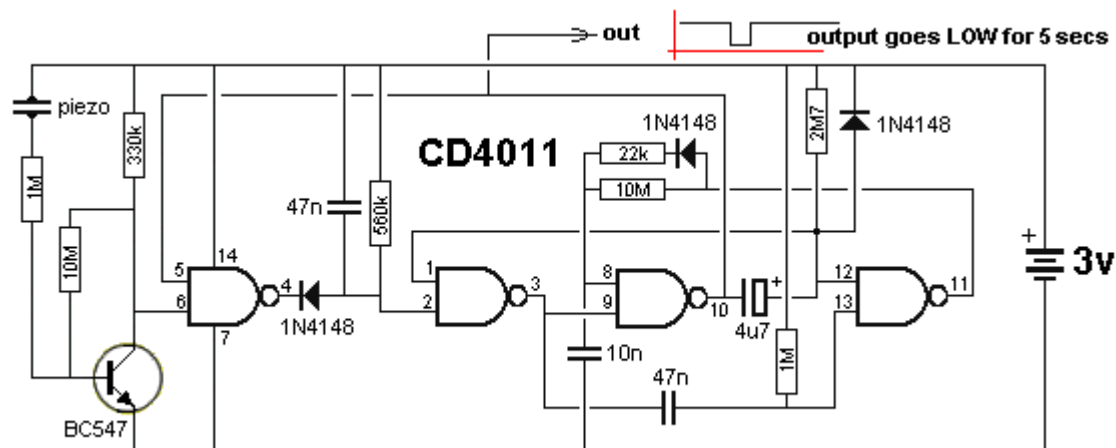


[50 555 Circuits eBook](#) can be accessed on the web or downloaded as a [.doc](#) or [.pdf](#). It has more than 50 very interesting 555 circuits and data on using a 555.

#### Table of Contents: (more has been added - see: 50 - 555 circuits)

Active High Trigger	One-Shot 555
Active Low Trigger	Organ
Amplifier using 555	Police Siren
Astable Multivibrator	Pulse Extender
Bi-Coloured LED	Pulser - 74c14
Bi-Polar LED Driver	PWM Controller
Car Tachometer	Railroad Lights (flashing)
Clark Zapper	Rain Alarm
Clicks Uneven	Replacing 556 with two 555's
Continuity Tester	Resistor Colour Codes
Dark Detector	Screamer Siren - Light Controlled
Driving A Bi-Coloured LED	Servo Tester
Driving A Relay	Simplest 555 Oscillator
Flashing Indicators	Siren 100dB
Flashing Railroad Lights	Square Wave Oscillator
Flip Flop	Stun Gun
Function of each 555 pin	Substituting a 555 - Part 1
Hee Haw Siren	Substituting a 555 - Part 2
High Frequency 555 Oscillator	Switch Debounce
How to use the 555	Tachometer
Increasing Output Current	Ticking Bomb
Increasing Output Push-Pull Current	Tilt Switch
Inverter 12v to 240v	Touch Switch
Inside the 555	Toy Organ
Kitt Scanner	Transistor Tester
Knight Rider	Trigger Timer - 74c14
Laser Ray Sound	Uneven Clicks
Latch	Using the 555

LED Dimmer	Voltage Doubler
Light Controlled Screamer Siren	Wailing Siren
Light Detector	Zapper (Dr Clark)
Low Frequency 555 Oscillator	Zener Diode Tester
Machine Gun	2 Minute Timer - 74c14
Memory Cell	10 Minute Timer - 74c14
Metal Detector	12v to 240v Inverter
Monostable 555	100dB Siren
Morse Keyer	555 Amplifier
Mosquito Repellent	555 Kit of Components
Motor PWM	555 Pinout
Multivibrator - Astable	555 Mistakes (No-No's)
Negative Voltage	556 Dual Timer
Normally Closed Trigger	



## KNOCK KNOCK DOORBELL

This very clever circuit only produces an output when the piezo detects two taps. It can be used as a knock-knock doorbell. A PC board containing all components (soldered to the board) is available from talking electronics for \$5.00 plus postage. Email [HERE](#) for details.

The circuit takes only a few microamp and when a tap is detected by the piezo, the waveform from the transistor produces a HIGH on pin 6 and the HIGH on pin 5 makes output pin 4 go low. This very quickly charges the 47n and it is discharged via the 560k to produce a brief pulse at pin 3.

The 47n is mainly to stop noise entering pin 2. Pin 1 is HIGH via the 2M7 and the LOW on pin 2 causes pin 3 to produce a HIGH pulse. The 47n is discharged via the internal diodes on pin 13 and when it goes LOW, pin 11 goes HIGH and charges the 10n via the 22k and diode.

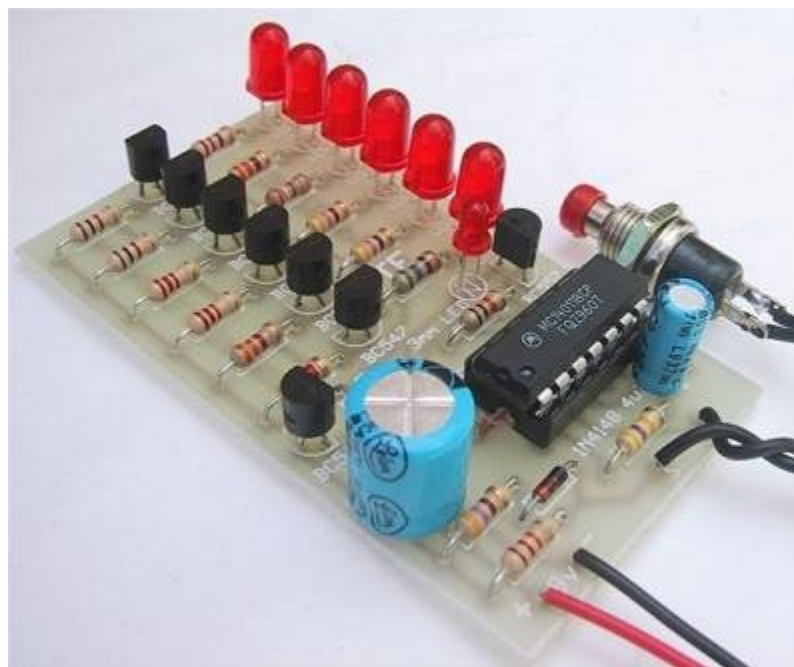
This puts a HIGH on pin 8 for approx 0.7 seconds and when a second tap is detected, pin 9 sees a HIGH and pin 10 goes LOW. This puts a LOW on pin 12 and a HIGH on pin 8. The LOW on pin 12 goes to pin 1. A HIGH and LOW on the second NAND gate produces a HIGH on pin 3 and the third NAND gate has a HIGH on both inputs. This makes pin 10 LOW and the 4u7 starts to charge via the 2M7 resistor. After 5 seconds pin 12 sees a HIGH and pin 11 goes LOW. The 10n is discharged via the 10M and when pin 8 sees a LOW, pin 10 goes HIGH. The output sits HIGH and goes LOW for about 7 seconds.

## LED ZEPPELIN

This circuit is a game of skill. See full article: [LED Zeppelin](#). The kit is available from talking electronics for \$15.50 plus postage. Email [HERE](#) for details. The game consists of six LEDs and an indicator LED that flashes at a rate of about 2 cycles per second. A push button is the "Operations Control" and by carefully pushing the button in synchronisation with the flashing LED, the row of LEDs will gradually light up.

But the slightest mistake will immediately extinguish one, two or three LEDs. The aim of the game is to illuminate the 6 LEDs with the least number of pushes.

We have sold thousands of these kits. It's a great challenge.

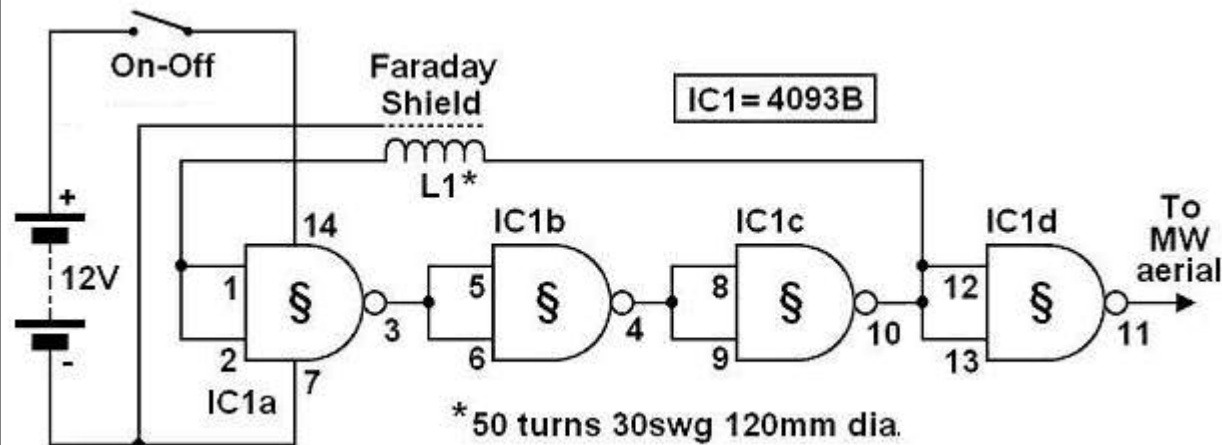


0V. A Faraday shield is a wrapping of tin foil around the coil, leaving a small gap so that the foil does not complete the entire circumference of the coil. The Faraday shield is again wrapped in insulation tape. A connection may be made to the Faraday shield by wrapping a bare piece of stiff wire around it before adding the tape. Ideally, the search coil will be wired to the circuit by means of twin-core or figure-8 microphone cable, with the screen being wired to the Faraday shield.

The metal detector is set up by tuning the MW radio to pick up a whistle (a harmonic of 2 MHz). Note that not every such harmonic works best, and the most suitable one needs to be found. The presence of metal will then clearly change the tone of the whistle. The metal detector has excellent stability, and it should detect a large coin at 80 to 90 mm, which for a BFO detector is relatively good. It will also discriminate between ferrous and non-ferrous metals through a rise or fall in tone.

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The author may be contacted at [scarboro@iafrica.com](mailto:scarboro@iafrica.com)



## SIMPLE BFO METAL LOCATOR

This circuit uses a single coil and nine components to make a particularly sensitive low-cost metal locator. It works on the principle of a beat frequency oscillator (BFO).

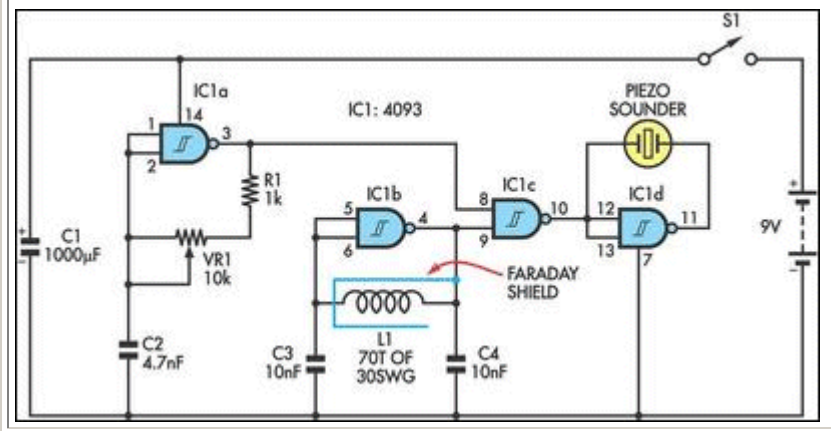
The circuit incorporates two oscillators, both operating at about 40kHz. The first, IC1a, is a standard CMOS oscillator with its frequency adjustable via VR1.

The frequency of the second, IC1b, is highly dependent on the inductance of coil L1, so that its frequency shifts in the presence of metal. L1 is 70 turns of 0.315mm enamelled copper wire wound on a 120mm diameter former. The Faraday shield is made of aluminum foil, which is wound around all but about 10mm of the coil and connected to pin 4 of IC1b.

The two oscillator signals are mixed through IC1c, to create a beat note. IC1d and IC1c drive the piezo sounder in push-pull fashion, thereby boosting the output.

Unlike many other metal locators of its kind, this locator is particularly easy to tune. Around the midpoint setting of VR1, there will be a loud beat frequency with a null point in the middle. The locator needs to be tuned to a low frequency beat note to one or the other side of this null point.

Depending on which side is chosen, it will be sensitive to either ferrous or non-ferrous metals. Besides detecting objects under the ground, the circuit could serve well as a pipe locator.



## 1.5v to 5v PHONE CHARGER

Look at the photos. The circuit is simple. It looks like two surface-mount transistors, an inductor, diode, capacitor, resistor and LED.

But you will be mistaken.

One of the "transistors" is a controller and the other is a FET.

The controller is powered from the output (5v) of the circuit and when it detects no-load, it shuts down and requires a very small current.

When the 1.5v battery is connected, the controller starts up at less than 1.5v due to the Schottky diode and charges the 1u capacitor by driving the FET and using the flyback effect of the inductor to produce a high voltage. When the output voltage is 5v, the controller turns off and the only load on the 1u is the controller. When the voltage drops across this capacitor, the controller turns on in bursts to keep the 1u charged to exactly 5v. The charger was purchased for \$3.00 so it is cheaper to buy one and use it in your own project. It also comes with 4 adapter leads!



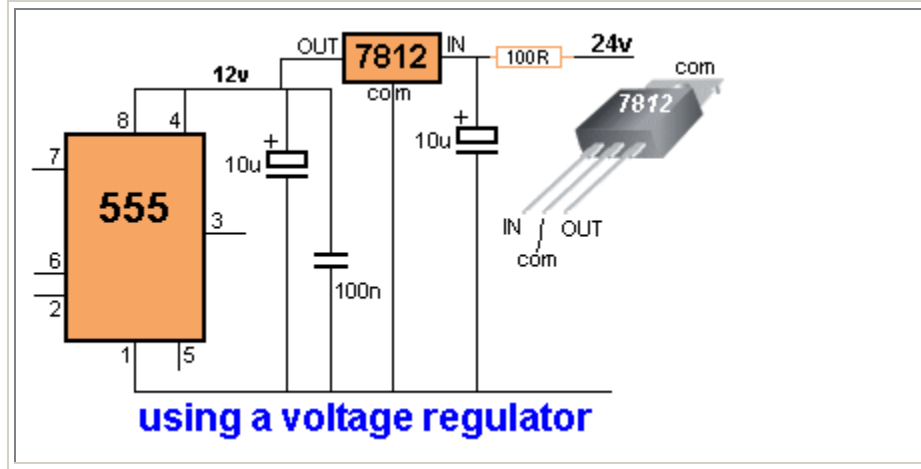
**The AA case and 4 adapter leads - cost: \$3.00!!**





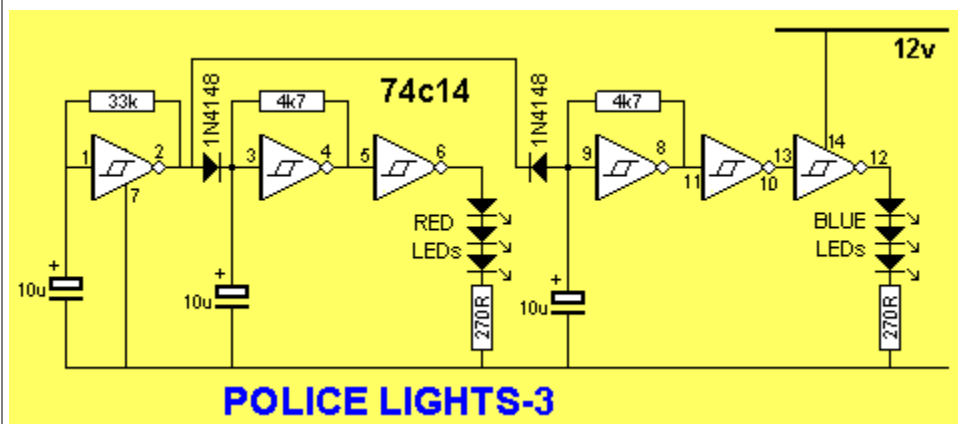
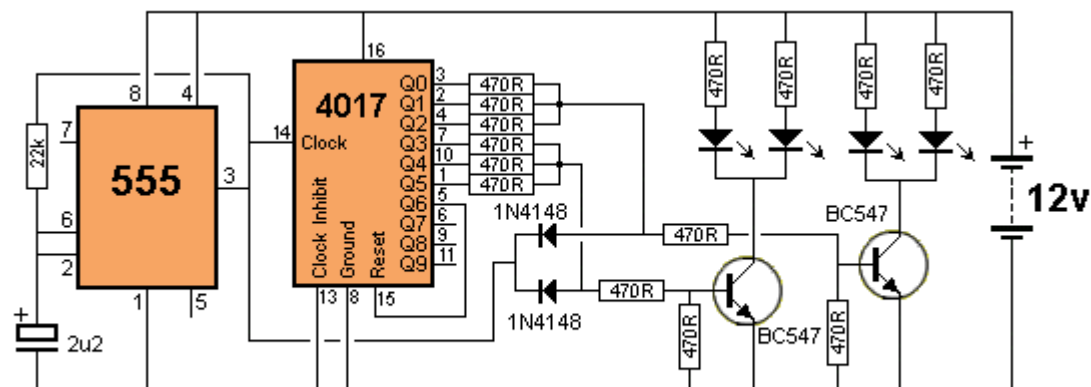
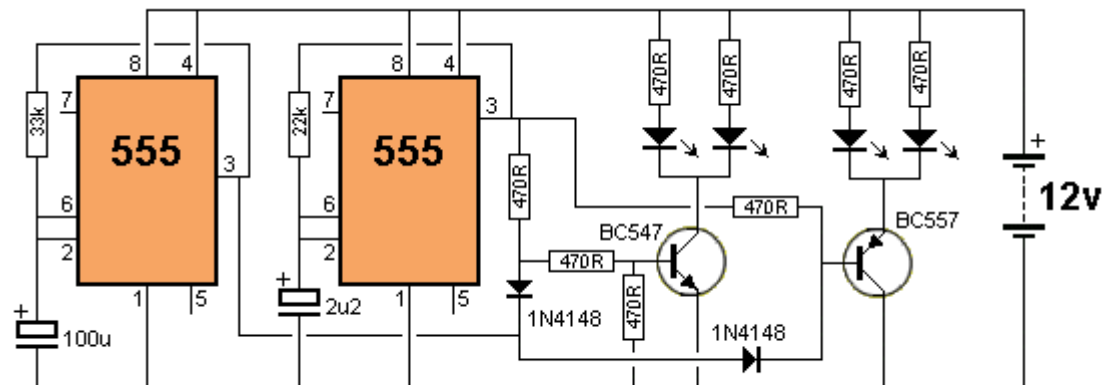






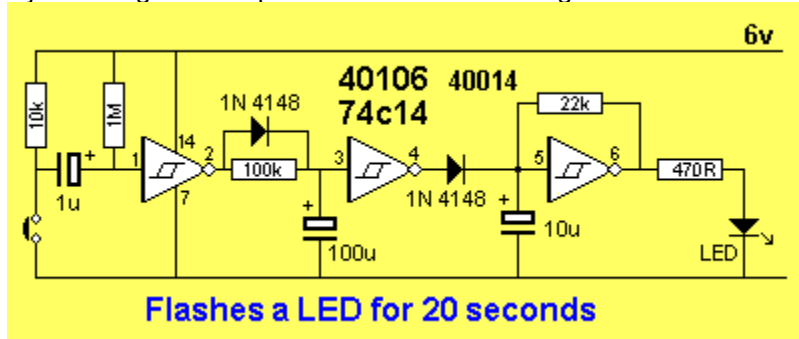
## POLICE LIGHTS

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

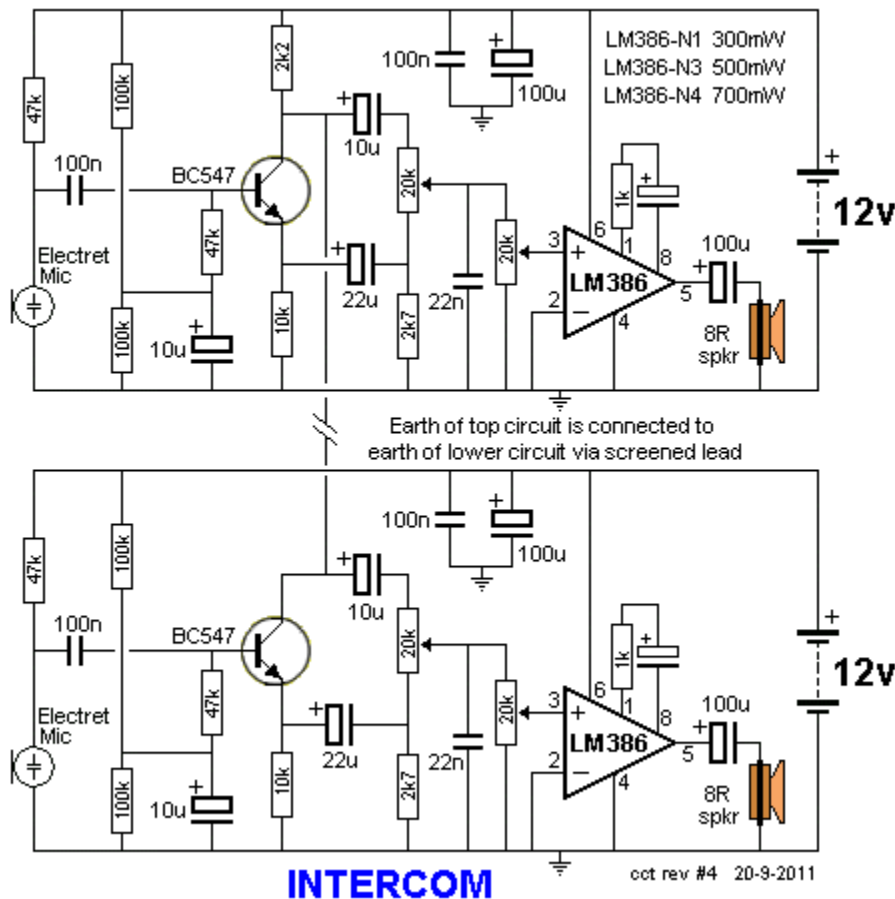


## FLASH LEDs FOR 20 SECONDS

This circuit comes from a request from a reader. It flashes a LED for 20 seconds after a switch is pressed. In other words, for 20 seconds as soon as the switch is pressed. The values will need to be adjusted to get the required flash-rate and timing.



## INTERCOM



This circuit uses a single transistor and LM386 amplifier IC to produce an intercom that allows hands-free operation.

As both microphones and loudspeakers are always connected, the circuit is designed to avoid feedback - known as the "Larsen effect".

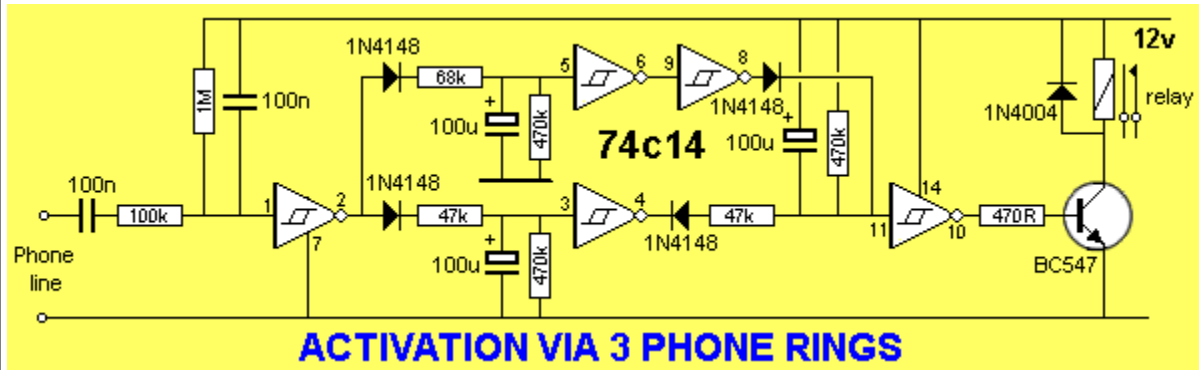
The microphone amplifier transistor is 180° phase-shifted and one of the audio outputs is taken at the collector and its in-phase output taken at the emitter. These are mixed by the 10u, 22u, 20k pot and 2k7 so that the two signals almost cancel out. In this way, the loudspeaker will reproduce a very faint copy of the signals picked-up by the microphone.

At the same time, as both collectors of the two intercom units are tied together, the 180° phase-shifted signal will pass to the audio amplifier of the second unit without attenuation, so it will be loudly reproduced by its loudspeaker.

The same operation will occur when speaking into the microphone of the second unit. When the 20k pot is set correctly, almost no output will be heard from the loudspeaker but a loud and clear reproduction will be heard at the output of the other unit. The second 20k pot adjusts the volume.

## ACTIVATE VIA 3 PHONE RINGS

This circuit connects to a phone line. When the phone rings for 3 or 4 rings, the relay is activated for about 1 minute. But if the phone rings for 6 or more rings, the circuit is not activated. The circuit takes less than 100uA when in quiescent state and when the phone rings, the ring voltage is passed to pin 1 via the 100k and 100nF capacitor. This causes pin 2 to go HIGH and charge two 100uF electrolytics. The lower 100uF charges in 7 seconds and the upper charges in 12 seconds. If the phone rings for only 3 rings, pin 4 goes LOW and charges the third 100uF via a 47k resistor. After a further 7 seconds, pin 10 goes HIGH. If the phone stops ringing after 3 rings, the lower 100uF starts to discharge via the 470k and after about 40 seconds pin 4 goes HIGH. The third 100uF now starts to discharge via the 470k across it and the relay turns off. If the phone rings for more than 5 rings, the top 100uF will charge and pin 6 will go LOW and cause pin 8 to go HIGH and prevent pin 11 going LOW via the gating diode.



## WATER LEVEL PUMP CONTROLLER

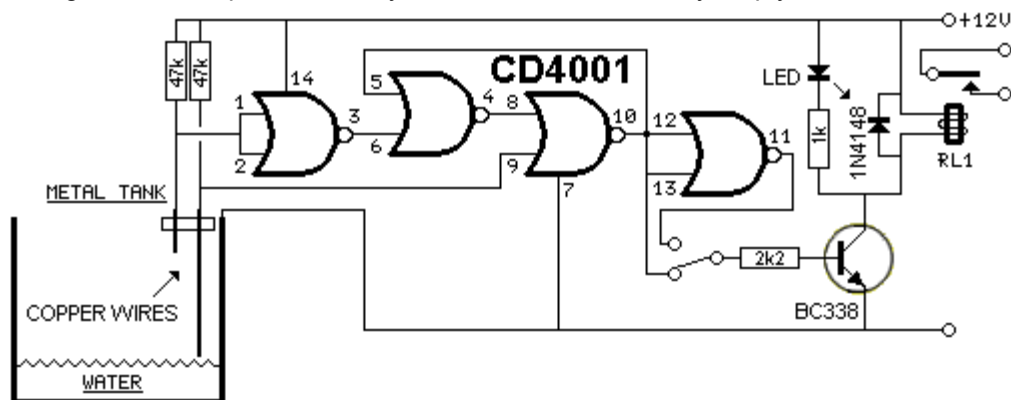
This circuit provides automatic level control of a water tank.

The shorter steel rod is the "water high" sensor and the longer is the "water low" sensor. When the water level is below both sensors, pin 10 is low. If the water comes in contact with the longer sensor the output remains low until the shorter sensor is reached. At this point pin 11 goes high and the transistor conducts. The relay is energized and the pump starts operating. When the water level drops the shorter sensor will be no longer in contact with the water, but the output of the IC will keep the transistor turned ON until the water falls below the level of the longer rod. When the water level falls below the longer sensor, the output of the IC goes low and the pump will stop.

The switch provides reverse operation. Switching to connect the transistor to pin 11 of the IC will cause the pump will operate when the tank is nearly empty and will stop when the tank is full. In this case, the pump will be used to fill the tank and not to empty it.

Note: The two steel rods must be supported by a small insulated (wooden or plastic) board. The circuit can be used also with non-metal tanks, provided a third steel rod having about the same height as the tank is connected to the negative.

Adding an alarm to pin 11 will let you know the tank is nearly empty.



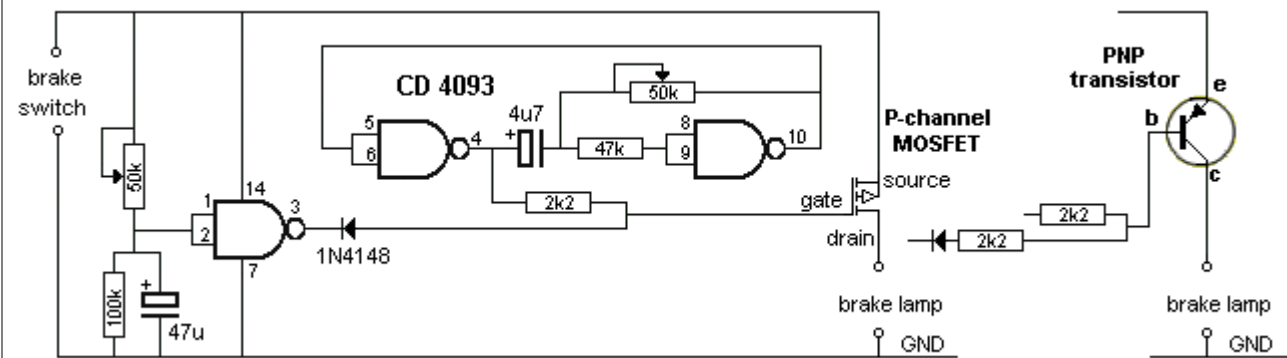
## BRAKE LIGHTS

This circuit makes the brake lights flash a number of times then stay ON. The circuit shows how a MOSFET works. The MOSFET is turned on with a voltage between the gate and source. This occurs in the circuit when the gate is LOW. The P-channel MOSFET can be replaced by a PNP transistor with the addition of a 2k2 resistor between the diode and base, to prevent the transistor being damaged when output pin 3 goes LOW. Ideally the PNP transistor should be replaced with a Darlington transistor.

This circuit originally designed by:

Ken Moffett

Scientific Instrumentation



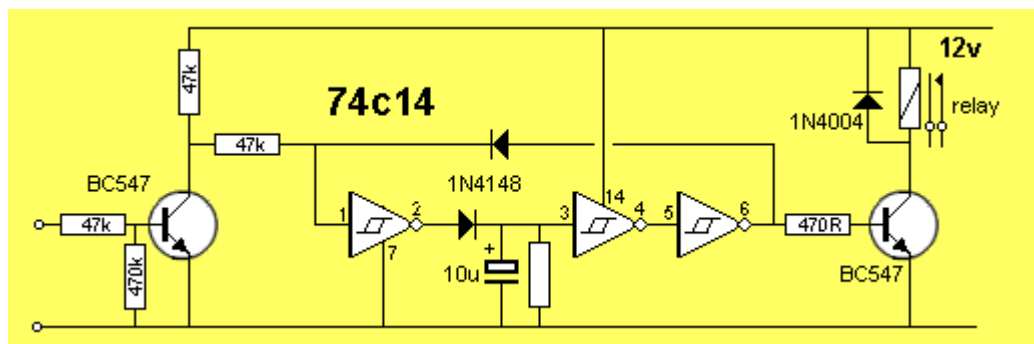
**ACTIVE FOR 1 SECOND**

This circuit is active for 1 second after it detects a signal on the base of the input transistor. The length of activation depends on the value of the resistor across the 10u electrolytic.

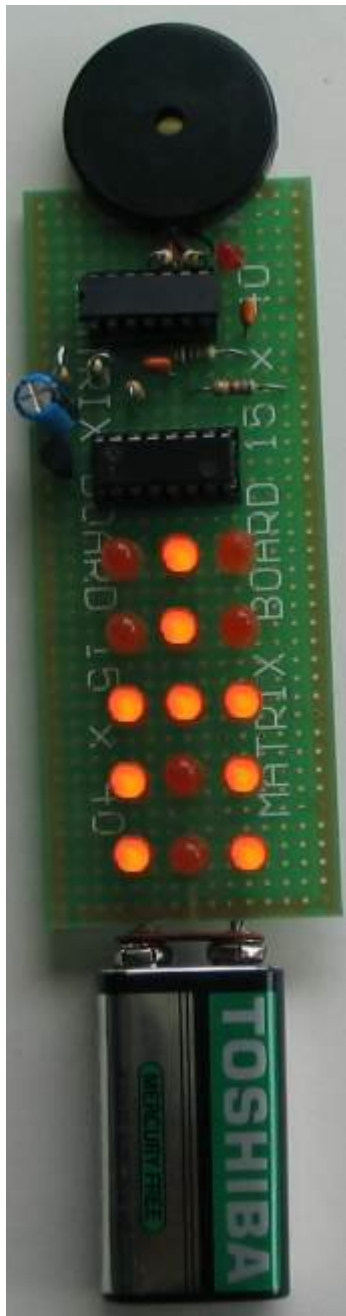
When pin 1 goes LOW, pin 2 goes HIGH and charges the 10u. Pin 3 goes HIGH, pin 4 goes LOW and pin 6 goes HIGH to turn on the transistor and activate the relay.

At the same time a HIGH is passed to pin 1 to keep it HIGH.

Pin 2 will be kept LOW and the 10u will discharge via the resistor across it and eventually pin 3 will go LOW and the relay will turn off. If a signal is still present on the base of the input transistor, the relay will remain energised as the circuit will charge the 10u again.



## THE DOMINO EFFECT



Here's a project with an interesting name. The original design was bought over 40 years ago, before the introduction of the electret microphone.

They used a crystal earpiece.

We have substituted it with a piezo diaphragm and used a quad op-amp to produce two building blocks. The first is a high-gain amplifier to take the few millivolts output of the piezo and amplify it sufficiently to drive the input of a counter chip. This requires a waveform of at least 6v for a 9v supply and we need a gain of about 600.

The other building block is simply a buffer that takes the high-amplitude waveform and delivers the negative excursions to a reservoir capacitor (100u electrolytic). The charge on this capacitor turns on a BC557 transistor and this effectively takes the power pin of the counter-chip to the positive rail via the collector lead.

The chip has internal current limiting and some of the outputs are taken to sets of three LEDs.

The chip is actually a counter or divider and the frequency picked up by the piezo is divided by 128 and delivered to one output and divided by over 8,000 by the highest-division output to three more LEDs. The other lines have lower divisions.

This creates a very impressive effect as the LEDs are connected to produce a balanced display that changes according to the beat of the music.

The voltage on the three amplifiers is determined by the 3M3 and 1M voltage-divider on the first op-amp. It produces about 2v. This makes the output go HIGH and it takes pin 2 with it until this pin sees a few millivolts above pin 3. At this point the output stops rising.

Any waveform (voltage) produced by the piezo that is lower than the voltage on pin 3 will make the output go HIGH and this is how we get a large waveform.

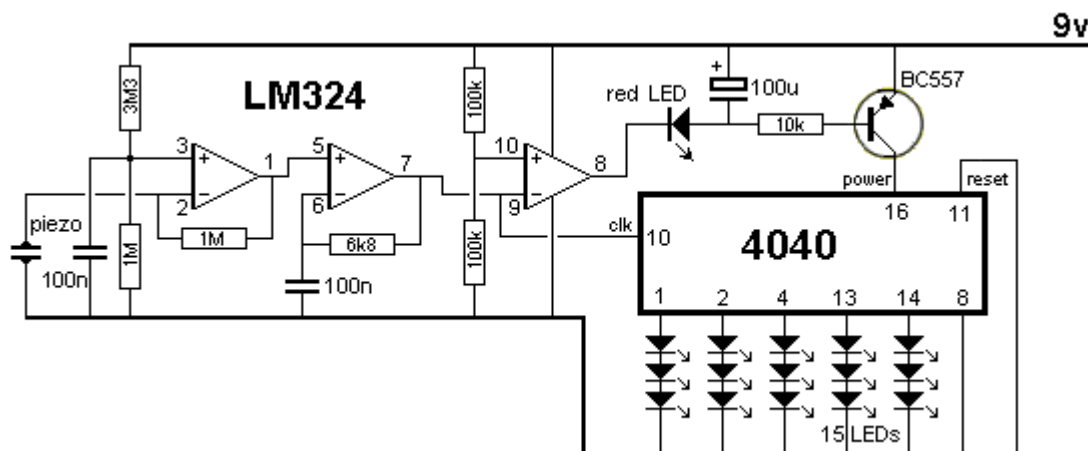
This signal is passed to the second op-amp and because the voltage on pin 6 is delayed slightly by the 100nF capacitor, it also produces a gain.

When no signal is picked up by the piezo, pin 7 is approx 2v and pin 10 is about 4.5v. Because pin 9 is lower than pin 10, the output pin 8 is about 7.7v (1.3v below the supply rail) as this is as high as the output will go - it does not go full rail-to-rail.

The LED connected to the output removes 1.7v, plus 0.6v between base and emitter and this means the transistor is not turned on.

Any colour LEDs can be used and a mixture will give a different effect.

Click the link above for more details on the project, including photos and construction notes.



## 10 LED CHASER

Here's an interesting circuit that creates a clock pulse for a 4017 from a flashing LED. The flashing LED takes almost no current between flashes and thus the clock line is low via the 1k to 22k resistor.

**6v - 10 v**



Here's a circuit from Velleman.

Sw1 is pressed for a brief period.

The voltage on the 1u rises until it puts a HIGH on input pin 11.

The voltage fluctuates at about half rail voltage as it puts a HIGH and LOW on Pin 11. It is charged by the 100k and discharged by the 10 and diode.

As the voltage on the 47u falls, the time taken to charge the 1u increases and creates the slow-down effect. Eventually the voltage on the 1u is not enough to put a HIGH on Pin 11 and the circuit freezes.



The circuit uses a single IC to perform 3 tests:

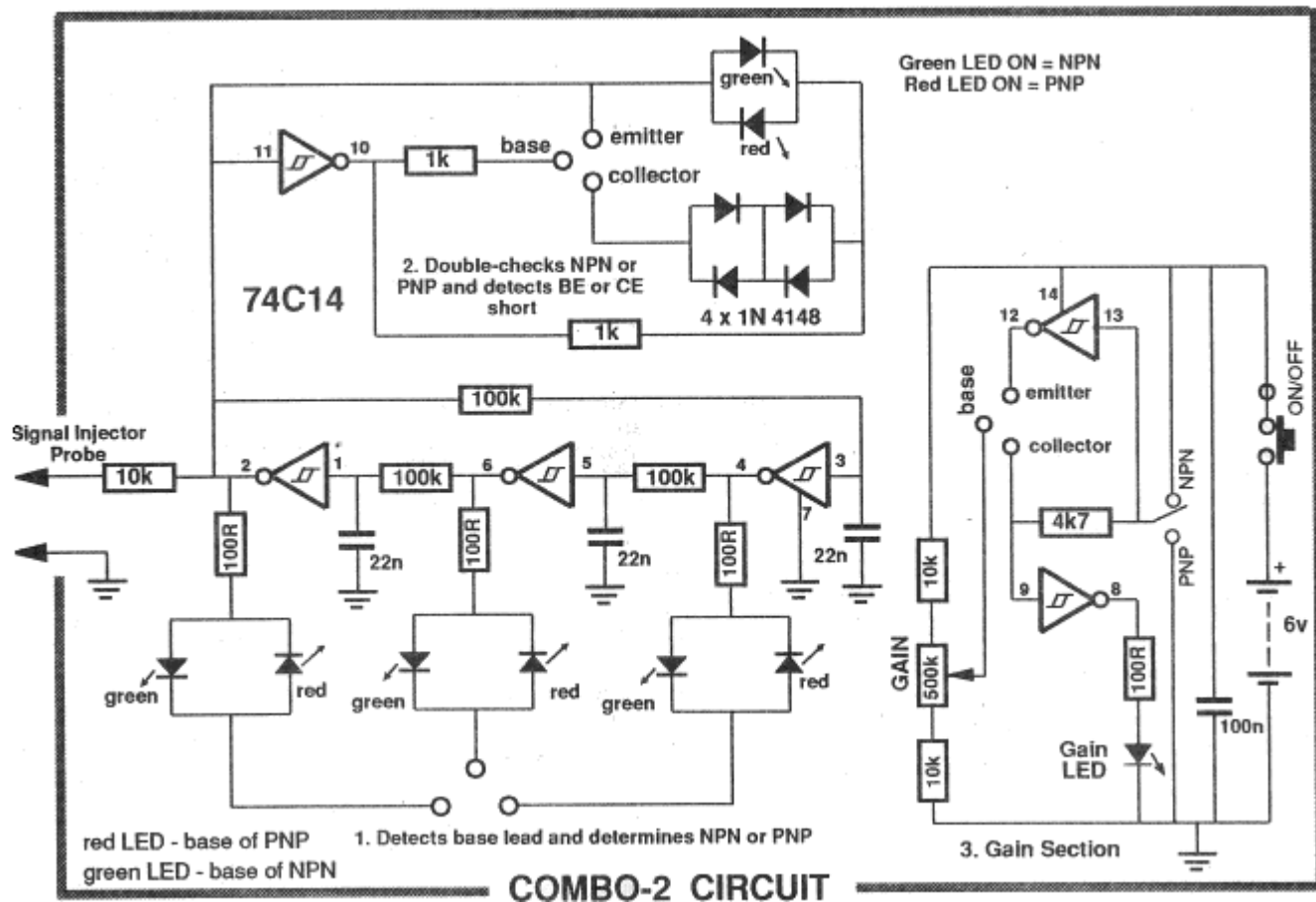
**Test 1:** Place the transistor in any orientation into the three terminals of circuit 1 (below, left) and a red LED will detect the base of a PNP transistor and a green LED will indicate the base of an NPN transistor.

**Test 2:** You now know the base lead and the type of transistor. Place the transistor in Test 2 circuit (top circuit) and when you have fitted the collector and emitter leads correctly (maybe have to swap leads), the red or green LED will come on to prove you have fitted the transistor correctly.

**Test 3:** The transistor can now be fitted in the GAIN SECTION. Select PNP or NPN and turn the pot until the LED illuminates. The value of gain is marked on the PCB that comes with the kit. The kit has ezy clips that clip onto the leads of the transistor to make it easy to use the project.

The project also has a probe at one end of the board that produces a square wave - suitable for all sorts of audio testing and some digital testing.

Project cost: \$22.00 from Talking Electronics.



## GELL CELL BATTERY CHARGER

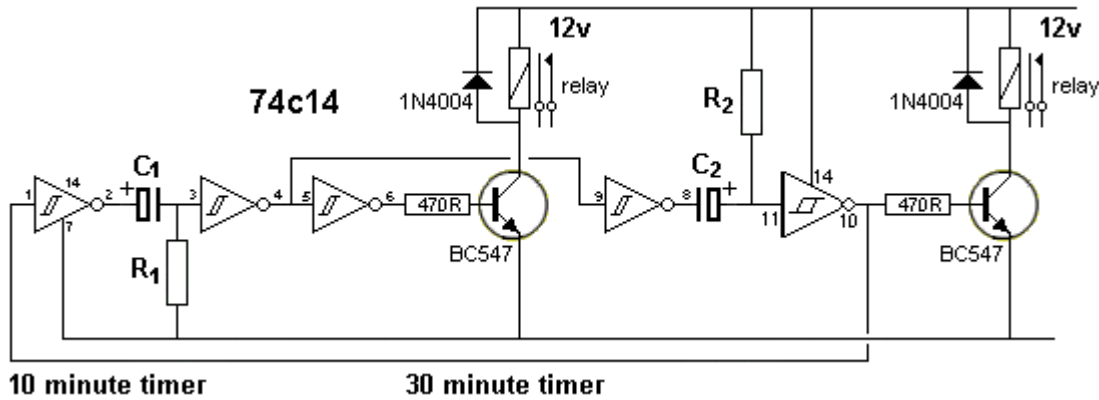
This circuit will charge gell cell batteries at 300mA or 650mA or 1.3A, depending on the CURRENT SENSING resistor in the 0v rail. Adjust the 5k pot for 13.4v out and when the battery voltage reaches this level, the current will drop to a few milliamps. The plug pack will need to be upgraded for the 650mA or 1.3A charge-current. The red LED indicates charging and as the battery voltage rises, the current-flow decreases. The maximum is shown below and when it drops about 5%, the LED turns off and the current gradually drops to almost zero.







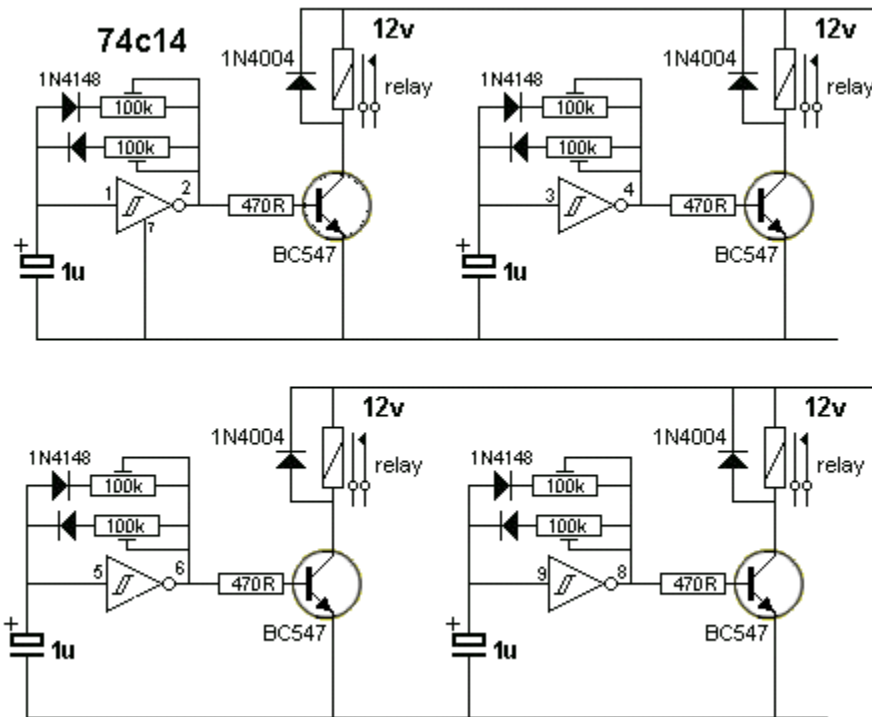
## 10 MINUTE AND 30 MINUTE TIMER



This circuit turns on the first relay for any period of time as determined by the value of C1 and R1. When relay 1 turns off, relay 2 turns ON for any period of time as determined by C2 and R2. When relay 2 turns off, relay 1 turns ON and the cycle repeats.

## 4 PUMPS

This circuit has been requested by a reader. He wanted 4 pumps to operate randomly in his water-fountain feature. A 74C14 IC can be used to produce 4 timing circuits with different on-off values. The trim-pots can be replaced with resistors when the desired effect has been created.



U1= CD40106B [mount in DIL socket]

Pins 1, 3, 11, 13 of U1 should be taken HIGH

M1, M2 = IRFU2407PBF or IRLU3915PBF

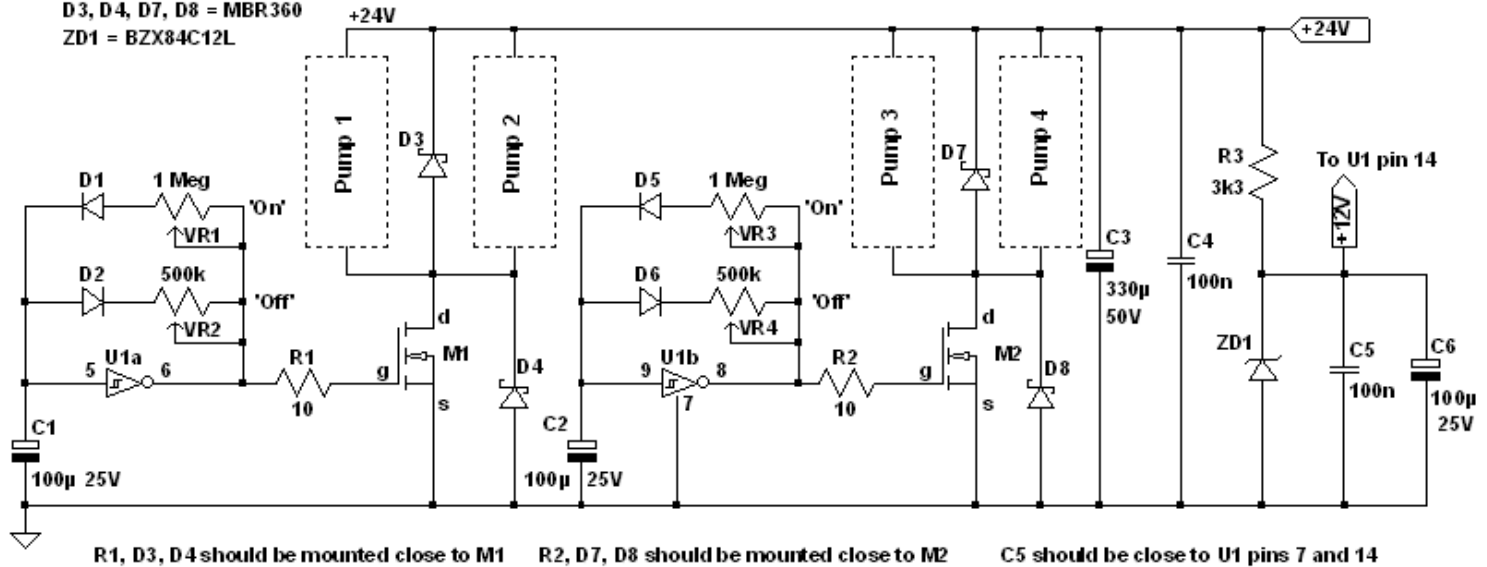
Observe anti-static precautions when handling M1, M2, U1

D1, D2, D5, D6 = 1N4148

D3, D4, D7, D8 = MBR360

ZD1 = BZX84C12L

## Pump Timers



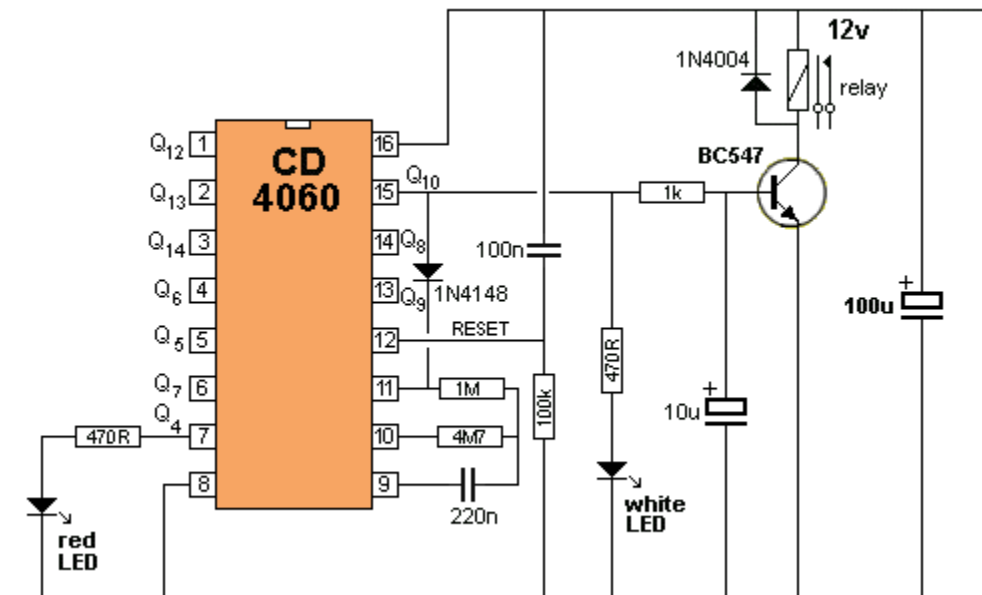
## LONG DURATION TIMER

To get a long duration timer we can create an oscillator, called a CLOCK OSCILLATOR, and feed it to a number of flip-flops. A flip-flop is a form of bi-stable multivibrator, wired so an input signal will change the output on every second cycle. In other words it divides (halves) the input signal. When two of these are connected in a "chain" the input signal divides by 4. The CD4060 IC has 14 stages. These are also called BINARY DIVIDERS and the chip is also called a COUNTER.

The IC also has components (called gates or inverters) on pins 9, 10 and 11 that can be wired to produce an oscillator. Three external components are needed to produce the duration of the oscillations. In other words the frequency of the "clock signal."

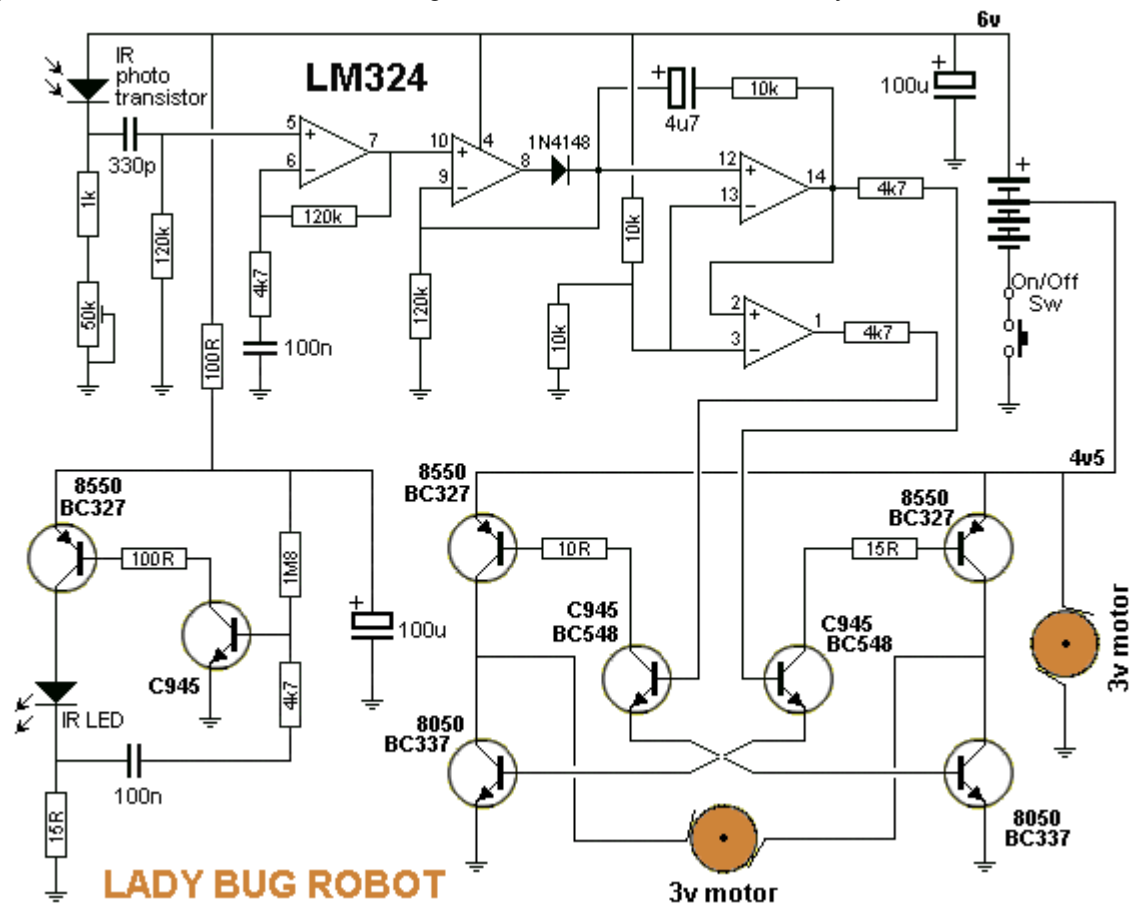
The output of the oscillator is connected (inside the chip) to the Binary Dividers and each stage goes HIGH then LOW due to the signal it is receiving. Each stage rises and falls at a rate that is half the previous stage and the final stage provides the long time delay as it takes  $2^{13}$  clock cycles before going HIGH. We have only taken from Q10 in this circuit and the outline of the chip has been provided in the circuit so different outputs can be used to produce different timings.

The diode on the output "jams" the oscillator and stops it operating so the relay stays active when the time has expired.



## LADYBUG ROBOT

**Ladybug Robot** moves with its six legs and makes use of infrared emitting diodes as its eyes to avoid obstacles along its path. Ladybug automatically makes a left turn the moment it detects an object in its path. It continues to move forward again when no obstacle is in the way.



**LADY BUG ROBOT**

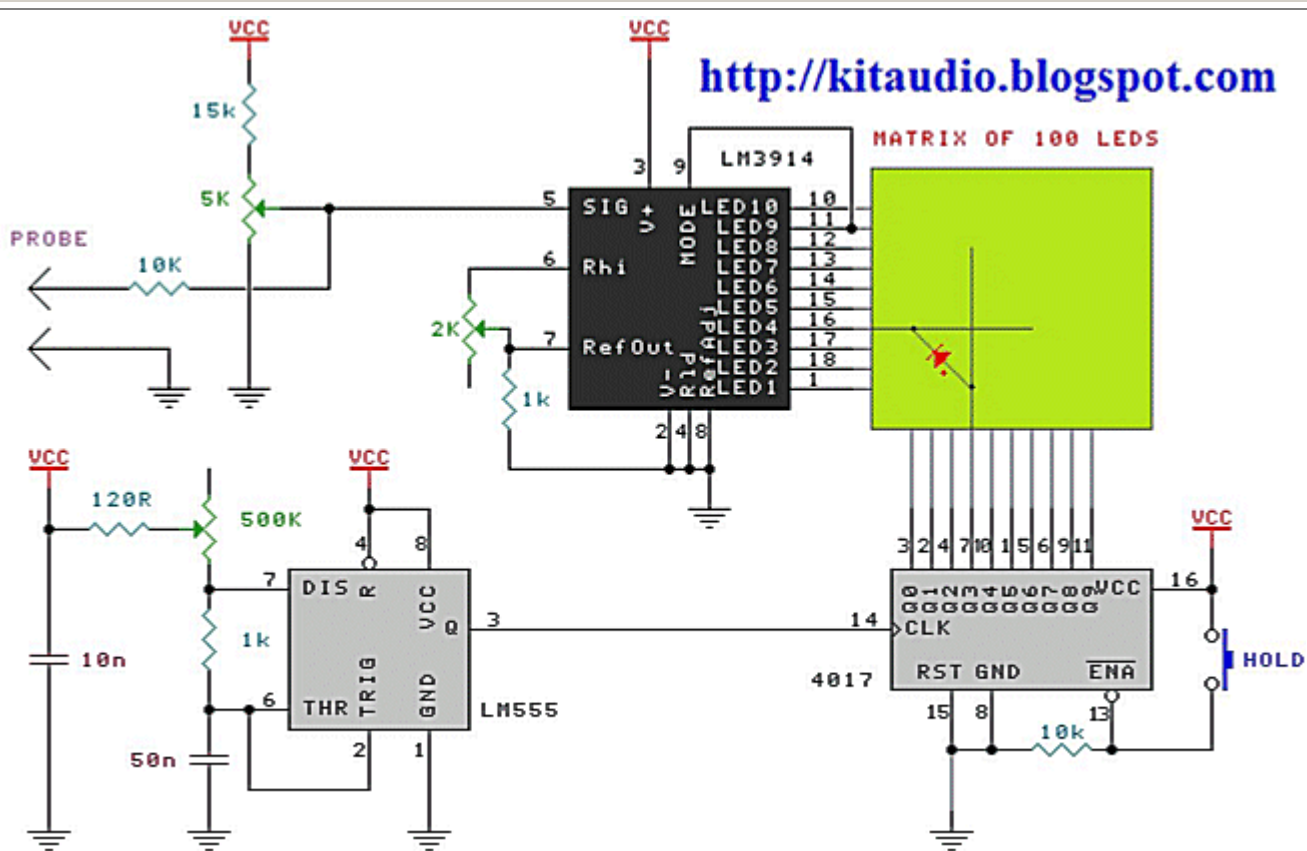
**3v motor**

**3v motor**

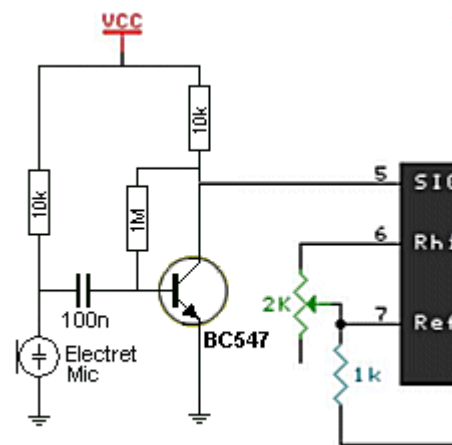
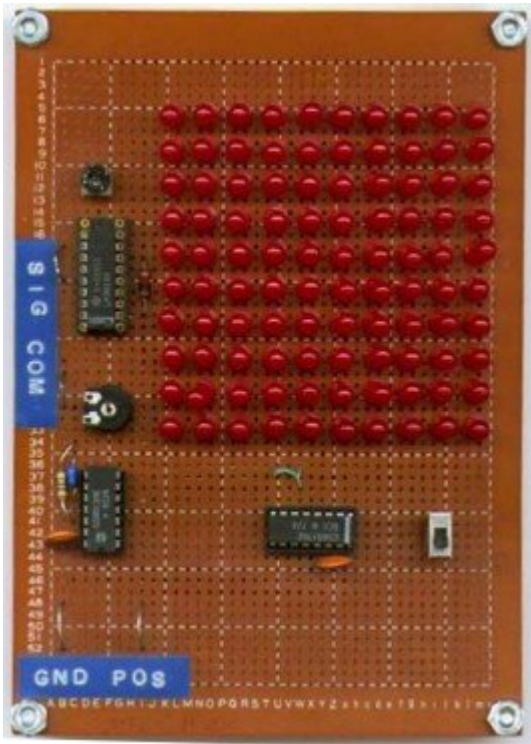


See [Hex Bug](#) in "200 Transistor Circuits" for a transistor version of this circuit.

## 100 LED CRO



This circuit produces a "trace" on a set of 100 LEDs, just like a Cathode Ray Oscilloscope. It is only suitable for low frequency signals such as audio but can also reproduce low-frequency square waves. It's fun to talk into the microphone and see the result on the screen. Add the audio amplifier below to the input of the LM3914 dot/bar Display Driver (that has been set to dot-mode). To see a trace across the centre of the screen. The audio will raise and lower the trace to produce a waveform. The photo on the right shows the authors model.







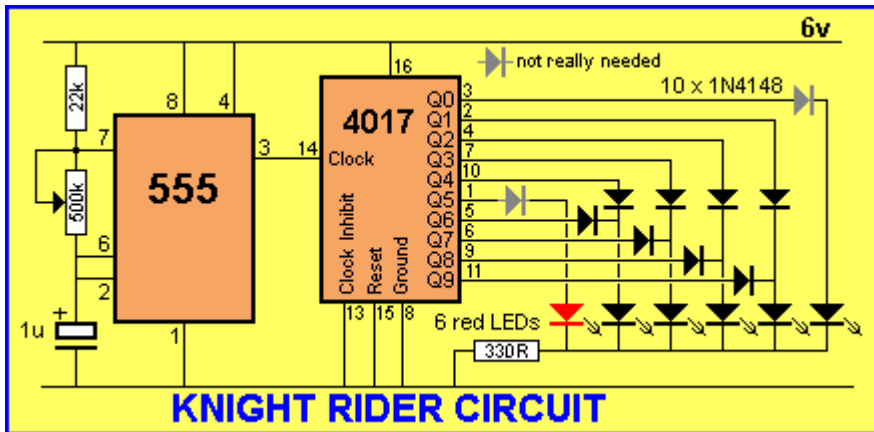
# KNIGHT RIDER

In the **Knight Rider** circuit, the 555 is wired as an oscillator. It can be adjusted to give the desired speed for the display. The output of the 555 is directly connected to the input of a Johnson Counter (CD 4017). The input of the counter is called the CLOCK line.

The 10 outputs  $Q_0$  to  $Q_9$  become active, one at a time, on the rising edge of the waveform from the 555. Each output can deliver about 20mA but a LED should not be connected to the output without a current-limiting resistor (330R in the circuit above).

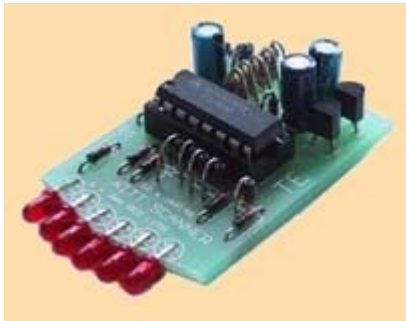
The first 6 outputs of the chip are connected directly to the 6 LEDs and these "move" across the display. The next 4 outputs move the effect in the opposite direction and the cycle repeats. The animation above shows how the effect appears on the display.

Using six 3mm LEDs, the display can be placed in the front of a model car to give a very realistic effect. The same outputs can be taken to driver transistors to produce a larger version of the display.

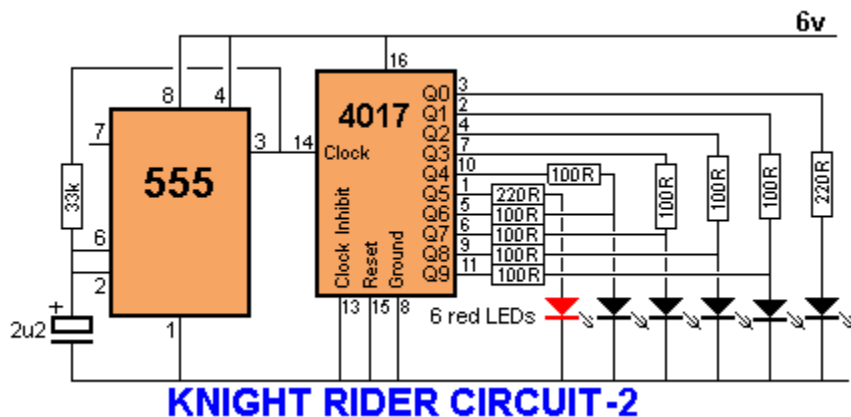


**BUY NOW**

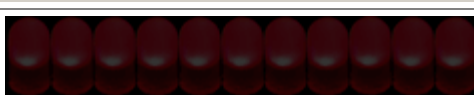
The **Knight Rider** circuit is available as a kit for less than \$15.00 plus postage as **Kitt Scanner**.



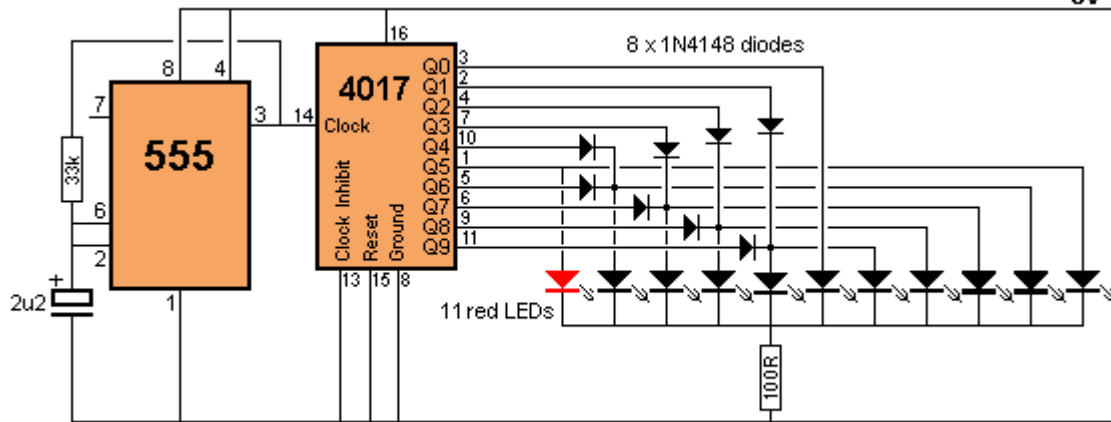
Here is a simple Knight Rider circuit using resistors to drive the LEDs. This circuit consumes 22mA while only delivering 7mA to each LED. The outputs are "fighting" each other via the 100R resistors (except outputs  $Q_0$  and  $Q_5$ ).



This circuit drives 11 LEDs with a cross-over effect:



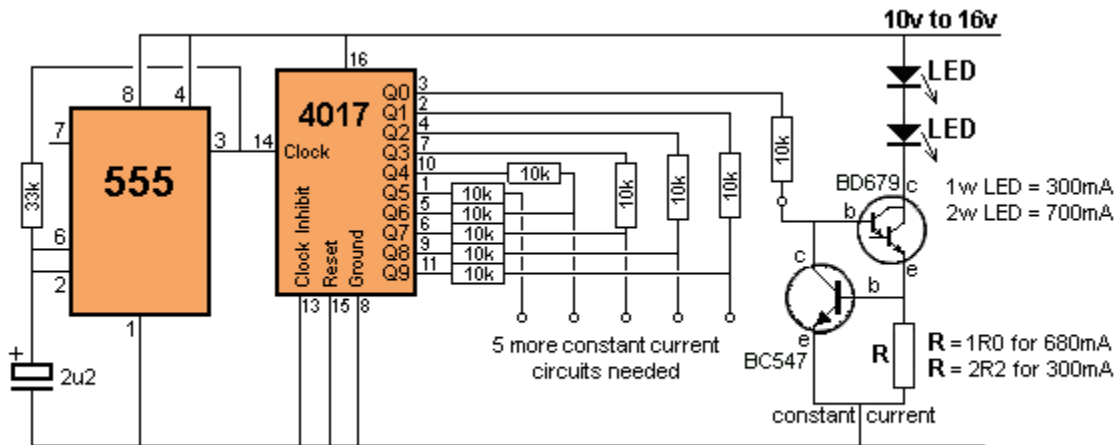
6v



**KNIGHT RIDER CIRCUIT-3**

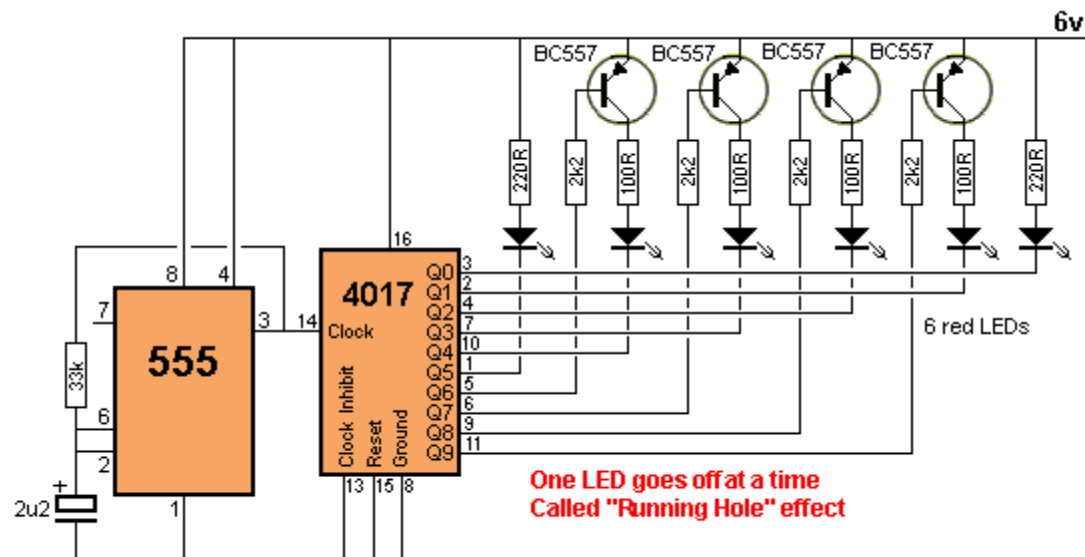
### KNIGHT RIDER FOR HIGH-POWER LEDs (constant current)

This circuit provides constant current for high-power LEDs. The battery voltage for a car can range from 11v to nearly 16v, depending on the state-of-charge and the RPM of the engine. This circuit provides constant current so the LEDs are not over-driven.



**KNIGHT RIDER FOR HIGH-POWER LEDs**

### KNIGHT RIDER "RUNNING HOLE" EFFECT



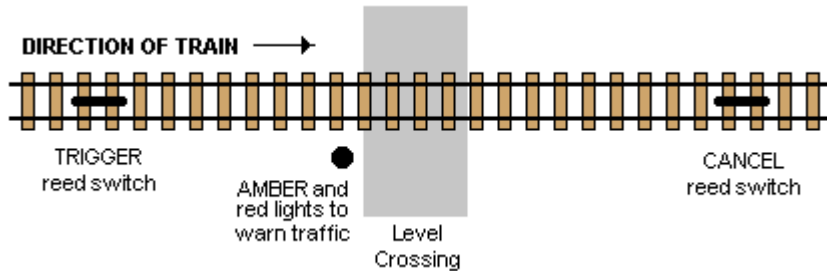
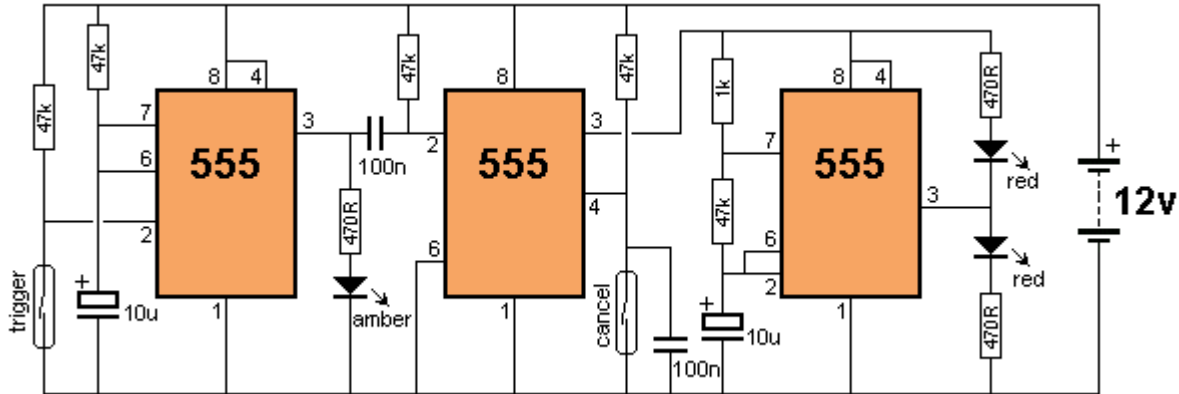
**KNIGHT RIDER CIRCUIT-5**

## CROSSING LIGHTS

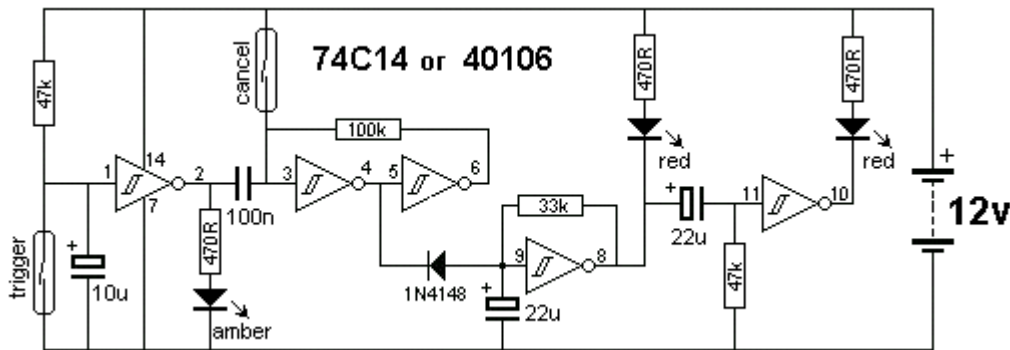
A magnet on the train activates the TRIGGER reed switch to turn on the amber LED for a time determined by the value of the first 10u and 47k.

When the first 555 IC turns off, the 100n is uncharged because both ends are at rail voltage and it pulses pin 2 of the middle 555 LOW. This activates the 555 and pin 3 goes HIGH. This pin supplies rail voltage to the third 555 and the two red LEDs are alternately flashed. When the train passes the CANCEL reed switch, pin 4 of the middle 555 is taken LOW and the red LEDs stop flashing.

See it in action: [Movie](#) (4MB)



The circuit can also be constructed with a 40106 HEX Schmitt trigger IC (74C14). The 555 circuit consumes about 30mA when sitting and waiting. The 40106 circuit consumes less than 1mA.



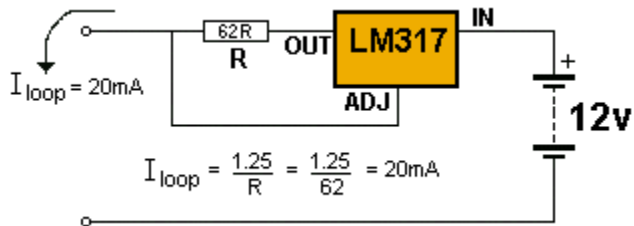
## 20mA CONSTANT-CURRENT GENERATOR

This circuit produces a constant 20mA current with an output voltage approx 3v lower than the battery voltage.

It uses an LM317 adjustable regulator which has a voltage-drop of about 3v between the IN and OUT terminals. If the battery voltage is 12v, the circuit will deliver about 9v at 20mA. The regulator has an internal voltage reference of 1.25v between OUT and ADJUST pins and when a resistor is placed between the OUT pin and the circuit being supplied, the current flowing through the resistor will produce a voltage-drop. As the current required by the circuit increases, the voltage across this resistor will increase. When it is 1.25v, the current will be 20mA. If the current increases due to the output resistance decreasing, the voltage across the resistor increases and the LM317 reduces the output voltage. This causes the current to reduce to 20mA. This is how the circuit produces a constant current.

The output current can be changed to any value according to the formula shown below.

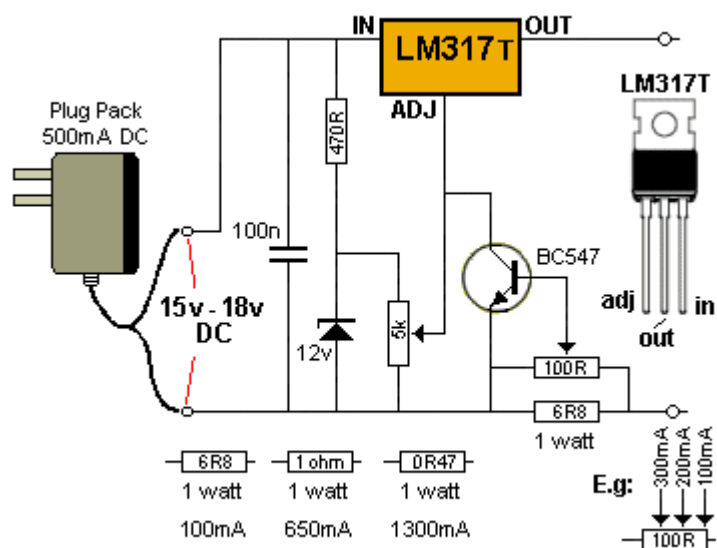




## ADJUSTABLE VOLTAGE AND CURRENT LIMITING

The single regulator in this circuit will provide a variable voltage from 1.225v to 12v or more, depending on the voltage of the plug pack and the zener diode. The current will also depend on the rating of the plug pack.

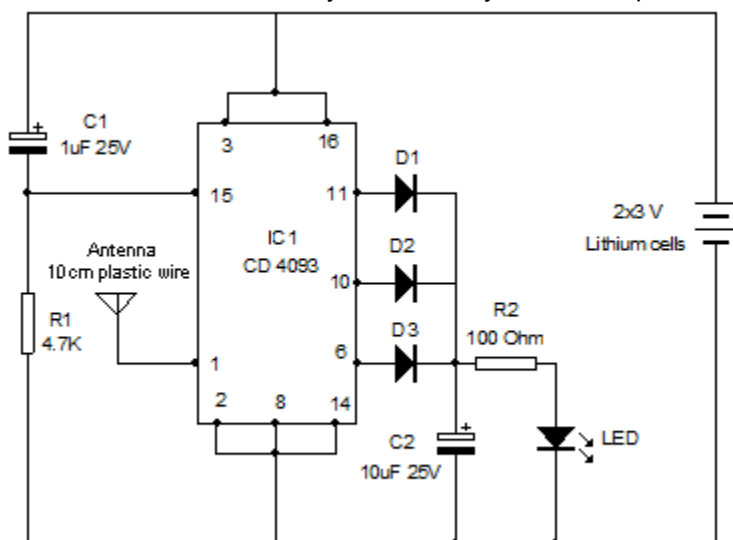
As soon as the current reaches the limit set by the 100R pot, the BC547 transistor starts to turn on and rob the regulator of voltage on the Adj pin. The output voltage starts to reduce. If the output is shorted, the output voltage will reduce to almost zero.



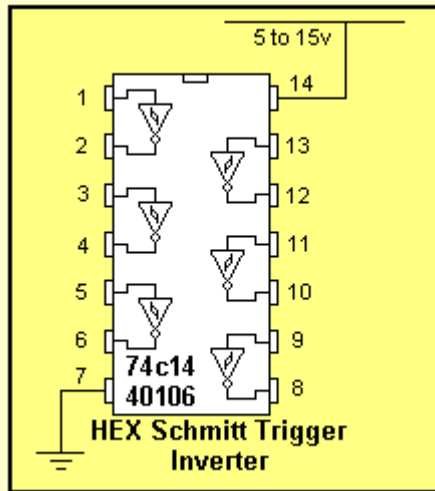
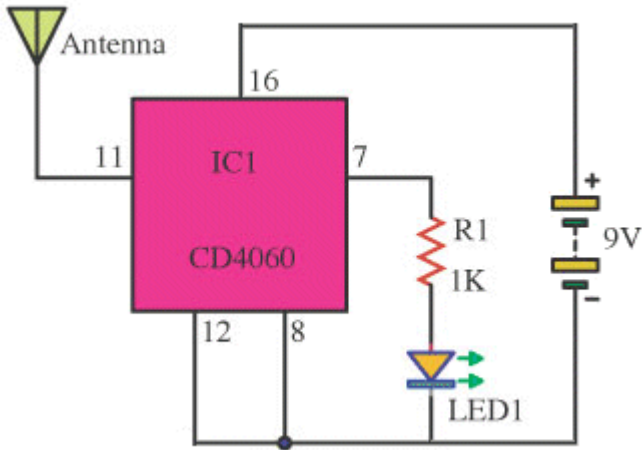
## MAINS DETECTOR

This circuit will detect active mains at 15cm. Mains wiring must not be touched. Many CMOS chips can be used for this purpose.

CD 4017, 4020, 4040 as they all have very sensitive inputs.



This circuit will also detect "Mains Hum." It is the simplest circuit and will work on 6v - 9v. Use a small length of copper-clad PC board 1cm wide for the detector. DO NOT TOUCH ANY WIRES or cables. The LED will flash when the antenna is 10cm to 15cm from the cable.



## THE 74c14 IC - also known as 40106

or 40014 - it works on 5v to 15v.

[But not 7414 or 74HC14 or 74HCT14 or 74LS14 as these IC's are for 5v supply ONLY.

They are TTL chips and operate on 4.5v to 5.5v and have low impedance inputs.]

The **74c14 IC** is one of the most useful chips on the market. When you realise its versatility, you will use it for lots of designs.

In this section we describe its capability and provide circuits to show how it can be used.

The 74C14 IC contains 6 Schmitt Trigger gates.  
Minimum supply voltage 5v

Maximum supply voltage 15v

Max current per output 10mA - 60mA total

Maximum speed of operation 4MHz

Current consumption approx 1uA with nothing connected to the inputs or outputs.

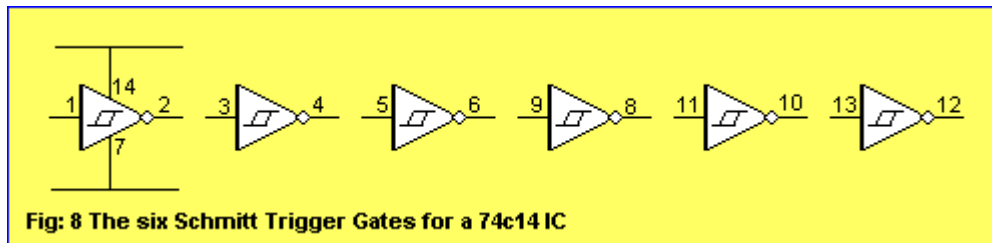
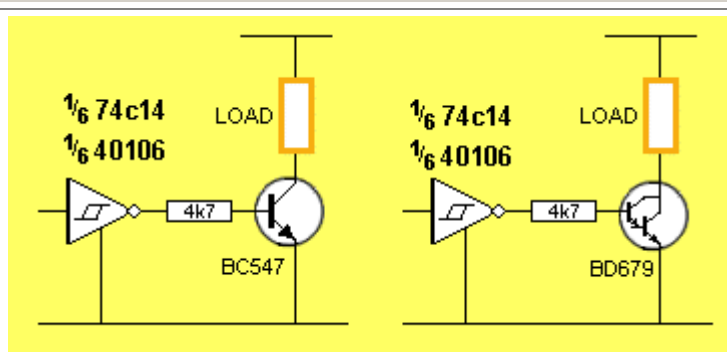


Fig: 8 The six Schmitt Trigger Gates for a 74c14 IC

The output of each gate will deliver about 10mA. This is sufficient to drive a LED, but if extra current is required, a transistor BUFFER will be needed. For up to 100mA, a BC547 can be used. For up to 4 amps a BD679 Darlington transistor can be used.



### Adding a BUFFER TRANSISTOR

Each gate is a separate "Building Block." It is basically an AMPLIFIER. It is a CURRENT AMPLIFIER and it is different to any other type of amplifier. Here is how it works: When the input is LOW, the output is HIGH and will deliver 10mA to a load. When the input is HIGH the output is LOW and it will sink 10mA from a load that is connected to rail. Here is the CURRENT AMPLIFYING part: It takes less than 1 microamp on the input to make the output high or low.

Here's the second feature of the gate:

When the input is LOW (A LOW is from 0v to 25% of rail voltage), it can be increased slowly or up to a frequency of 4MHz, and when the voltage is 66% of rail voltage, the output immediately changes from HIGH to LOW.

When the input is HIGH (from 70% to 100% of rail voltage) and it decreases slowly or up to a frequency of 4MHz, the output immediately changes from LOW to HIGH when the voltage drops to 33% of rail voltage.

This produces a GAP between 33% and 66% called the HYSTERESIS GAP and it prevents noisy input voltages changing the output. The input voltage has to rise and/or fall about 33% of rail voltage for the output to change.

There are 6 of the gates in the IC and they are all internally wired to the power rails. You can think of the input as having infinite impedance (resistance), so it does not put a load on anything connected to this pin.

Here is an animation of how the gate works. The input has to be above mid-rail for the output to change and below mid-rail for the output to change back to its original state.

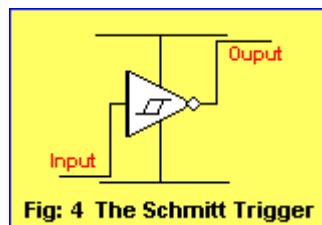


Fig: 4 The Schmitt Trigger

### The next feature to understand is called **THE TIME DELAY CIRCUIT**

The time delay circuit is also known as a "TIMING CIRCUIT," "DELAY CIRCUIT," or "R-C CIRCUIT". These names all refer to a CAPACITOR and RESISTOR in series. It does not matter if the capacitor is placed above or below the resistor as the **time delay** will be the same. (The only difference will be the value of the voltage at the beginning and end of the timing cycle.)

The join of the two components is the point where the voltage is detected and is called the "Detection Point."

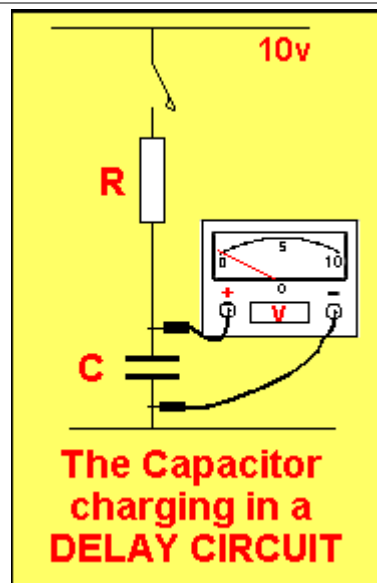
The Detection Point is monitored by a **Detection Circuit**. This will be the input of one of the Schmitt gates.

The detection circuit **must not load** the timing circuit. In other words the detection circuit must have a very high input impedance. That's the advantage of this IC. It is ideal for detecting the voltage on a DELAY CIRCUIT.

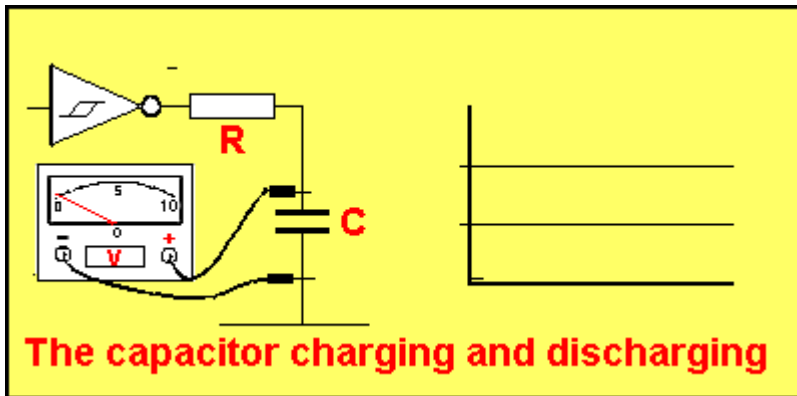
When voltage is applied to a TIMING CIRCUIT, the capacitor begins to charge. If we monitor the voltage across the capacitor, we can determine when it is at a particular voltage level. It will take a PERIOD OF TIME to reach this level and this is the TIME DELAY we require.

In the animation below we see the capacitor charging via a resistor, with a meter showing the approx voltage across the capacitor. The capacitor does not charge at a constant rate, but this characteristic does not concern us at the moment.

The point to remember is the TIME it takes for the capacitor to charge.



If we add the TIMING CIRCUIT (DELAY CIRCUIT) to the output of a Schmitt gate, we can see the capacitor charging and discharging:



**Here is the clever part.** Instead of the voltmeter monitoring the voltage across the capacitor, the input of the Schmitt Inverter can be connected to the capacitor.

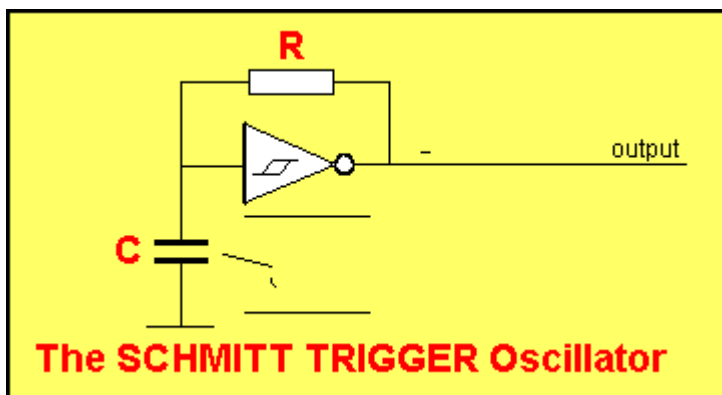
If the voltage across the capacitor is less than 66% of rail voltage, the output of the gate is HIGH and the capacitor begins to charge. When the voltage reaches 67%, the output goes LOW and the capacitor begins to discharge. When the voltage across it reaches 32% of rail voltage, the Schmitt Inverter changes state and the output goes HIGH. In this way we need only one gate to create an oscillator.

There are two very important things to observe in the animation below.

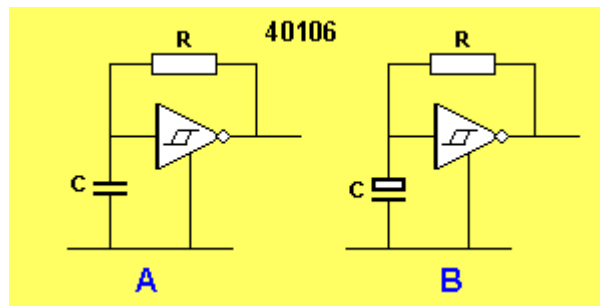
1. The output is a square wave. In other words the output goes from one state to the other **VERY QUICKLY** and this produces the characteristic square wave-shape.
2. The voltage across the capacitor is EXACTLY 32% to 67% of rail voltage.

The animation below shows the gate in operation.

You will notice that the diagram does not show the chip connected to the positive and negative rail. It is **ASSUMED** the chip is connected to the supply voltage and that's how the output produces the HIGH.



Here are the basic oscillator blocks for a 74C14 (40106) IC:

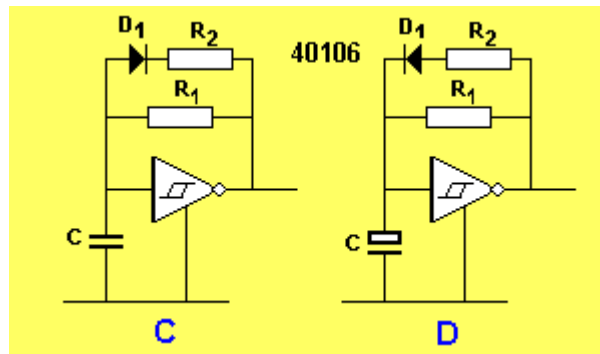


**Fig A shows a capacitor - high frequency oscillator**  
**Fig B shows an electrolytic - low frequency oscillator**

An oscillator is created by placing a resistor from output to input and a capacitor from input to 0v. The output will be a square-wave and the mark (high) will be equal to the space (low).

The frequency of the output will depend on the value of R and C. Values of 1k to 4M7 for R and 100p to 100u for C can be used. This is shown in circuits A and B above.

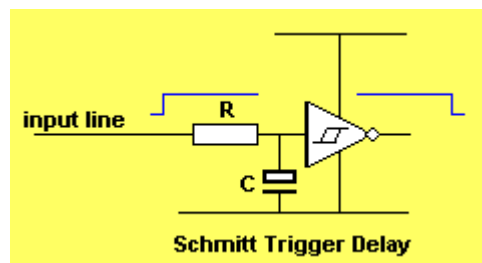
If an unequal HIGH and LOW is required, a diode is placed between output and input:



In figure C the output is low for a short period of time as the two resistors R1 and R2 are discharging the capacitor. If R2 is a very low value compared with R1 we can get the low duration to be 10% or less, of the HIGH.

In figure D the diode is reversed compared to figure C and output is high for a short period of time as the two resistors R1 and R2 are charging the capacitor.

Here are some basic building blocks:



## Delay

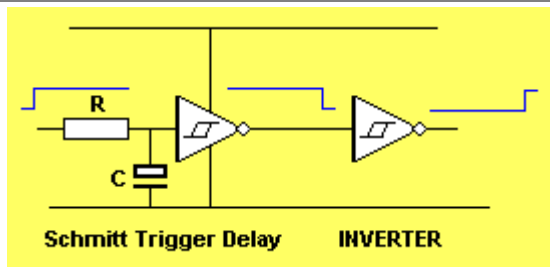
In the diagram above, the **input line** goes HIGH and remains HIGH. It can be detecting a piece of equipment being turned on, for example.

This action charges capacitor **C** via resistor **R**. After a period of time (called the Delay Time), the input of the Schmitt Trigger reaches 67% of rail voltage and the output goes LOW.

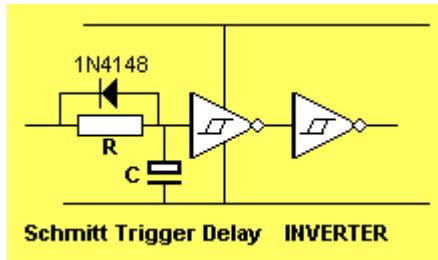
The Delay Time is determined by the values of R and C. We are not concerned with the actual values of R and C at this point in time. They can be worked out by experimentation.

The point to note is the placement of the two components to produce a **DELAY**.

If the output is required to be the opposite of the circuit above, an inverter is added:

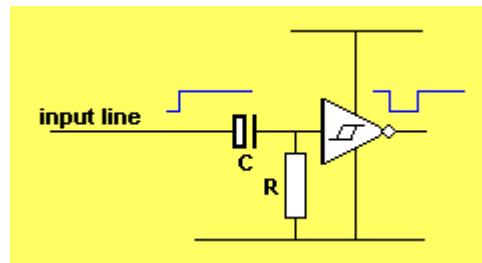


If a diode is added across the input resistor, the capacitor "C" will be discharged when the input goes low, so the "Delay Time" will be instantly available when the input goes HIGH:

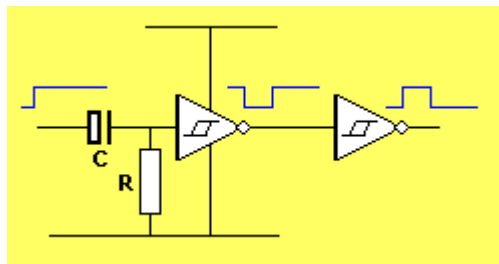


## Pulse

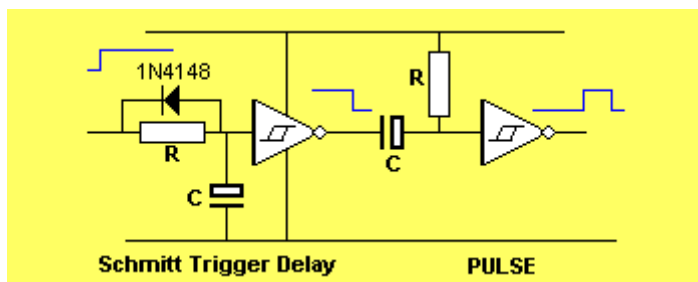
The following circuit produces a PULSE when the **input line** goes HIGH:



To invert the output, add an inverter:

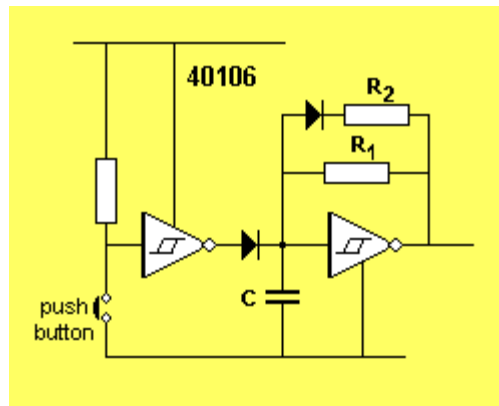


To produce a pulse after a delay, the following circuit is required:



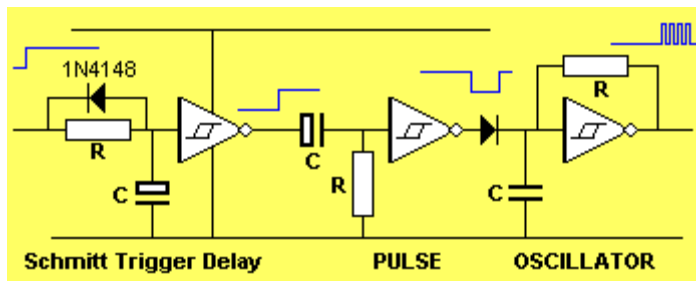
## Gating

To gate an oscillator via another inverter, a diode is placed between the two gates:

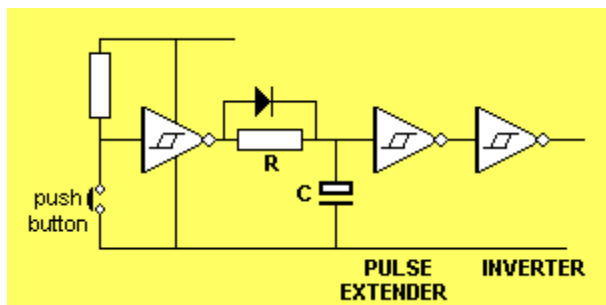


When the push-button is pressed, the input of the first gate goes LOW and the output goes HIGH. The high from the diode prevents the capacitor discharging via the oscillator and it is "jammed" or "frozen" with the output LOW.

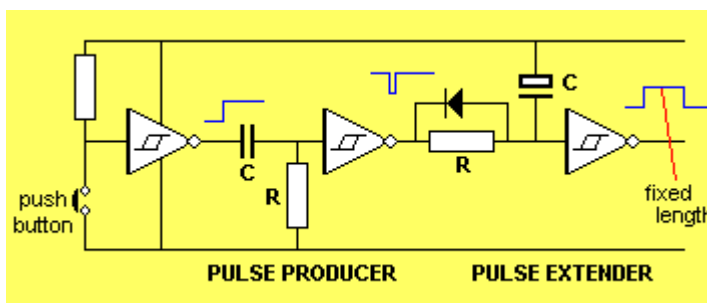
The following circuit produces a tone for a short period of time as determined by the pulse section. When the output of the Pulse section is LOW, the oscillator will operate. When the Pulse section is HIGH the oscillator is JAMMED.



To extend the action of a push button, a pulse-extender circuit can be added:



To produce a pulse of constant length, (no matter how long the button is pressed), the following circuit is needed:

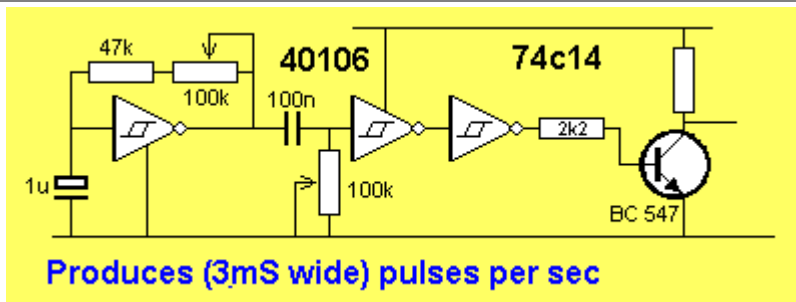


To produce a TOGGLE SWITCH, the following circuit is needed.

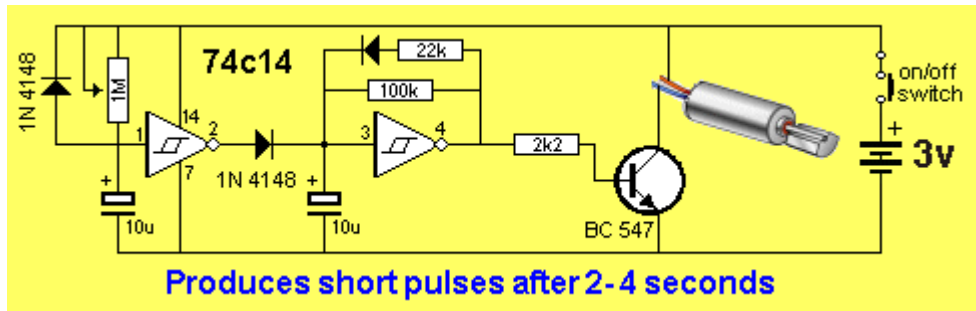
The input of the 40106 has a microscopic current availability and over a period of a few hours it will charge the 100n and cause the circuit to re-trigger. That's why the 4M7 is needed.



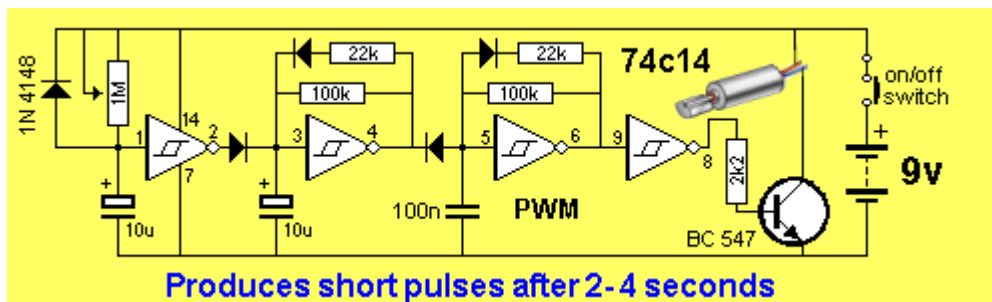




This circuit pulses the pager motor about 2 - 4 seconds after the circuit is turned on:



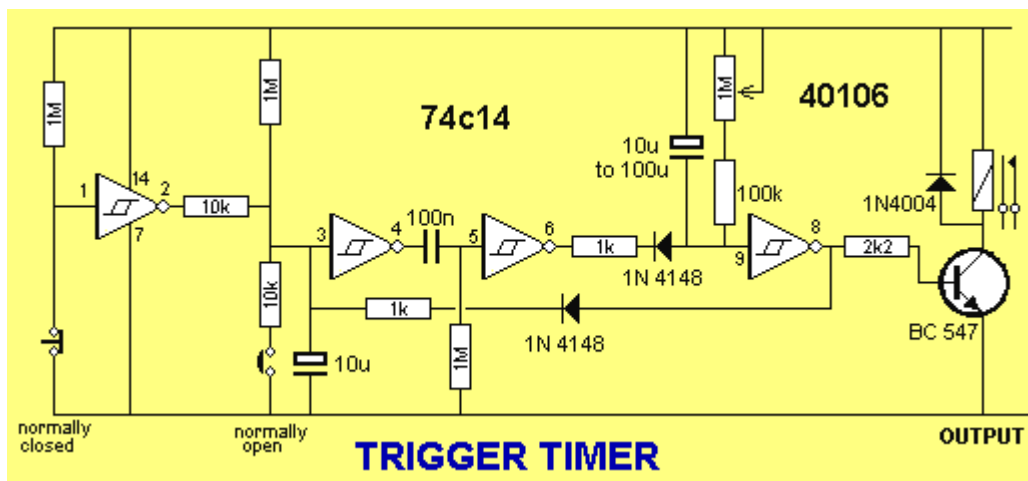
The following circuit allows a higher voltage to be used and PWM controls the energy to the Pager Motor. The component values will have to be determined by experimentation:



## TRIGGER TIMER

The next design interfaces a "Normally Open" and "Normally Closed" switch to a delay circuit.

The feedback diode from the output prevents the inputs re-triggering the timer (during the delay period) the so that a device such as a motor, globe or voice chip can be activated for a set period of time.



This alarm circuit only has one fault. The alarm keeps wailing if the door is kept open. It only turns off after 5-10 minutes when the door is closed.

The CD4093 is a **quad 2-input NAND gate** and each is wired as an inverter in this circuit.

The first gate "A" is a timer and the output does not go HIGH until the 100u charges via the 470k. This is the Exit/Entry delay.

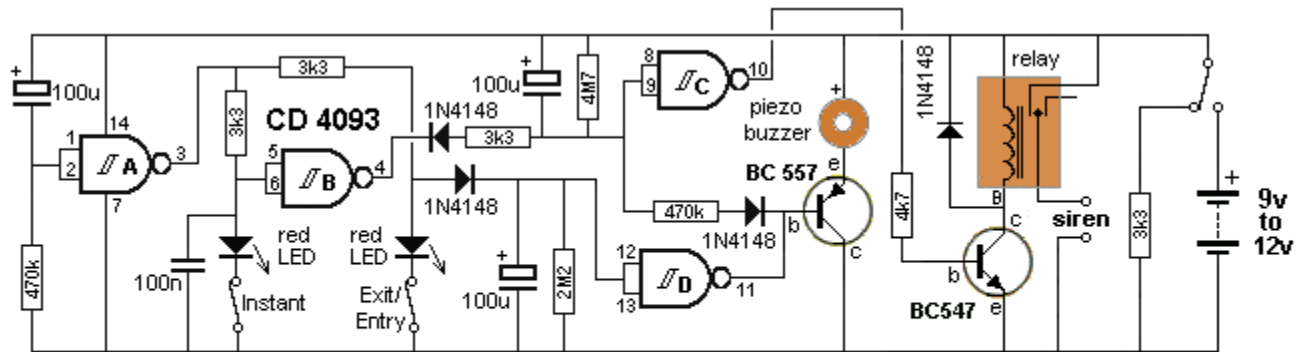
When it goes HIGH, the two LEDs are turned ON via the 3k3 resistors. This arms the alarm.

Gate "B" is an inverter that detects when the Instant input is broken and it charges the 100u via the 3k3 resistor.

Gate "C" detects the charge on the 100u and turns on the BC547 transistor via the 4k7 resistor.

The 100u and 4M7 provide the 5-10 minutes timer for the "wailing."

The 100u and 2M2 provide the timer provide the timer for the buzzer when you enter. It will buzz for 20 seconds then turn off. If the Entry door is left open, the main siren will wail after 45 seconds.



## 2-SECTOR HOME ALARM

## BURGLAR ALARM 4-ZONE

This circuit uses a dedicated alarm chip from Talking Electronics (**TE555-BA4**). The chip costs \$2.50 and contains a 4-zone Burglar Alarm circuit. All you need are the surrounding components to complete the project. These components are available as a kit for \$20.00 including the dedicated chip and this makes it one of the cheapest kits on the market (postage for kit \$6.50). Click [HERE](#) to order the chip or the kit.

The only additional parts you require are 4 reed switches. These can be purchased on eBay for \$5.38 for a set of 5 Normally Open switches (post free).

Here is the link:

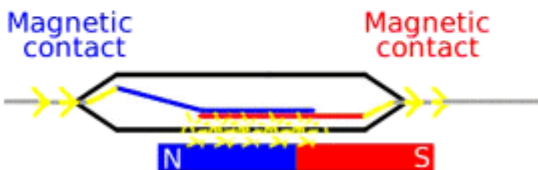
[http://www.ebay.com/itm/5-Set-Door-Or-Window-Safety-Contact-Magnetic-Alarm-Reed-Switch-NO-with-Screws-/290746194636?pt=LH\\_DefaultDomain\\_0&hash=item43b1d2dacc](http://www.ebay.com/itm/5-Set-Door-Or-Window-Safety-Contact-Magnetic-Alarm-Reed-Switch-NO-with-Screws-/290746194636?pt=LH_DefaultDomain_0&hash=item43b1d2dacc)



### 1. "Normally open" reed switch



### 2. Switch closes when magnet is near

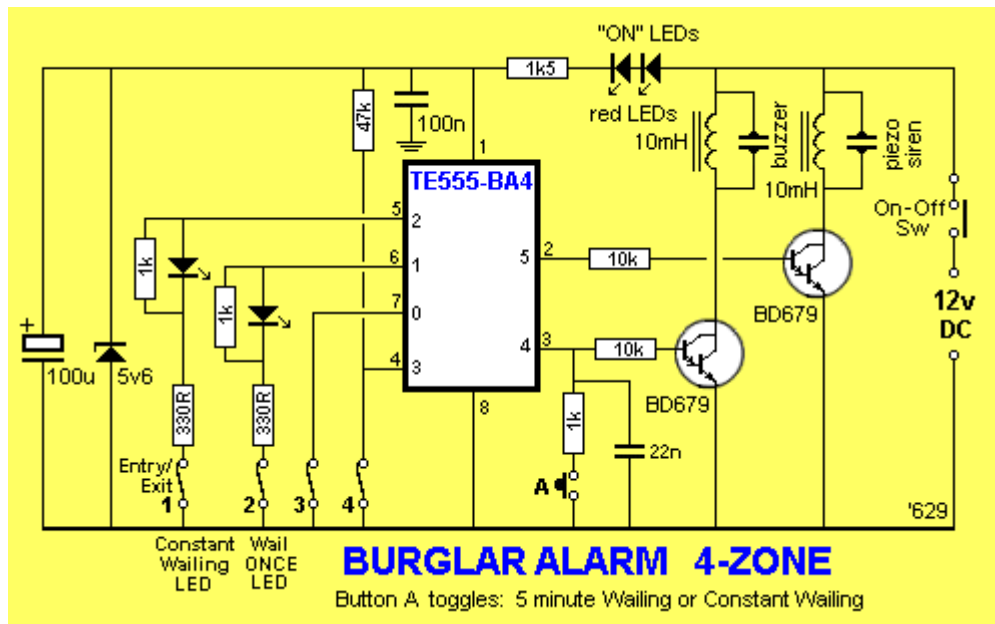


Build the circuit on a piece of matrix board (or the Circuit Board included in the kit) and connect the inputs to the screw terminals. 6 separate 2-screw terminals are provided in the kit to make it easy to wire-up the alarm. The alarm takes about 1mA when monitoring a house and about 100mA when activated.

The siren is only activated ONCE for 5 minutes when a break-in occurs as this is the maximum allowable time for a siren to wail in Australia.

If you want the alarm to constantly wail after a break-in, push button A when the alarm is turned on (and the exit beep is being produced). The constantly wailing LED will flash. Push the button again and the 5 minute LED will flash. The button toggles between the two features.

You can use reed switches for the input devices for doors and drawers. You can also trap the burglar by placing money under a clip and have a very thin length of tinned copper wire wound around two pins. When the money is removed, the wire is pulled off the pins. A single strand of wire can be obtained from a length of hook-up flex.



## POWER SUPPLY

The alarm can be connected to a 12v gell cell with a rating of 1.2AHr and it can be automatically charged using our

[Automatic Battery Charger](http://www.talkingelectronics.com/projects/200TrCcts/101-200TrCcts.html#84) in 101 Transistor Circuits.

<http://www.talkingelectronics.com/projects/200TrCcts/101-200TrCcts.html#84>

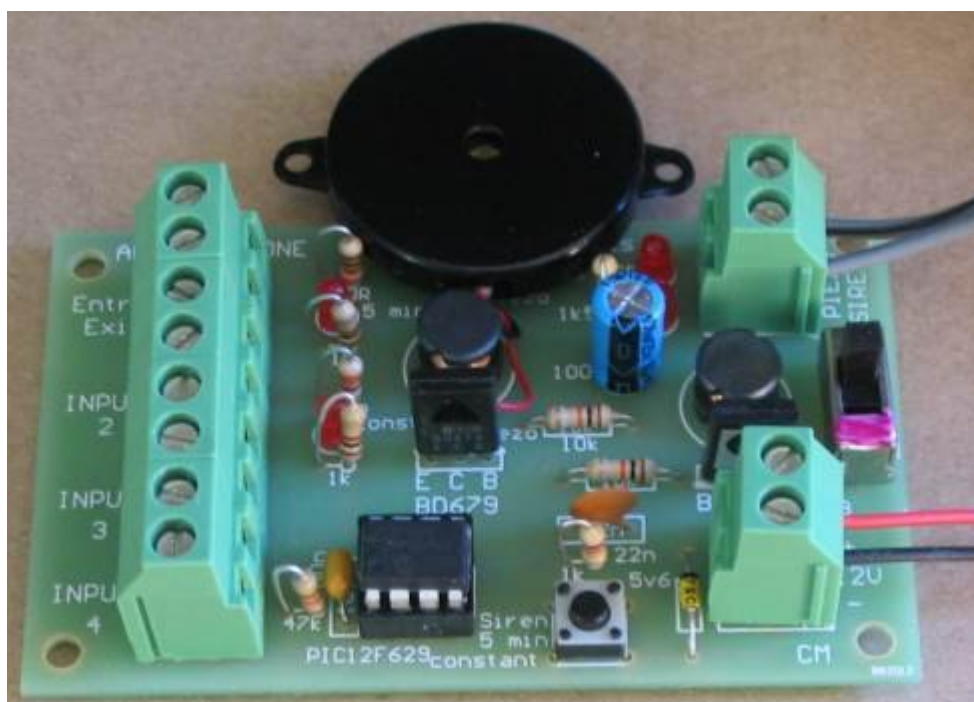
## HOW THE CIRCUIT WORKS

Any of the inputs can be used for the Entry/Exit.

It is connected to the door you will use to enter or exit the property. The alarm gives you 45 seconds to exit.

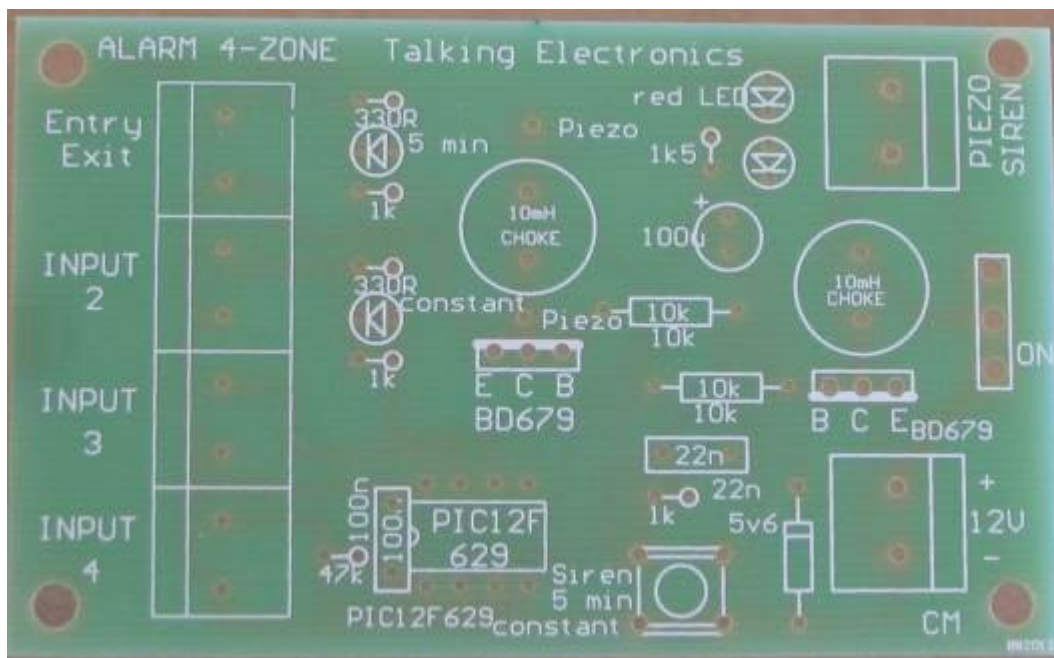
When you enter the property, the buzzer turns on as soon as you open the door and beeps for 45 seconds to allow you to turn off the alarm.

If the alarm is not turned off, the main piezo siren produces a soft tone for 30 seconds and then a piercing wailing sound.





This allows you to turn off the alarm before the loud wailing is produced and is one of the best features of the alarm as the worry of false-triggering an alarm prevents many householders setting their alarm. Any unused inputs must be connected with a link so the alarm can be set. When the circuit is turned ON, you have 45 seconds to exit the premises. The chip then flashes either the 5-min LED or the Constant LED to indicate if the siren will wail for 5 minutes or constantly. You can change the setting by pressing the button. The circuit then beeps for 45 seconds to give you time to exit the property. It then monitors all 4 inputs.



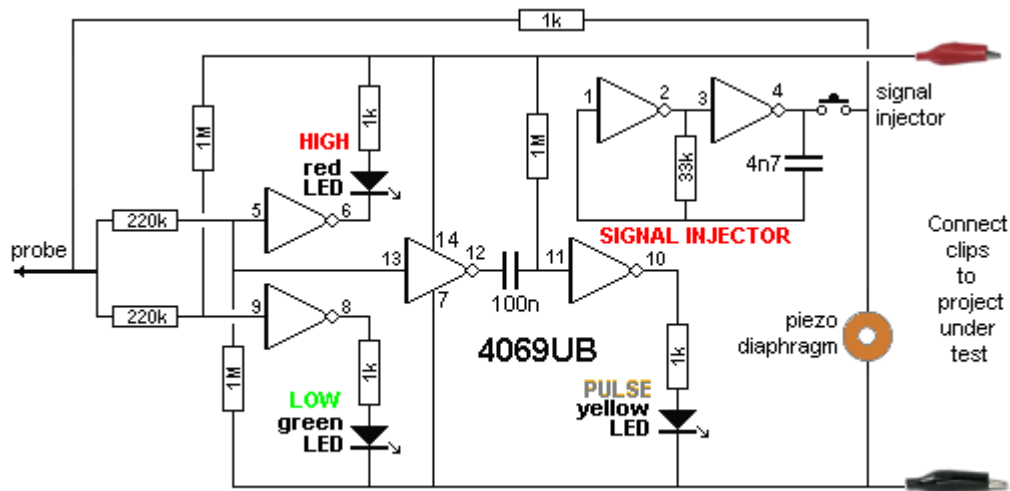
**Alarm 4-Zone PCB**

The main chip contains an internal oscillator to drive a piezo diaphragm and also a wailing oscillator for the Piezo Siren. The Piezo Siren is an 80dB piezo diaphragm driven by a BD679 Darlington transistor with a 10mH choke to produce a high voltage for the diaphragm. The chip operates on 5v and the rest of the circuit uses 12v. A very simple voltage-dropper consisting of 2 LEDs and 1k5 drops the 12v to 5v.



**LOGIC PROBE** Kits are available for this project from Talking Electronics for \$8.00 plus postage.

A **LOGIC PROBE** is a very handy piece of equipment to have when testing a project. This project provides: High, Low, Pulse, detects a Tone and has a Signal Injection feature. You can build it in an evening on a piece of Matrix Board.

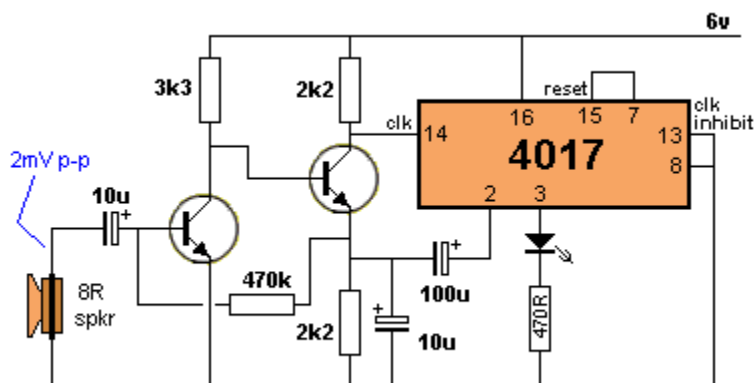


**LOGIC PROBE with SIGNAL INJECTOR**



## CLAP SWITCH "ON-OFF"

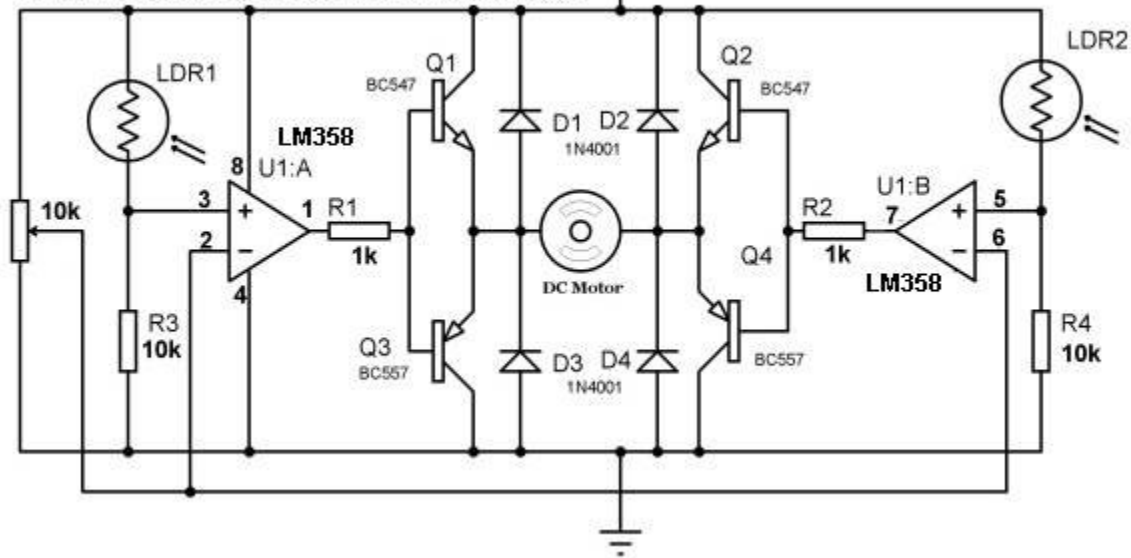
This circuit turns the LED ON with a clap or short whistle. And a further clap turns it OFF. It uses a speaker as a microphone and the fourth output of the 4017 is used to reset the chip. The 100u on pin 2 upsets the amplifier and prevents it clocking the chip, until the electro either charges or discharges.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



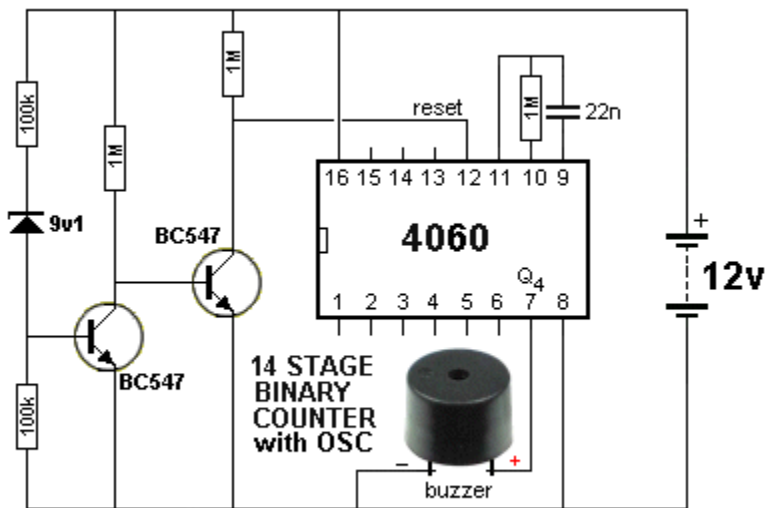
## SOLAR TRACKER

This circuit can be used to track the movement of the sun. The Motor should be connected to the panel so it rotates the panel in the direction of movement of the sun.

See: <http://www.electrosome.com/solar-tracker-system-using-lm358/>



## BATTERY-LOW BEEPER



## BATTERY-LOW BEEPER

This circuit will produce a beep-beep-beep from the piezo buzzer when the battery voltage falls to about 10v.

This is very handy when you have a battery powering a piece of equipment and you don't know its state of charge.

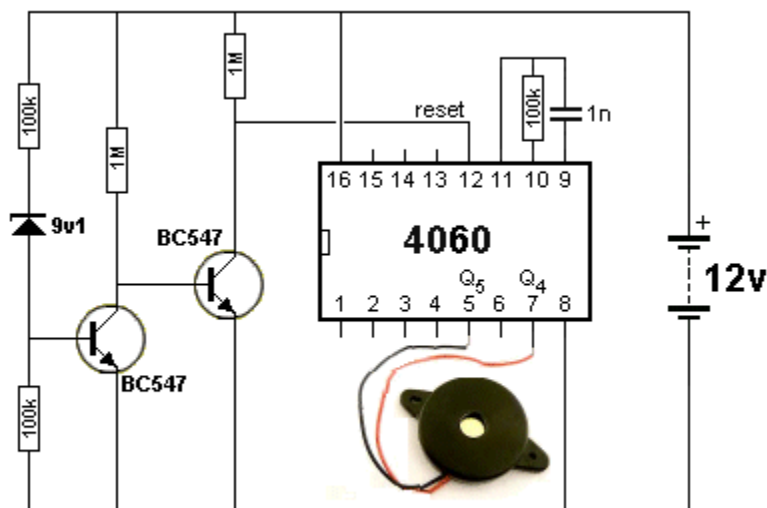
When the voltage is above 10v, the zener diode conducts and turns ON the first transistor. The voltage between the collector and emitter of this transistor is less than 0.3v and the voltage on the base of the second transistor is 0.3v. Thus the second transistor is not turned ON and it is effectively removed from the circuit. This means the reset pin of the CD 4060 is connected to the positive rail via a 1M resistor. This puts a HIGH on the reset pin and turns the chip off and prevents the oscillator producing clock pulses.

The chip contains inverters between pins 9, 10 and 11 so that when components are connected to these pins, an oscillator is produced. The technical name for this oscillator is called a CLOCK.

When pin 12 is taken HIGH it inhibits the oscillator (prevents the clock pulses passing to the divider stages).

When the battery voltage falls below 10v, the first transistor is turned OFF and the second transistor is turned ON. This takes the reset line to the 0v rail and the chip allows the clock pulses from the oscillator to pass to a set of flip flops arranged to divide the signal.

If you do not have an electro-mechanical buzzer, a piezo diaphragm can be used. The output volume will not be as loud. The oscillator components will need to be changed to produce a higher clock frequency. This frequency will be divided-down and detected at one or two of the outputs. You can try all the outputs to see what result is the best.



## BATTERY-LOW BEEPER

If you do not have a 9v1 zener, it can be made from 5v6 zener and 3v6 zener or a 5v6 and a white LED or two red LEDs. It can also be made from three white LEDs and a red LED. You can use a zener, LEDs and a signal diode to adjust the voltage to any desired value.

When a very small current flows through a zener, LED or diode, the characteristic voltage that develops across it is LESS than when its rated current flows. However this lower voltage can be used to produce a "trigger-point." The only way to determine this voltage is to add the component to the circuit.

The first transistor reacts at this trigger-point and the second transistor simply inverts the voltage on the collector.

The second transistor is not classified as an amplifier but an INVERTER.

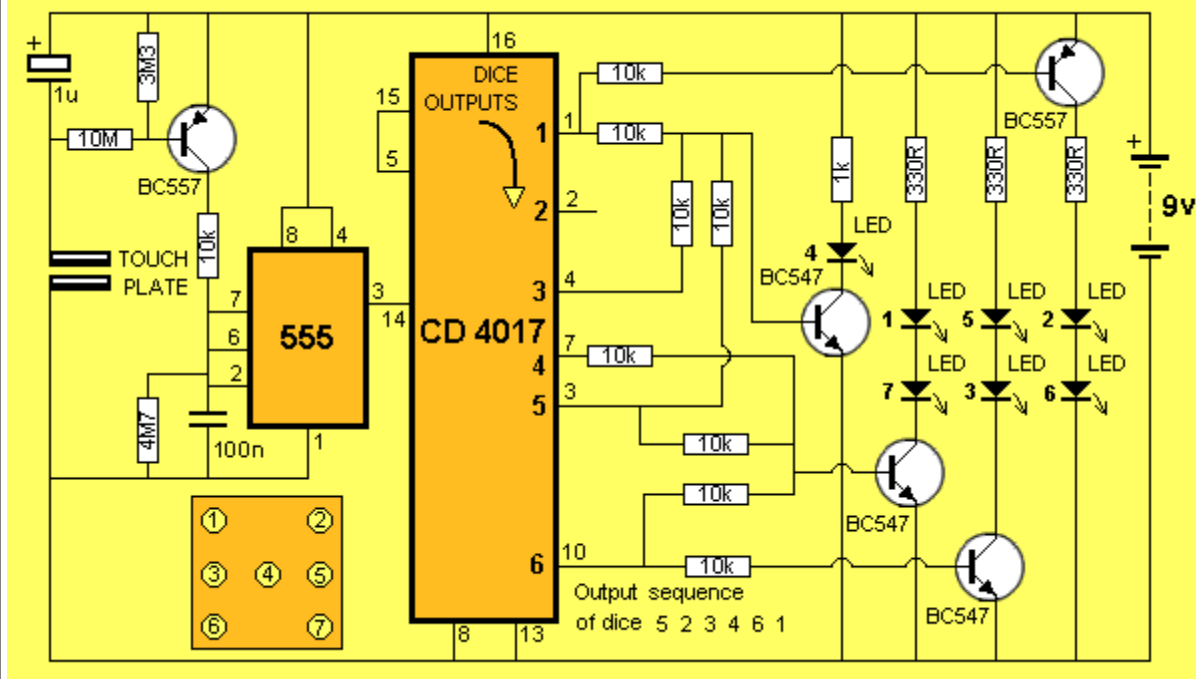
To see more on this project, visit: <http://electronicsmaker.info>

## LED DICE

This circuit produces a realistic effect of the "pips" on the face of a dice. The circuit has "slow-down" to give the effect of the dice "rolling."

See the full project: [LED DICE](#)

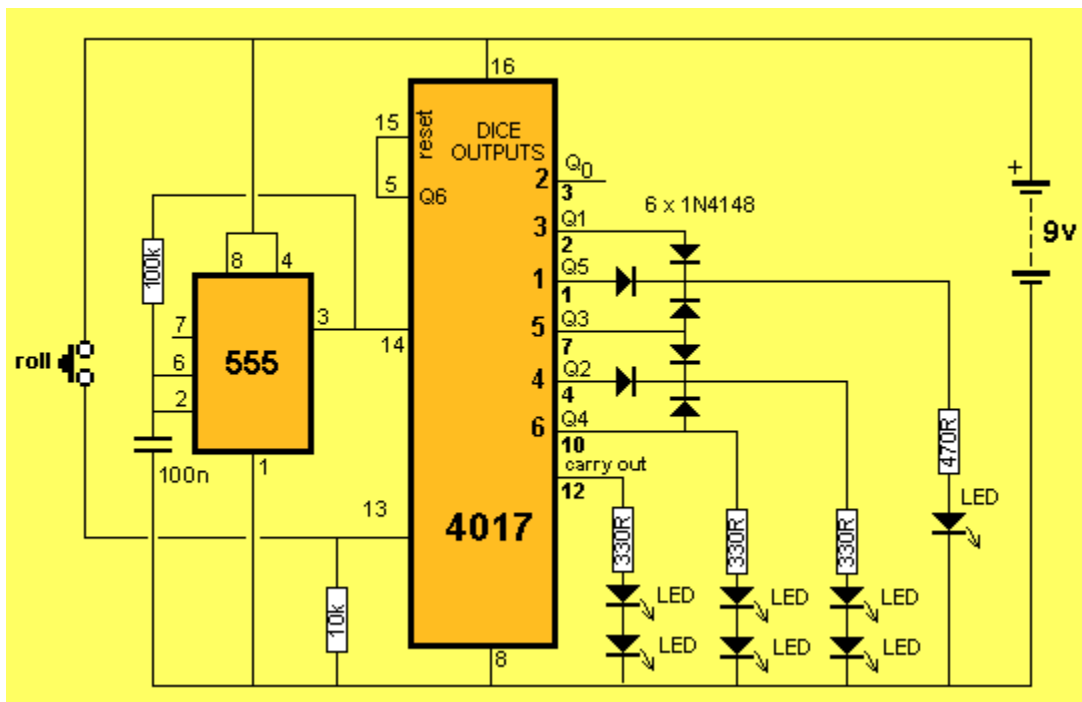




### A SIMPLER CIRCUIT:

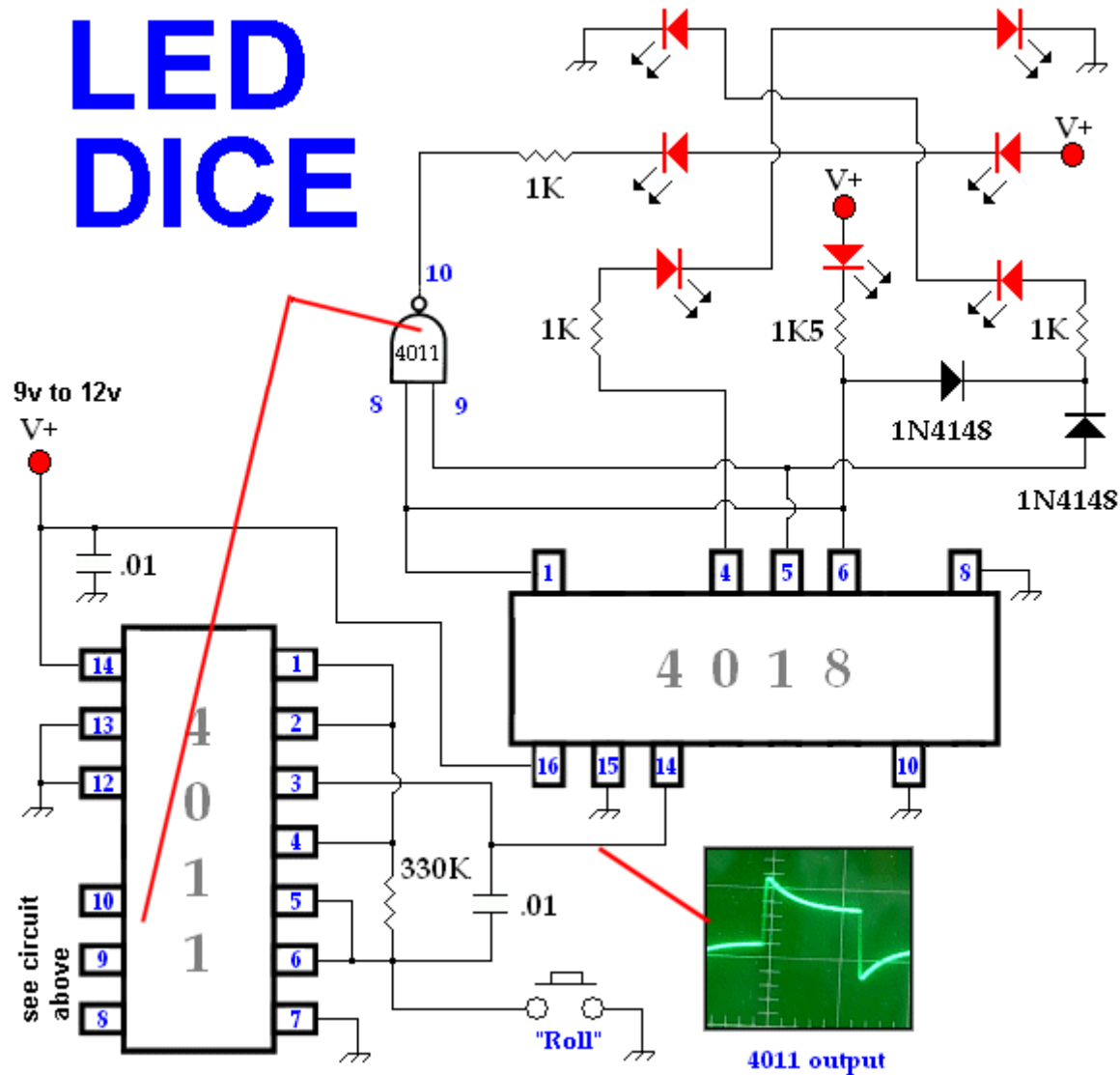
The circuit above can be simplified and output Pin 12 can be used to illuminate two of the LEDs as this line is HIGH for the times when Q0, Q1, Q2, Q3, and Q4 are HIGH and goes LOW when Q5 - Q9 is HIGH.

This means the 4017 starts with Q0 HIGH. But Q0 is not an output. This means that when Q0 is HIGH, "carry out" is HIGH and "2" will be displayed. The next clock cycle will produce "3" on the display when Q1 is HIGH, then "4" when Q2 is HIGH, "5" when Q3 is HIGH and "6" when Q4 is HIGH. When Q5 goes HIGH, it illuminates "1" on the display because "carry out" goes LOW.



**LED DICE - minimum components**


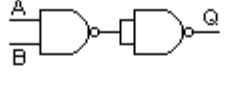

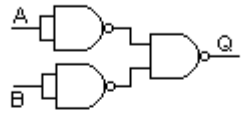

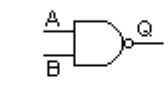

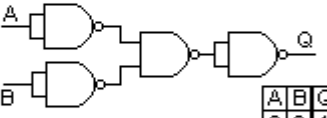

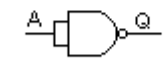

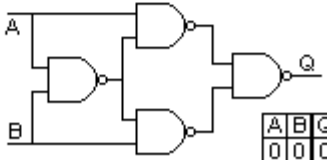
# LED DICE



LED DICE - using CD4018 5-bit Counter

## LOGIC GATES

All gates can be made from a CD4011 or equiv (quad NAND gate IC)

<b>AND</b> 		<table><tr><th>A</th><th>B</th><th>Q</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table>	A	B	Q	0	0	0	0	1	0	1	0	0	1	1	1
A	B	Q															
0	0	0															
0	1	0															
1	0	0															
1	1	1															
<b>OR</b> 		<table><tr><th>A</th><th>B</th><th>Q</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table>	A	B	Q	0	0	0	0	1	1	1	0	1	1	1	1
A	B	Q															
0	0	0															
0	1	1															
1	0	1															
1	1	1															
<b>NAND</b> 		<table><tr><th>A</th><th>B</th><th>Q</th></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table>	A	B	Q	0	0	1	0	1	1	1	0	1	1	1	0
A	B	Q															
0	0	1															
0	1	1															
1	0	1															
1	1	0															
<b>NOR</b> 		<table><tr><th>A</th><th>B</th><th>Q</th></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table>	A	B	Q	0	0	1	0	1	0	1	0	0	1	1	0
A	B	Q															
0	0	1															
0	1	0															
1	0	0															
1	1	0															
<b>NOT</b> 		<table><tr><th>A</th><th>Q</th></tr><tr><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td></tr></table>	A	Q	0	1	1	0									
A	Q																
0	1																
1	0																
<b>XOR</b> 		<table><tr><th>A</th><th>B</th><th>Q</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table>	A	B	Q	0	0	0	0	1	1	1	0	1	1	1	0
A	B	Q															
0	0	0															
0	1	1															
1	0	1															
1	1	0															

## LOGIC GATES

It's very handy to remember that all the logic gates can be made from a Quad NAND gate such as CD4011.

## 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 complex.

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.















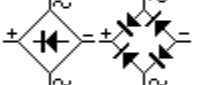




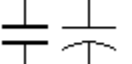
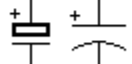




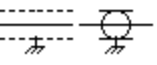







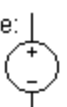
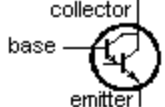







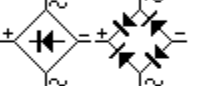




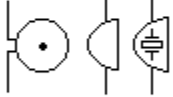









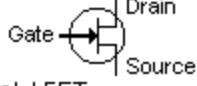
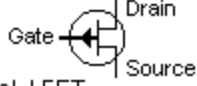

You must to refer to the manufacturer's specification sheet to identify each pin, to be sure you have identified them correctly.

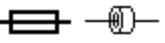
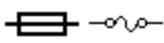


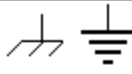

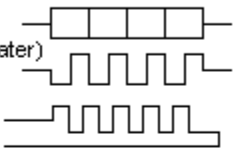
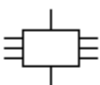
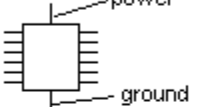





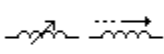


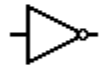







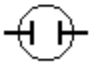

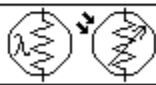
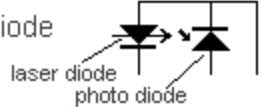



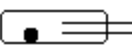






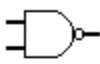



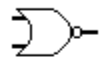

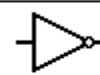



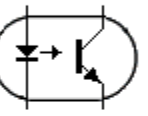
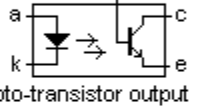
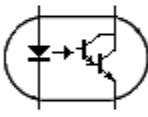
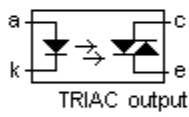



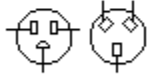

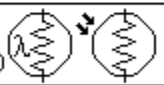




Colin Mitchell

## **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) for the latest additions.








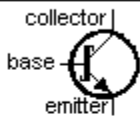
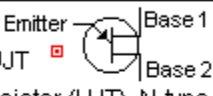
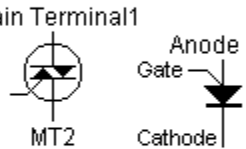
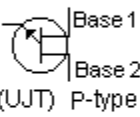


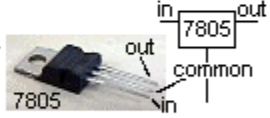



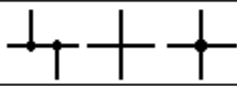
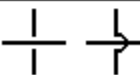


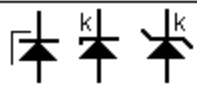
# CIRCUIT SYMBOLS by TALKING ELECTRONICS

AC current:  voltage: 	ALTERNISTOR TRIAC A TRIAC and 33 - 43v DIAC 	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 	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 	Electret Microphone (Condenser mic) 
Electrolytic (Polarised Capacitor)  alternate symbols: (positive on top)    	Electrolytic - Tanatulum positive end black band or chamfer 	Exclusive-OR Gate (XOR Gate) 
Field Effect Transistor (FET) n-channel also: N-Channel J FET 	Field Effect Transistor (FET) p-channel also: P-Channel J FET 	Flashing LED (Light Emitting Diode) (Indicates chip inside 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 	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:		Switch - Rotary	
Thermal Probe		Thyristors:		Thermocouple	
Transformer Air Core		Thyristors:		Tilt switch mercury	
		Thyristors:		Touch Sensor	
		Thyristors:		Transformer (Tapped Primary/Sec)	



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 <b>BASIC ELECTRONICS</b> Go to: <a href="http://www.talkingelectronics.com">http://www.talkingelectronics.com</a>	

## IC PINOUTS

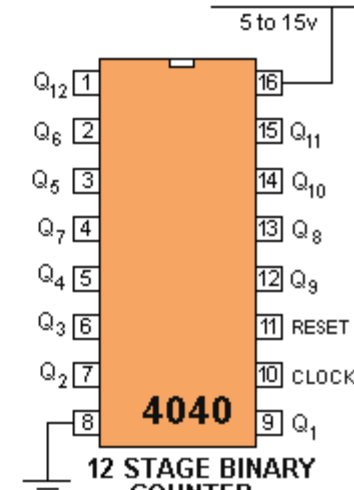
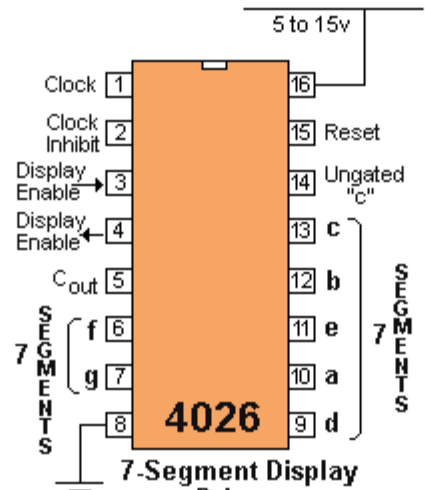
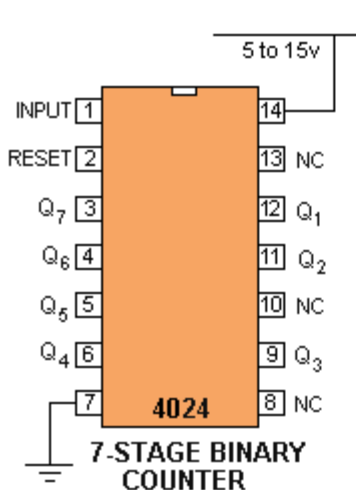
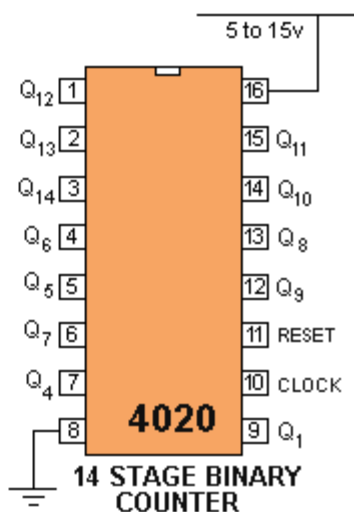
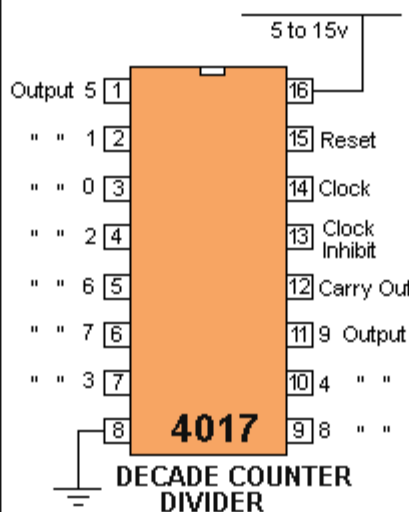
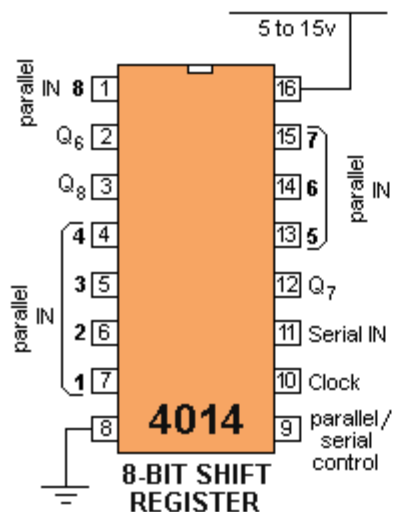
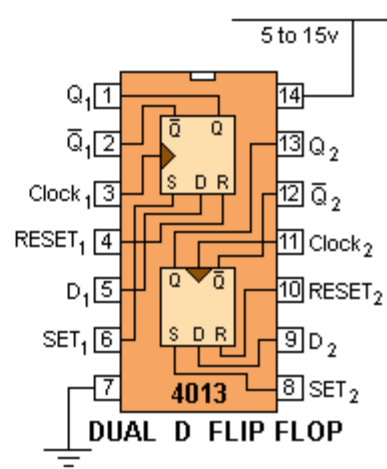
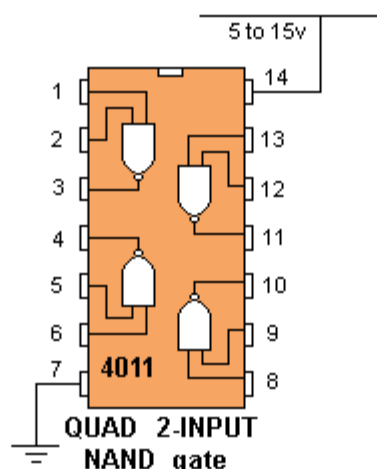
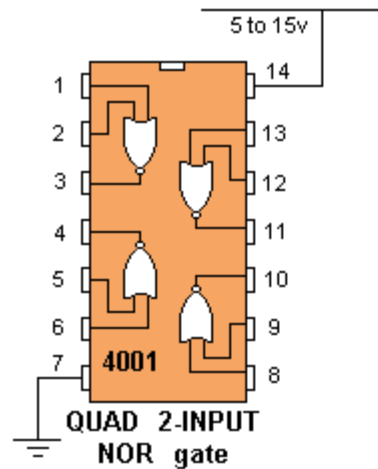
The following list covers just a few of the IC's on the market and these are the "simple" or "basic" or "digital" or "op-amp" IC's suitable for experimenting.

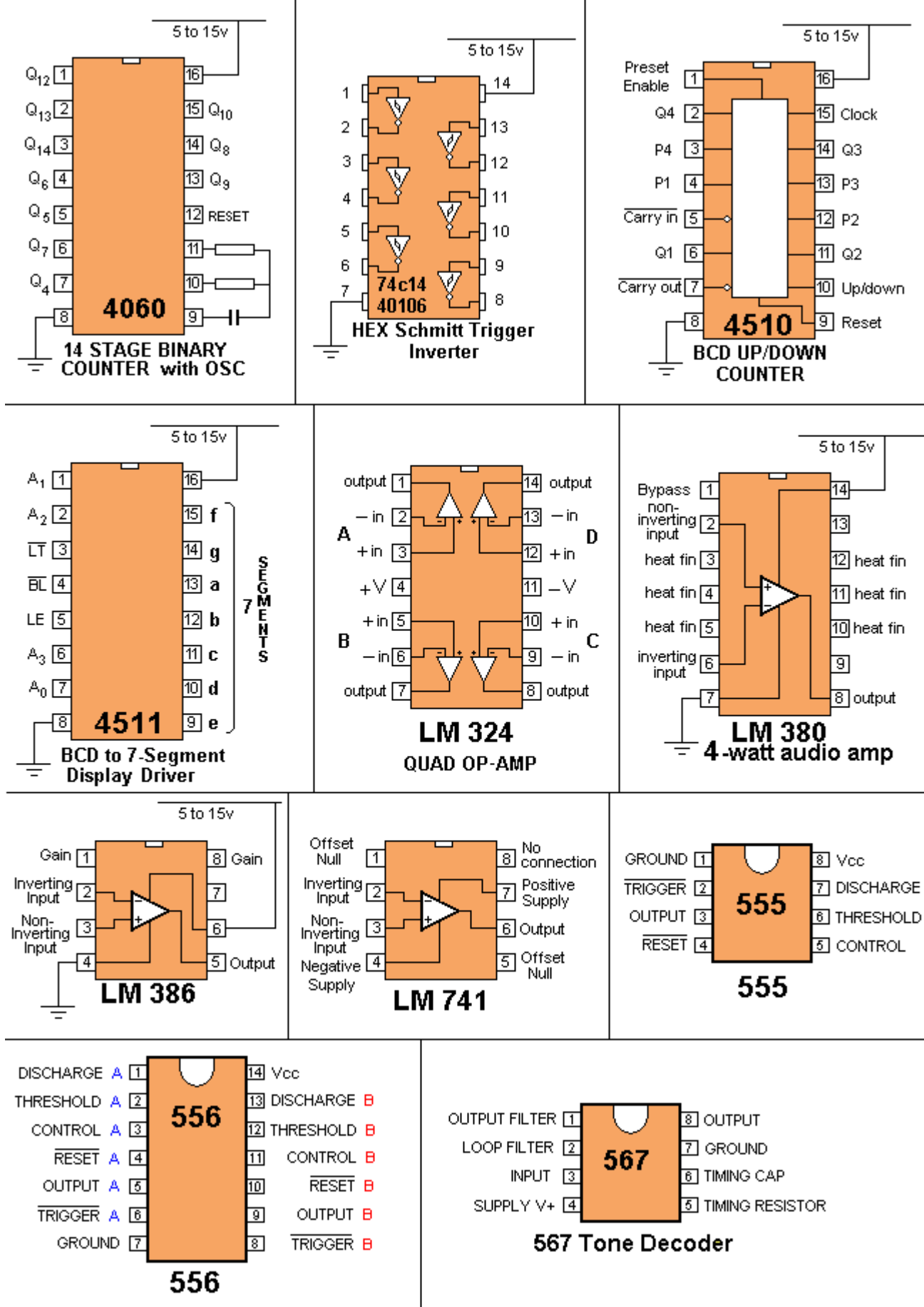
When designing a circuit around an IC, you have to remember two things:

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.

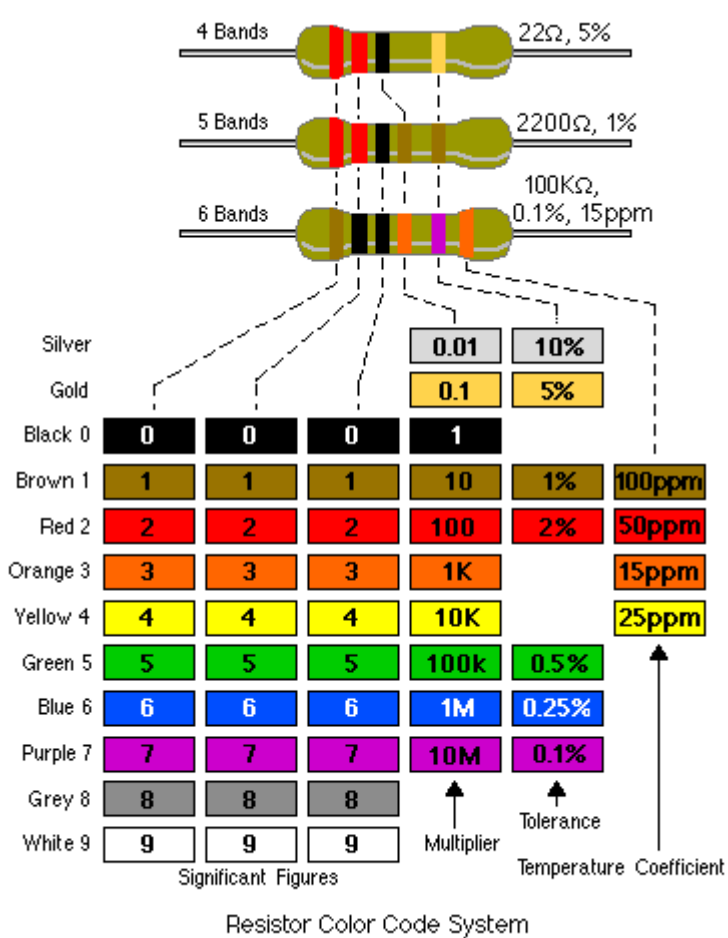




### All the resistor colours:

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

1R0	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	0R1
18k	180k	1M8	R22
22k	220k	2M2	0R0
27k	270k	2M7	zero ohm (link)
33k	330k	3M3	 $\frac{1}{10}$ th watt and 0.25 watt
39k	390k	3M9	
47k	470k	4M7	
56k	560k	5M6	
68k	680k	6M8	
82k	820k	8M2	



## MAKE ANY RESISTOR VALUE:

If you don't have the exact resistor value for a project, don't worry. Most circuits will work with a value slightly higher or lower.

But if you want a particular value and it is not available, here is a chart.

Use 2 resistors in series or parallel as shown:

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

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

4R7 = 4.7 ohms

### 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:

Required Value	C1	Series/ Parallel	C2	Actual value:
10	4.7	P	4.7	9.4
12	10	P	2.2	12.2
15	22	S	47	14.9
18	22	S	100	18
22	10	P	12	22
27	22	P	4.7	26.7
33	22	P	10	32
39	220	S	47	38.7
47	22	P	27	49
56	47	P	10	57
68	33	S	33	66
82	27	S	56	83

The value "10" in the chart above can be 10p, 10n or 10u. The chart works for all decades (values).