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For more data on the 555, see these pages:

555-Page 1	for CD users: 555-Page 1
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555-Test	555-Test

To learn about the development and history of the 555, go to these links:

http://semiconductormuseum.com/Museum_Index.htm - a general discussion about the development of the transistor

http://semiconductormuseum.com/Transistors/LectureHall/Camenzind/Camenzind_Index.htm - history of the 555 - Page1

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For a list of every electronic symbol, see: [Circuit Symbols](#).

For more articles and projects for the hobbyist: see [TALKING ELECTRONICS WEBSITE](#)

84 CIRCUITS as of 12-9-2010 plus [Frequency Divider](#), [Constant Current](#), [170v Power Supply](#), [Audio Frequency Meter](#), [Toggle](#), [Reversing A Motor](#), [Automatic Curtain Closer](#), [Stepper Motor Controller](#), [Animated Display Controller](#), [4 Alarm Sounds](#), [Dice LED Effects](#), [Headlight Selector](#)
97 CIRCUITS as of 12-1-2011 plus [12v DC to 12v DC Battery Charger](#) [Water Level Detector](#)

Talking Electronics

See [TALKING ELECTRONICS WEBSITE](#)

email Colin Mitchell: talking@tpg.com.au

INTRODUCTION

This e-book covers the 555.

The 555 is everywhere and it is one of the cheapest and most-rugged chips on the market.

It comes as a TTL 555 and will operate from 4v to about 16-18v. It costs from 20 cents (eBay) to \$1.20 depending on the quantity and distributor. The circuitry inside the chip takes about 10mA - even when the output is not driving a load. This means it is not suitable for battery operation if the chip is to be powered ALL THE TIME.

The 555 is also available as a CMOS chip (ICM7555 or ICL7555 or TLC555) and will operate from 2v to 18v and takes 60uA when the circuitry inside the chip is powered. The "7555" costs from 60 cents (eBay) to \$2.00

We call the TTL version "555" and the CMOS version "7555." This is called ELECTRONICS JARGON.

The 555 comes as a single timer in an 8-pin package or a dual timer (556) in a 14 pin package.

The 7555 comes as a single timer in an 8-pin package or a dual timer (7556) in a 14 pin package.

The 555 and 7555 are called TIMERS or Timer Chips. They contain about 28 transistors and the only extra components you need are called TIMING COMPONENTS. This is an external resistor and capacitor. When a capacitor is connected to a voltage, it takes a

period of time to charge. If a resistor is placed in series with the capacitor, the timing will increase. The chip detects the rising and falling voltage on the capacitor. When the voltage on the capacitor is 2/3 of the supply the output goes LOW and when the voltage falls to 1/3, the output goes HIGH.

We can also do other things with the chip such as "freezing" or halting its operation, or allowing it to produce a single HIGH-LOW on the output pin. This is called a "ONE-SHOT" or MONOSTABLE OPERATION.

When the chip produces an output frequency above 1 cycle per second, (1Hz), the circuit is called an OSCILLATOR and below one cycle per second, it is called a TIMER. But the chip should not be called a "555 Timer," as it has so many applications. That's why we call it a "555." (triple 5)

Another thing you have to be aware of is the voltage on output pin 3. It is about 1-2v LESS THAN rail voltage and does not go to 0v (about 0.7v for 10mA and up to 1900mV for 200mA sinking current). For instance, to get an output swing of 10v you will need a 12.6v supply. In "electronic terms" the 555 has very poor sinking and sourcing capabilities.

For photos of nearly every electronic component, see this website:

https://www.egr.msu.edu/eceshop/Parts_Inventory/totalinventory.php

You can also search the web for videos showing the 555 in action.

Here are a few:

[Making A 555 LED Flasher - Video Tutorial](#)

[Three 555 LED Flasher](#)

[555 Timer Flasher](#)

[Fading LED with 555 timer](#)

Each website has lots more videos and you can see exactly how the circuits work. But there is nothing like building the circuit and that's why you need to re-enforce your knowledge by ACTUAL CONSTRUCTION.

Learning Electronics is like building a model with Lego bricks. Each "topic" or "subject" or "area" must be covered fully and perfectly, just like a Lego brick is perfect and fits with interference-fit to the next block. When you complete this eBook, you can safely say you will have mastered the 555 - one more "building block" under your belt and in the process learn about DC motors, Stepper motors, servos, 4017 chips, LEDs and lots of other things. Any one of these can take you off in a completely different direction. So, lets start . . .

Colin Mitchell

TALKING ELECTRONICS.

talking@tpg.com.au

To save space we have not provided lengthy explanations of how any of the circuits work. This has already been covered in TALKING ELECTRONICS Basic Electronics Course, and can be obtained on a [CD for \\$10.00](#) (posted to anywhere in the world) See Talking Electronics website (<http://www.talkingelectronics.com>) for more details on the 555 by clicking on the following four pages: [555-Page 1](#) [555-Page 2](#) [555-Page 3](#) [555-Test](#)

Many of the circuits have been designed by Colin Mitchell: [Music Box](#), [Reaction Timer Game](#), [Traffic Lights](#), [TV Remote Control Jammer](#), [3x3x3 Cube](#), while others are freely available on the web. But this eBook has brought everything together and covers just about every novel 555 circuit. If you think you know everything about the 555, take the [555-Test](#) and you will be surprised!

SI NOTATION

All the schematics in this eBook have components that are labelled using the System International (SI) notation system. The SI system is an easy way to show values without the need for a decimal point. Sometimes the decimal point is difficult to see and the SI system overcomes this problem and offers a clear advantage.

Resistor values are in ohms (R), and the multipliers are: k for kilo, M for Mega.

Capacitance is measured in farads (F) and the sub-multiples are u for micro, n for

nano, and p for pico. Inductors are measured in Henrys (H) and the sub-multiples are

mH for milliHenry and uH for microHenry.

A 10 ohm resistor would be written as 10R and a 0.001u capacitor as 1n.

The markings on components are written slightly differently to the way they are shown on a circuit diagram (such as 100p on a circuit and 101 on the capacitor or 10 on a capacitor and 10p on a diagram) and you will have to look on the internet under **Basic Electronics** to learn about these differences.

NEW! FROM TALKING ELECTRONICS

A new range of 555 chips have been designed by Talking Electronics to carry out tasks that normally need 2 or more chips.

These chips are designated: TE 555-1, TE555-2 and the first project to use the TE 555-1 is [STEPPER MOTOR CONTROLLER TE555-1](#).



It's a revolutionary concept. Instead of using an old 8-pin TTL 555 chip, you can use a new TE555-1,2,3 8-pin chip and save board space as well as components. These new chips require considerably less external componentry and the possibilities are endless. Depending on the circuit, they can have a number of timing and frequency outputs as well as a "power-down" feature that consumes almost no current when the circuit is not operating. See the first project in this series: [STEPPER MOTOR CONTROLLER TE555-1](#).

See also: [Stepper Motor Controller](#) project

See also [TE 555-2](#) [TE555-3](#) [TE 555-4](#) [TE555-5](#)

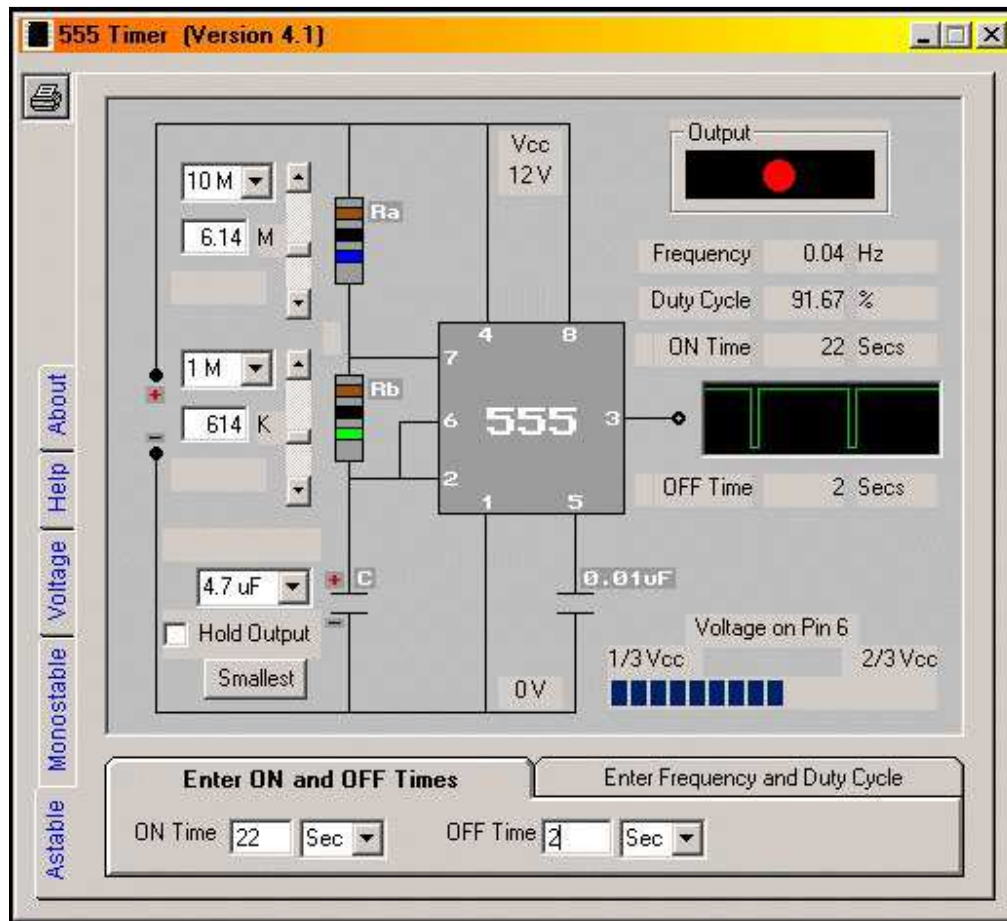
555 TIMER CALCULATOR

A program to work out the values for a 555 in Astable or Monostable mode is available from Andy Clarkson's website:

<http://clarkson-uk.com/555-timer/>

[555-Timer.zip](#) (987KB). Call a folder: "555 Timer." Unzip and run "555 Timer setup.exe"

Setup will produce a desktop icon. Click on icon for program. Set the voltage for the 555 then use the Astable or Monostable tabs to design your circuit. Read the Help screen to understand the operation of: "Hold Output" and "smallest."



7555 CMOS CALCULATOR [see 7555](#)

The 555 comes in a low-power CMOS version. The drive-current from pin 3 is less than the TTL "555."

At 5v, a 7555 will deliver 2mA and sink only 8mA

At 12v a 7555 will deliver 10mA and sink 50mA

At 15v a 7555 will deliver 100mA and sink 100mA

Use the following 7555 calculator to find the OUTPUT FREQUENCY in Astable mode or OUTPUT TIME in Monostable mode:

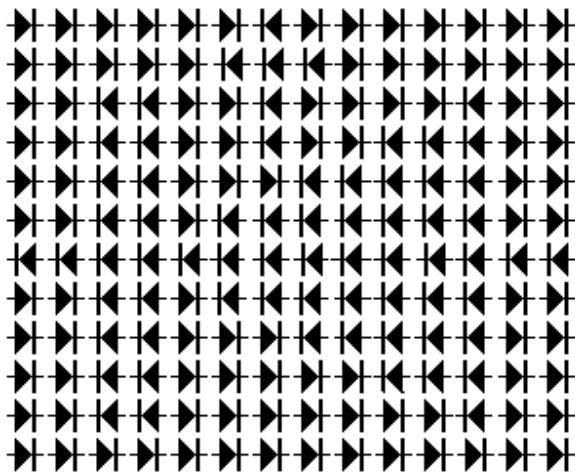
[7555 CMOS Calculator](#)

Here's a 555 made with 22 transistors by Malcolm Faed. See his [video](#).

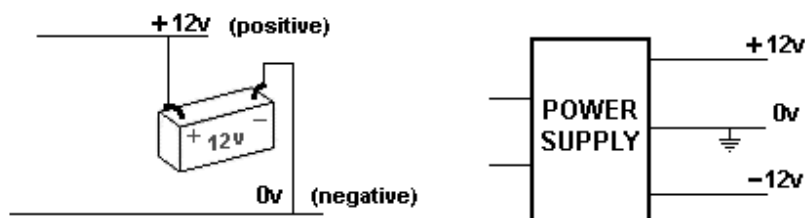


See his [Electric Vehicle website](#).

How are your powers of observation?
Can you find the LED:



THE POWER SUPPLY



Sometimes you will see a circuit as shown in the **first diagram** with 12v or +12v on the top rail and 0v or a negative sign or the word "negative" on the bottom rail. In **this case** the word negative means earth or "chassis of a car" and we commonly refer to this as "negative earth" or "negative chassis."

In the **second diagram**, the output from a power supply has a positive 12 volts and a negative 12v with the 0v rail in the middle. In **this case** the negative 12v rail is twelve volts BELOW the earth rail and that's why we call it the **NEGATIVE RAIL**.

This means that when you hear "Negative Rail," you need to work out if it means the negative terminal of a battery (as in the first case - meaning 0v or earth) or if the voltage is below zero volts (as in the second case).

BUY NOW

SQUARE WAVE OSCILLATOR KIT

A [Square Wave Oscillator](#) Kit is available from Talking Electronics for under \$10.00. See full details of [circuit](#) below.

(This link will send an email to Colin Mitchell and you will be advised of costs and how to send money via Paypal or credit card.)

Or email Colin Mitchell: talking@tpg.com.au

BUY NOW

555 KIT

A kit of components to make many of the circuits described

in this eBook is available for \$10.00 plus \$7.00 post.

Or email Colin Mitchell: talking@tpg.com.au

The kit contains the following components:
(plus **extra** 30 resistors and 10 capacitors for experimenting), plus:

- 2 - 220R
- 2 - 1k
- 2 - 4k7
- 2 - 10k
- 2 - 33k
- 2- 100k
- 2 - 1M
- 1 - 10k mini pot
- 1 - 100k mini pot
- 2 - 10n
- 2 - 100n
- 1 - 10u electrolytic
- 1- 100u electrolytic
- 2 - 1N4148 signal diodes
- 2 - BC547 transistors
- 1 - BC557 transistor
- 1 - 555 timer chip
- 1 - 8 pin IC socket
- 1 - red LED
- 1 - green LED
- 1 - orange LED
- 1 - mini 8R speaker
- 1 - mini piezo
- 1 - LDR (Light Dependent Resistor)
- 1 - 10mH inductor
- 1 - push button
- 1 - tactile push button
- 1 - **Experimenter Board** (will take 8, 14 and 16 pin chips)

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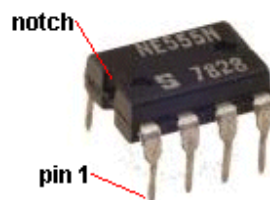
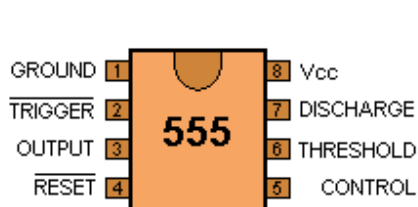
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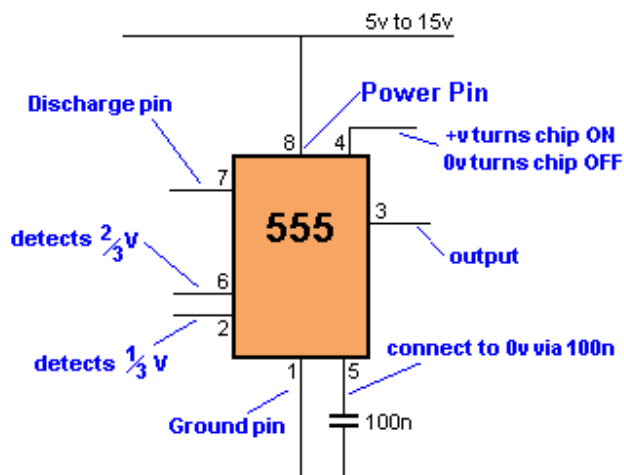
THE 555 PINS

Here is the identification for each pin:



555 PINOUT

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



The Function of each PIN

Pin 1 GROUND. Connects to the 0v rail.

Pin 2 TRIGGER. Detects $\frac{1}{3}$ of rail voltage to make output HIGH. Pin 2 has control over pin 6. If pin 2 is LOW, and pin 6 LOW, output goes and stays HIGH. If pin 6 HIGH, and pin 2 goes LOW, output goes LOW while pin 2 LOW. This pin has a very high impedance (about 10M) and will trigger with about 1uA.

Pin 3 OUTPUT. (Pins 3 and 7 are "in phase.") Goes HIGH (about 2v less than rail) and LOW (about 0.5v less than 0v) and will deliver up to 200mA.

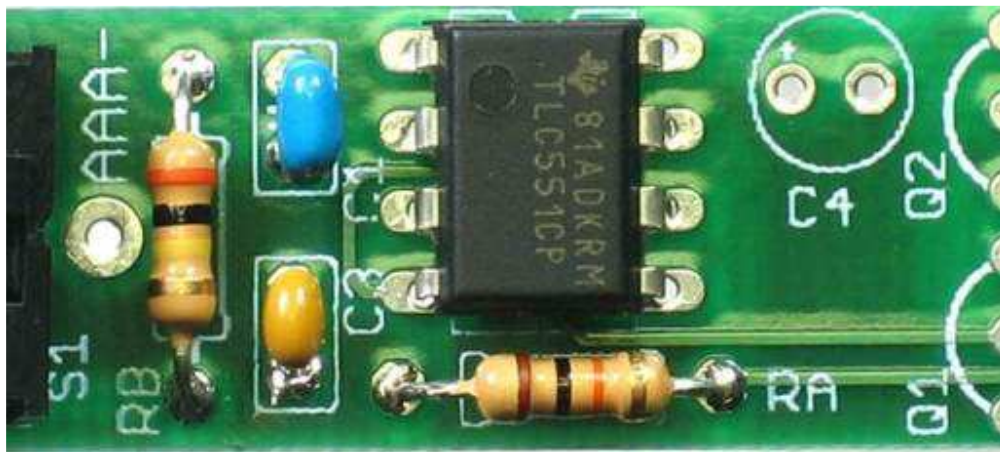
Pin 4 RESET. Internally connected HIGH via 100k. Must be taken below 0.8v to reset the chip.

Pin 5 CONTROL. A voltage applied to this pin will vary the timing of the RC network (quite considerably).

Pin 6 THRESHOLD. Detects $\frac{2}{3}$ of rail voltage to make output LOW only if pin 2 is HIGH. This pin has a very high impedance (about 10M) and will trigger with about 0.2uA.

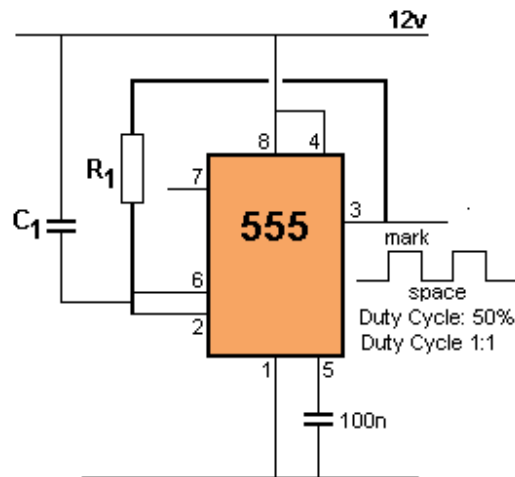
Pin 7 DISCHARGE. Goes LOW when pin 6 detects $\frac{2}{3}$ rail voltage but pin 2 must be HIGH. If pin 2 is HIGH, pin 6 can be HIGH or LOW and pin 7 remains LOW. Goes OPEN (HIGH) and stays HIGH when pin 2 detects $\frac{1}{3}$ rail voltage (even as a LOW pulse) when pin 6 is LOW. (Pins 7 and 3 are "in phase.") Pin 7 is equal to pin 3 but pin 7 does not go high - it goes OPEN. But it goes LOW and will sink about 200mA. **You can connect pin 7 to pin 3 to get a slightly better SINK capability from the chip.**

Pin 8 SUPPLY. Connects to the positive rail.



555 in a circuit - note the circle on the chip to identify pin 1

This is sometimes called a "push-out-pin" (hole) and sometimes it has no importance. But in this case it represents pin 1.



C1 to POSITIVE RAIL

50%:50%.

If a resistor and capacitor (or electrolytic) is placed on the output, the result is very similar to a sinewave.

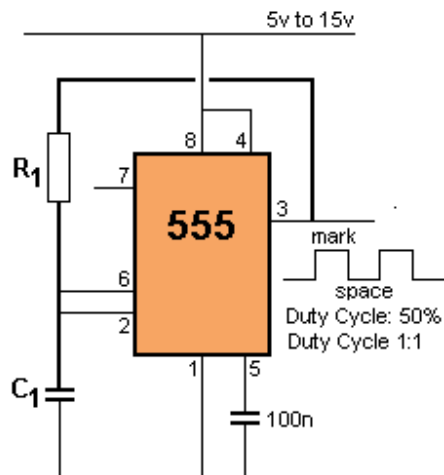
THE SIMPLEST 555 OSCILLATOR

The simplest 555 oscillator takes output pin 3 to capacitor C1 via resistor R1.

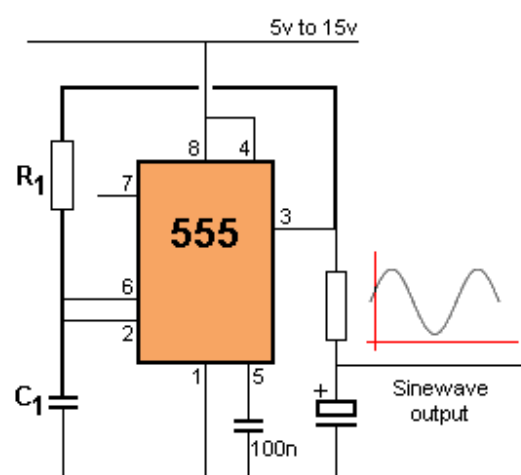
When the circuit is turned on, C1 is uncharged and output pin 3 is HIGH. C1 charges via R1 and when Pin 6 detects 2/3 rail voltage, output pin 3 goes LOW. R1 now discharges capacitor C1 and when pin 2 detects 1/3 rail voltage, output pin 3 goes HIGH to repeat the cycle.

The amount of time when the output is HIGH is called the MARK and the time when the output is LOW is called the SPACE.

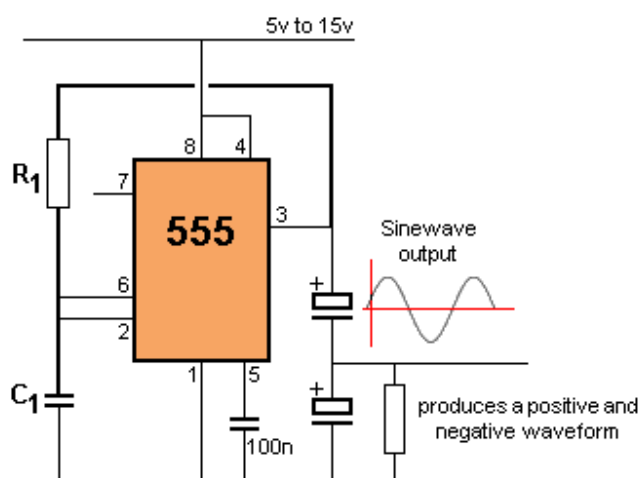
In the diagram, the mark is the same length as the space and this is called 1:1 or



**SIMPLEST 555
OSCILLATOR**



SINEWAVE OUTPUT



SINEWAVE OUTPUT

C1 to POSITIVE RAIL

C₁ can be connected to the positive rail. This is not normal practice, however it does work. The output frequency changes when the capacitor is changed from the negative rail to the positive rail. Theoretically the frequency should not change, but it does, and that's why you have to check everything. The frequency of operation in this arrangement is different to connecting the components via pin7 because pin3 does not go to full rail voltage or 0v. This means all the output frequencies are lower than those in the "555 Frequency Calculator."

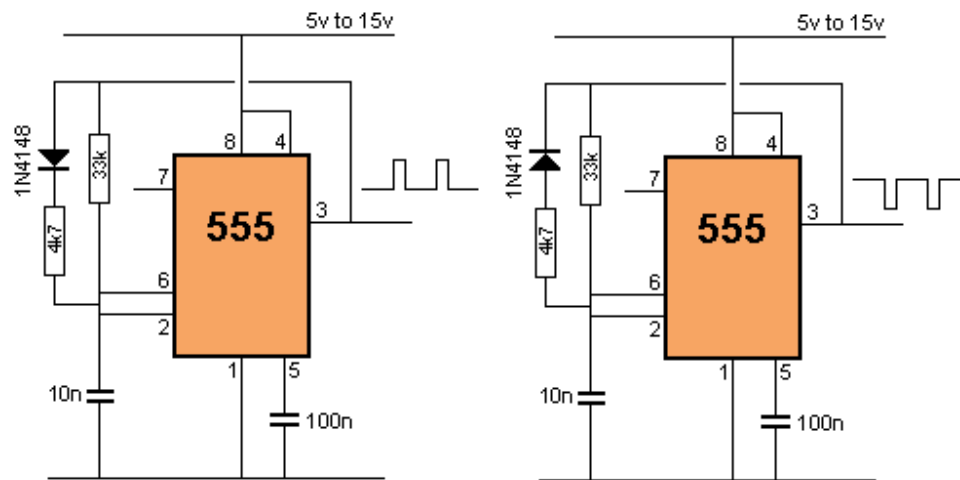
The table shows the frequency for the capacitor connected to the 0v rail and 12v rail:

C ₁ to 0v rail			C ₁ to 12v rail		
1k	1n	505kHz	1k	1n	255kHz
1k	10n	115kHz	1k	10n	130kHz
1k	100n	23kHz	1k	100n	16kHz
10k	1n	112kHz	10k	1n	128kHz
10k	10n	27kHz	10k	10n	16kHz
10k	100n	3700Hz	10k	100n	1600Hz

CHANGING THE MARK-SPACE RATIO

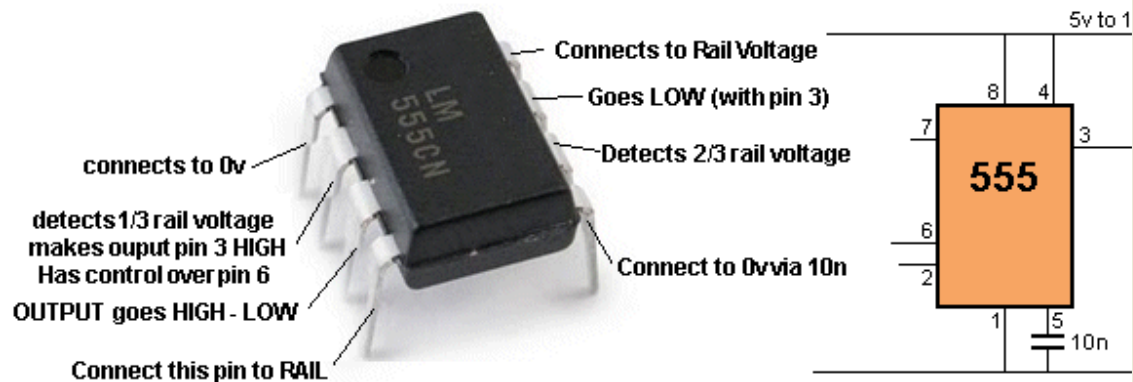
This ratio can be altered by adding a diode and resistor as shown in the following diagrams.

In the first diagram, the 555 comes ON ("fires-up") with pin 3 low and pin 2 immediately detects this low and makes pin 3 HIGH. The 10n is quickly charged via the diode and 4k7 and this is why the MARK is "short." When the capacitor is $2/3V_{cc}$, pin 6 detects a HIGH and the output of the 555 goes LOW. The 10n is discharged via the 33k and this creates the long-duration SPACE (LOW). The second diagram creates a long-duration HIGH:



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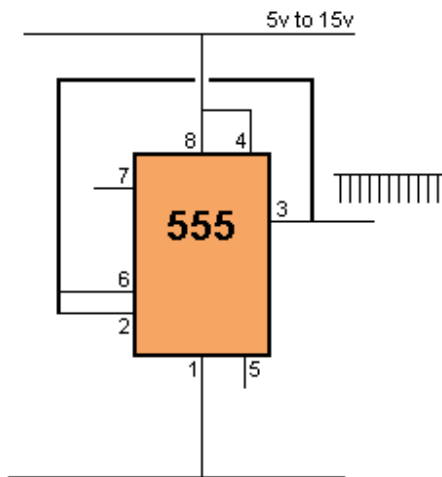
HOW TO REMEMBER THE PINS:



THE 555 PINS AND THEIR FUNCTION

THE FASTEST 555 OSCILLATOR

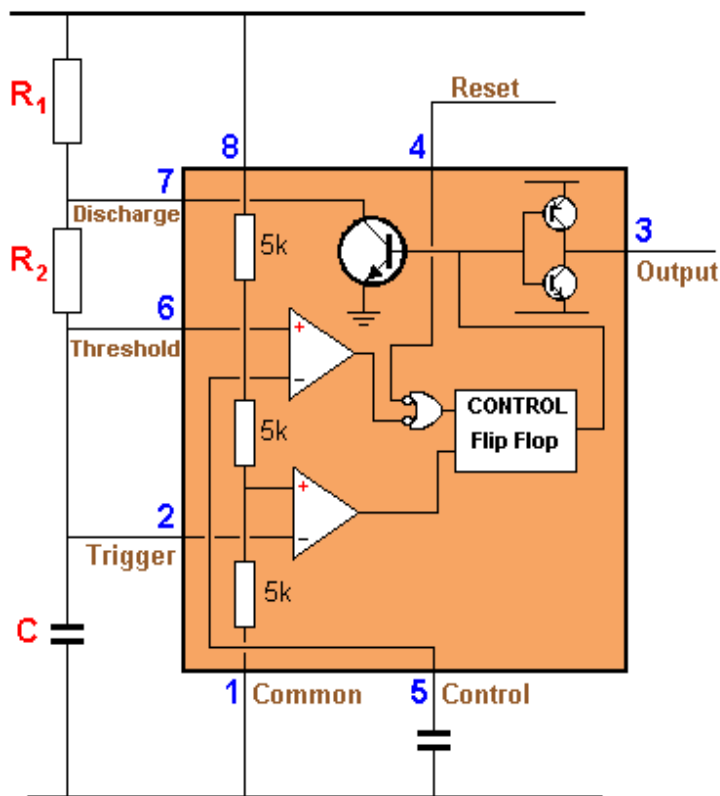
The highest frequency for a 555 can be obtained by connecting the output to pins 2 and 6. This arrangement takes about 5mA and produces an output as shown. The max frequency will depend on the supply voltage, the manufacturer, and the actual type of 555 chip.



FASTEST 555 OSCILLATOR

View the output on a CRO. Our 555 "Test Chip" produced a frequency of 300kHz at 5v and also at 12v. (CMOS versions will operate at a higher frequency.) Note the very short LOW TIME.

INSIDE THE 555



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 a 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 can be up to 2.5v **less than rail voltage**
Output can be **0.5v to 1.5v above ground**
Sources up to 200mA
Some chips sink only 50mA, some will sink 200mA

A NE555 was tested at 1kHz, 12.75v rail and 39R load.

The Results:

Output voltage 0.5v low, 11.5v high at output current of 180mA

The "test chip" performance was excellent.

HOW TO USE THE 555

There are many ways to use the 555. They can be used in hundreds of different circuits to do all sorts of clever things. They can also be used as three different types of oscillators:

(a) Astable Multivibrator - constantly oscillates

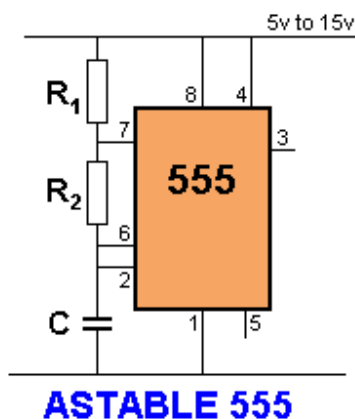
For frequencies above 1 cycle per second, it is called an oscillator (multivibrator or square wave oscillator).

For frequencies below 1 cycle per second it is called a TIMER or DELAY.

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

(c) Voltage Controlled Oscillator - called a VCO.

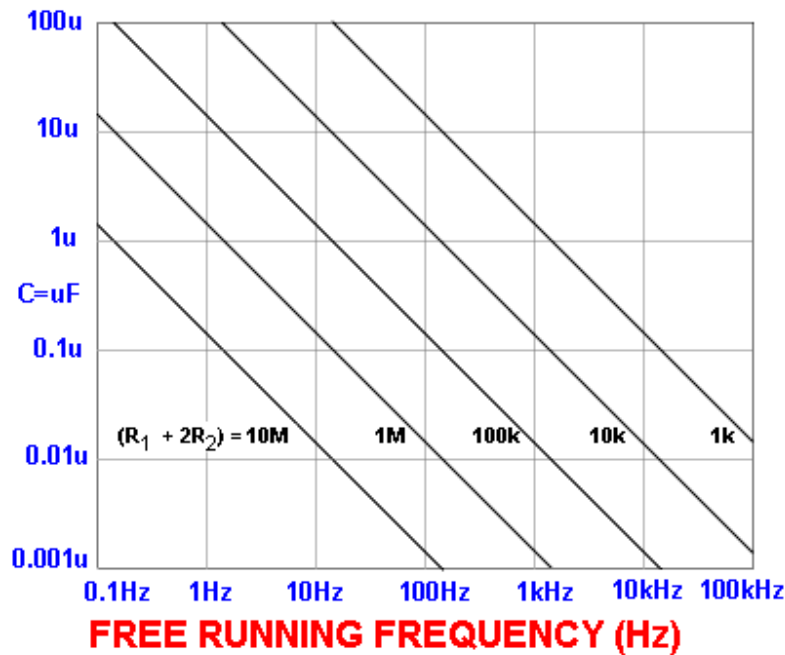
THE ASTABLE (or FREE RUNNING) MULTIVIBRATOR



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.

The following graph applies to the Astable circuit:



Using the graph:

Suppose $R_1 = 1k$, $R_2 = 10k$ and $C = 0.1u$ (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

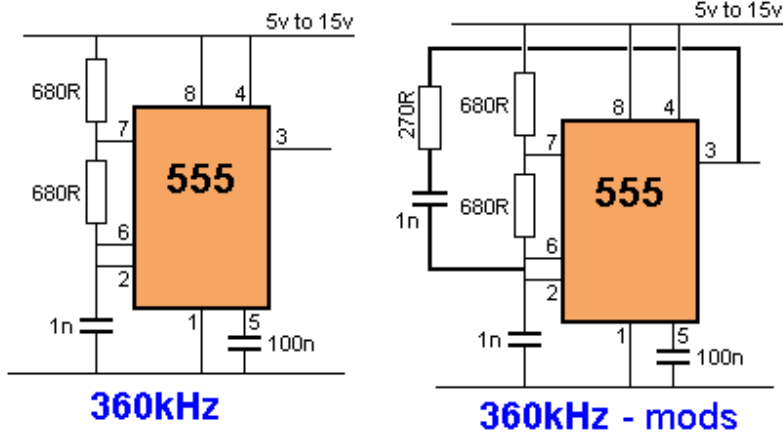
C	$R_1 = 1k$ $R_2 = 6k8$	$R_1 = 10k$ $R_2 = 68k$	$R_1 = 100k$ $R_2 = 680k$
0.001 μ	100kHz	10kHz	1kHz
0.01 μ	10kHz	1kHz	100Hz
0.1 μ	1kHz	100Hz	10Hz
1 μ	100Hz	10Hz	1Hz
10 μ	10Hz	1Hz	0.1Hz

0.001 μ = 1n
0.01 μ = 10n
0.1 μ = 100n

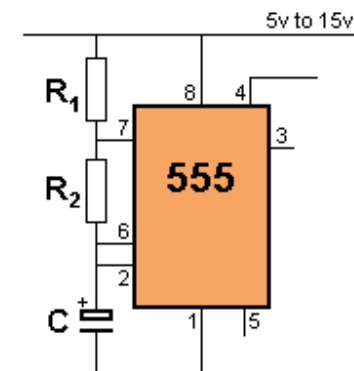
HIGH FREQUENCY OSCILLATORS

360kHz is the absolute maximum as the 555 starts to malfunction with

irregular bursts of pulses above this frequency. To improve the performance of the oscillator, a 270R and 1n can be added as shown in the second circuit:



LOW FREQUENCY OSCILLATORS - called TIMERS



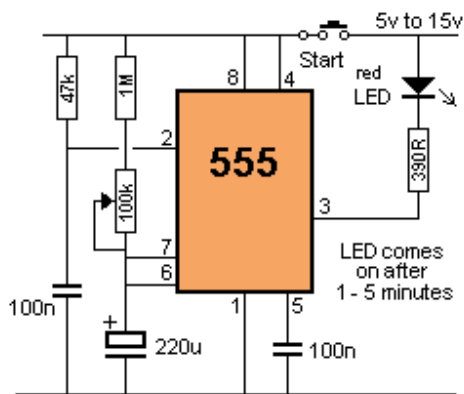
If the capacitor is replaced with an electrolytic, the frequency of oscillation will reduce. When the frequency is less than 1Hz, the oscillator circuit is called a timer or "delay circuit." The 555 will produce delays as long as 30 minutes but with long delays, the timing is not accurate.

LOW FREQUENCY 555

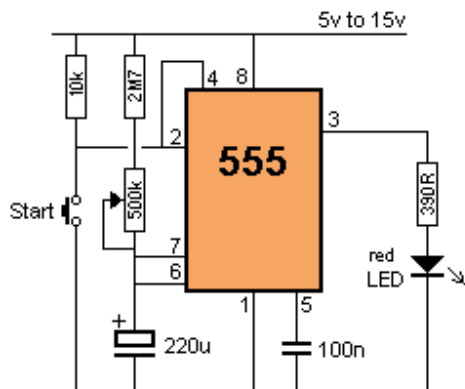
555 Delay Times:

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

The following circuits show a 1-5 minute timer and 10 minute timer:



1 - 5 min TIMER



10 MINUTE TIMER

CMOS 555

A low power version of the 555 is available from many manufacturers and basically it is a CMOS version of the TTL 555 device.

The CMOS 555 has the same pinouts as the TTL version and can be fitted into the same 8 pin socket but if the circuit needs more current than can be supplied by the CMOS version, it will not produce the same results.

It is the low current capability of the CMOS version that will be the major reason why you cannot directly replace the TTL version with the CMOS version.

It will operate from 1v (only some manufacturers) to 15v and will work up to 3MHz in astable mode.

Current consumption @5v is about 250uA (1/4mA)

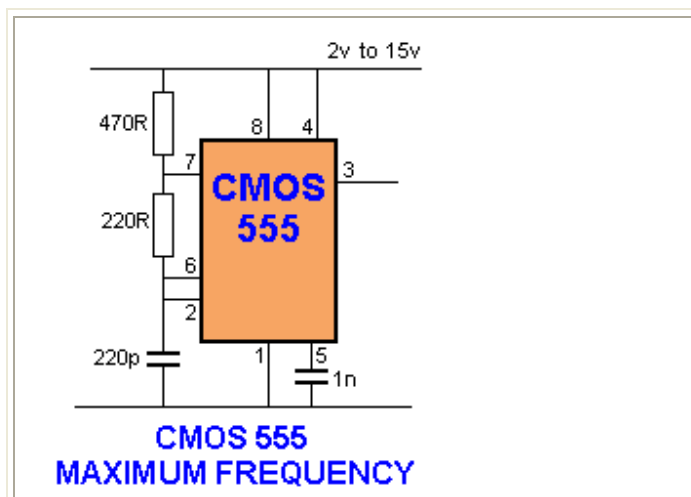
But the major thing to remember is the output current capability.

At 2v, the chip will only deliver 0.25mA and sink only 1mA.

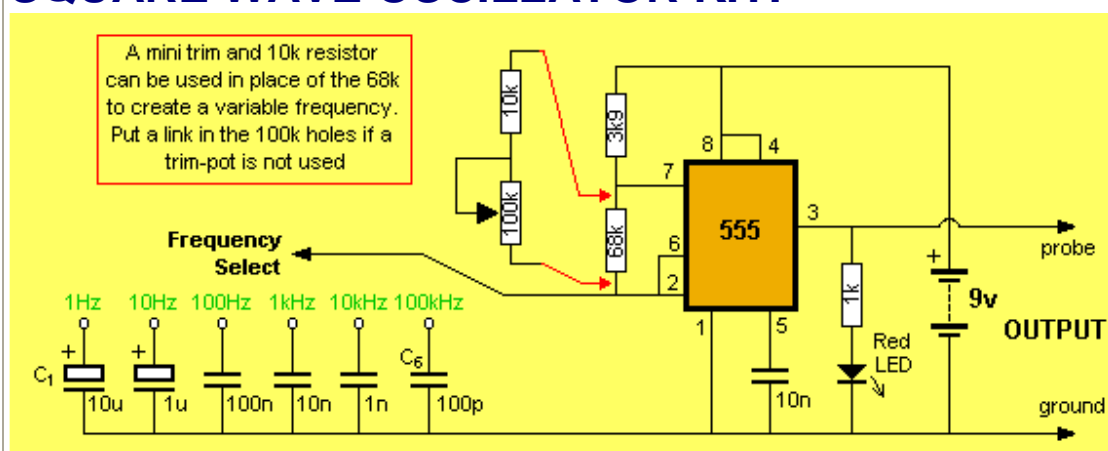
At 5v, the chip will deliver 2mA and sink only 8mA

At 12v the chip will deliver 10mA and sink 50mA

At 15v the chip will deliver 100mA and sink 100mA



SQUARE WAVE OSCILLATOR KIT:

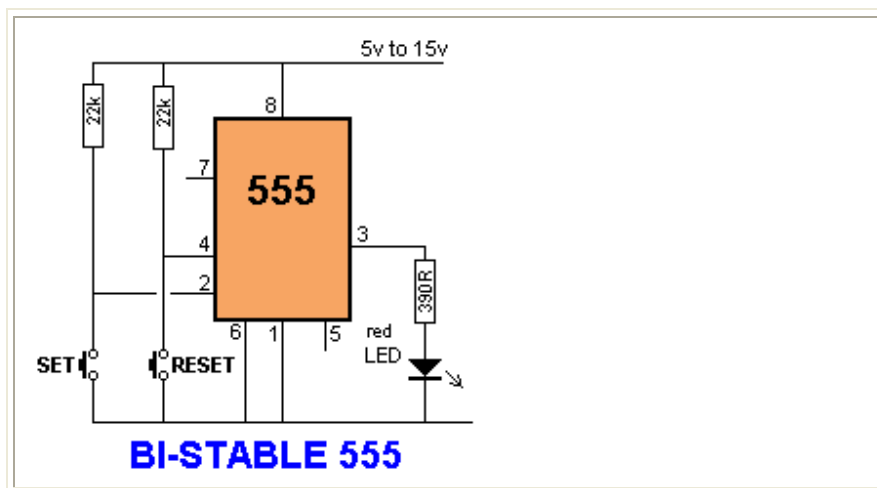


A square wave oscillator kit can be purchased from Talking Electronics for approx \$10.00
See website: **Square Wave Oscillator**
It has adjustable (and settable) frequencies from 1Hz to 100kHz and is an ideal piece of Test Equipment.
(This link will send an email to Colin Mitchell and you will be advised of costs and how to send money via Paypal or credit card.)

Bi-stable or "Latch" or "2-state" 555

The bi-stable 555 has two steady states. SET turns ON the LED and RESET turns the LED off. The 555 comes on in reset mode as Pin2 does not see a LOW to SET the 555.

See also: [Divide By Two](#)



Monostable or "One Shot" or Pulse Extender

When the circuit is turned on, the output is LOW and a brief negative pulse on pin 2 will make the output go HIGH for a period of time determined by the value of R and C. If pin 2 is low for longer than this period, the output will remain HIGH while pin 2 is LOW and immediately go LOW when pin 2 goes HIGH.

CIRCUIT OPERATION

When the circuit is turned on, the capacitor is uncharged. Pin 6 sees a LOW and pin 2 sees a HIGH.

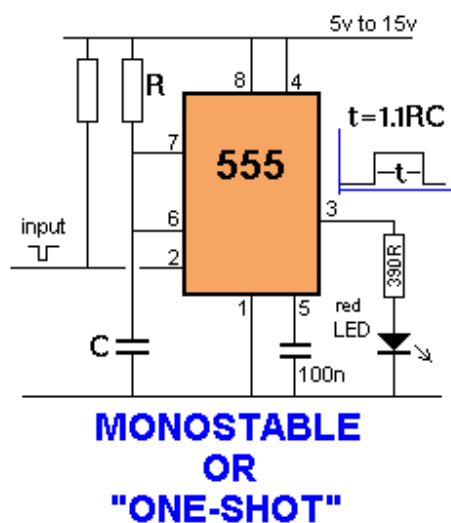
Remember: Pin 2 must be LOW to make the output HIGH.

Pin 6 must be HIGH to make the output LOW.

Neither pin is "controlling the chip" at start-up and the chip is designed to output a LOW with these start-up conditions.

In other words, the chip starts in RESET mode. Pin 7 is LOW and the capacitor does not charge.

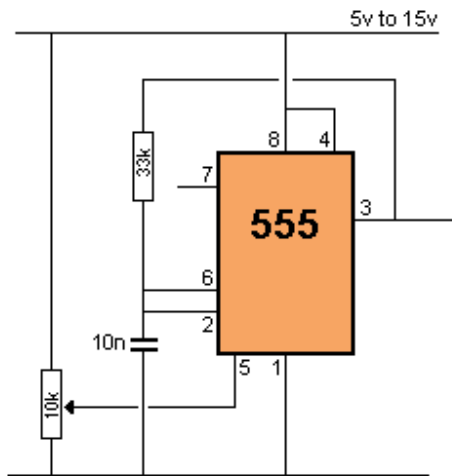
When pin 2 see a LOW pulse, the chip goes to SET mode and the output goes HIGH. Pin 7 goes OPEN and capacitor C charges via R. When pin 6 sees $2/3$ rail voltage, the chip goes to RESET mode with pin 3 and 7 LOW. The capacitor instantly discharges via pin 7 and the circuit waits for a negative pulse on pin 2.



THE 555 AS A VOLTAGE

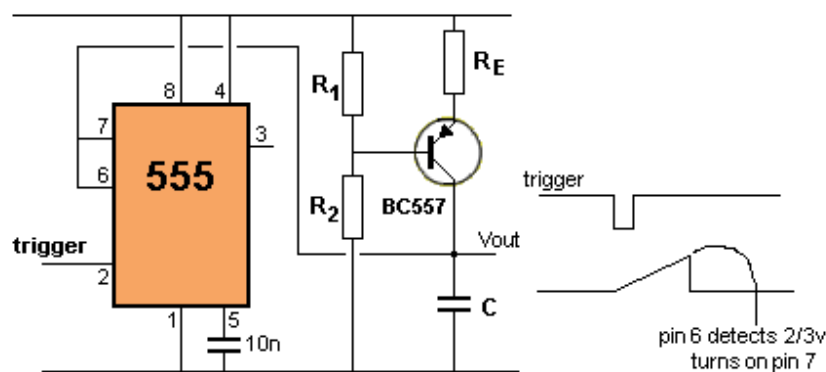
CONTROLLED OSCILLATOR (VCO)

By adjusting the voltage on pin 5, (the CONTROL pin) the frequency of the oscillator can be adjusted quite considerably. See [Police Siren](#) for an application.



THE 555 AS A RAMP GENERATOR

When a capacitor is charged via a constant current, the waveform across it is a ramp.



[to Index](#)

FREQUENCY DIVIDER

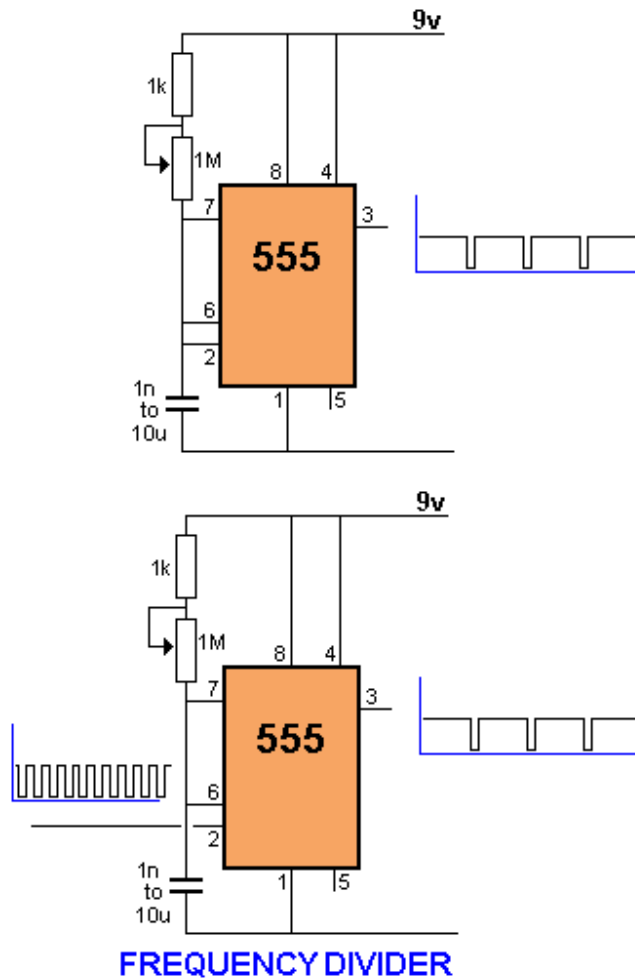
A 555 can be used to divide a frequency by almost any division.

It works this way:

A 555 is set-up to produce the required output frequency.

Pin 2 is then taken to the input frequency and this turns the 555 into a Monostable Multivibrator.

The circuit will detect a LOW on pin 2 to start the timing cycle and pin 3 will go HIGH. The 555 will not respond to any more pulses on pin 2 until pin 6 detects a HIGH via the charging of the capacitor. The value of C and the 1M pot need to be adjusted to produce the desired results.



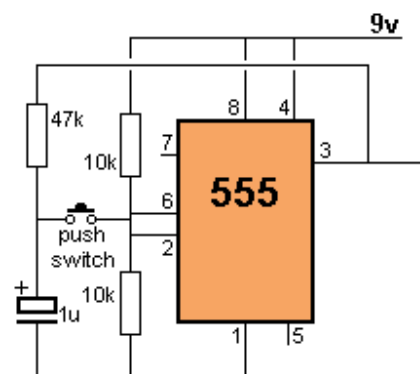
DIVIDE BY 2

A 555 can be used to divide-by-2

When pins 2 and 6 are connected, they detect $1/3$ and $2/3$ of rail voltage. When the detected voltage is below $1/3$, the output goes HIGH and when the voltage is above $2/3$, the output goes LOW.

The push switch detects the output voltage and after a short period of time the electrolytic will charge or discharge and it will be HIGH or LOW.

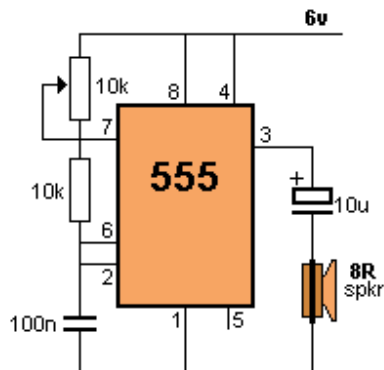
If the switch is pressed for a short period of time, the output will change. If the switch is kept pressed, the output will oscillate at a low frequency.



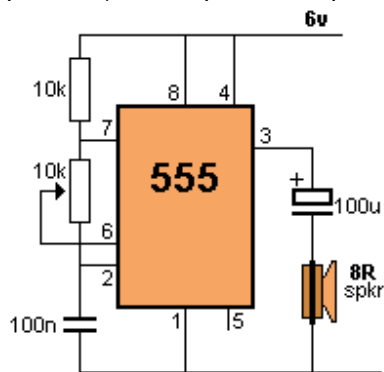
"No-No's"s"

Here are some mistakes to avoid:

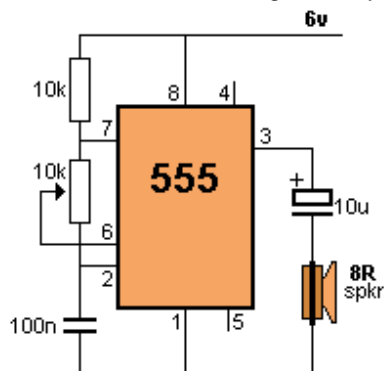
1. Pin 7 gets connected to the 0v rail via a transistor inside the chip during part of the operation of the 555. If the pot is turned to very low resistance in the following circuit, a high current will flow through the pot and it will be damaged:



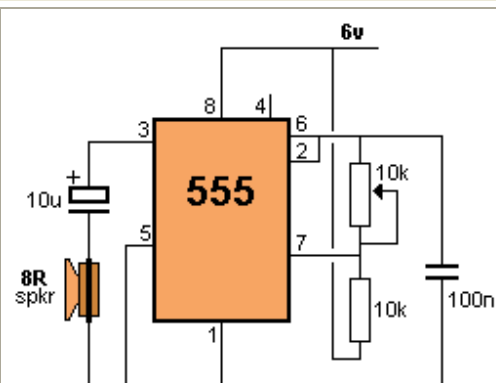
2. The impedance of the 100u electrolytic will allow a very high current to flow and the chip will get very hot. Use 10u maximum when using 8R speaker. (The temp of the chip will depend on the frequency of the circuit.)



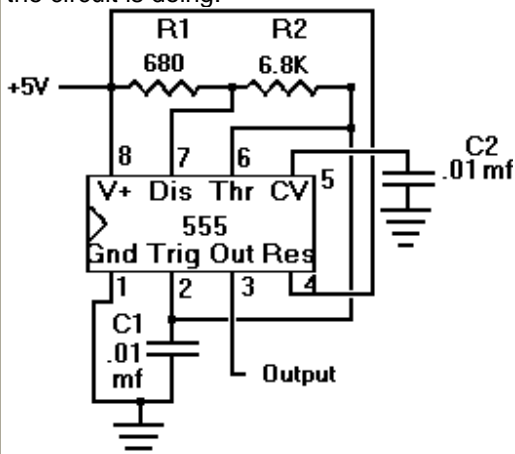
3. The reset pin (pin 4) is internally tied HIGH via approx 100k but it should not be left floating as stray pulses may reset the chip.



4. Do not draw 555 circuits as shown in the following diagram. Keep to a standard layout so the circuit is easy to follow.

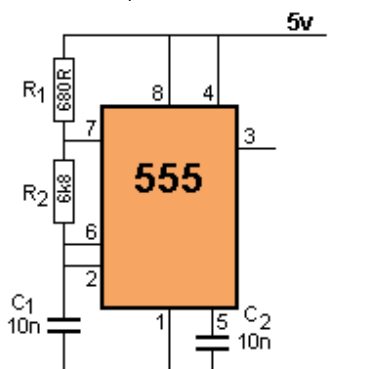


5. Here's an example from the web. It takes a lot of time to work out what the circuit is doing:



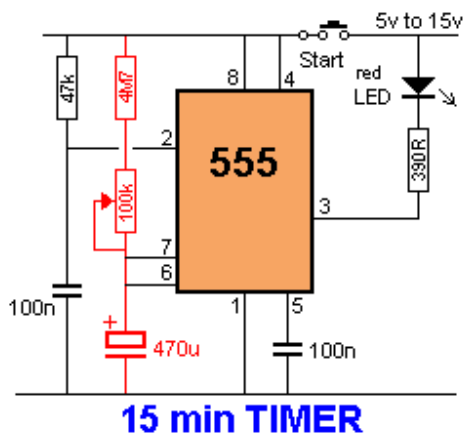
The aim is to lay-out a circuit so that it shows instantly what is happening. That's why everything must be in recognised locations.

Here is the corrected circuit: From this diagram it is obvious the circuit is an oscillator (and not a one-shot etc).

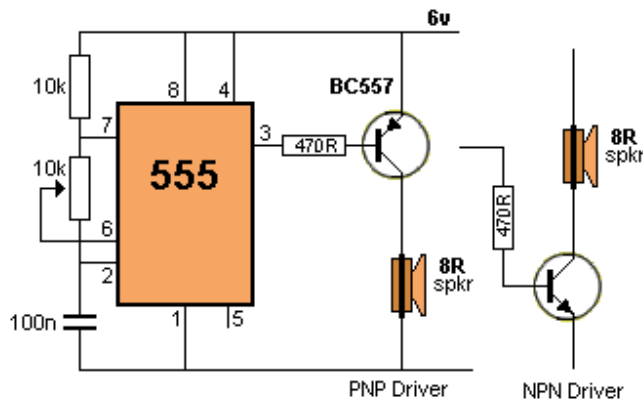


6. Don't use high value electrolytics and high resistances to produce long delays. The 555 is very unreliable with timing values above 5-10 minutes. The reason is simple. The charging current for the electrolytic is between 1 - 3 microamp in the following diagram (when the electro is beginning to charge) and drops to less than 1 microamp when the electro is nearly charged.

If the leakage of the electro is 1 microamp, it will never fully charge and the 555 will never "time-out."



7. Do not connect a PNP to the output of a 555 as shown in the following diagram. Pin 3 does not rise high enough to turn the transistor OFF and the current taken by the circuit will be excessive. Use an NPN driver.



555's

Here is a list of 555's from different manufacturers plus the range of low voltage, low current 555's. The normal 555 is called a TTL or Transistor-Transistor-Logic chip and it consumes about 10mA when "sitting and doing nothing." It will work from 4v to 18v.

A low current version is available from the list below, (called a CMOS version) and consumes about 10uA to 100uA. Some of these chips work from 1.5v to 15v (ZSCT1555 = 9v max) but they can sink and source only about 100mA (less than 30mA at 2v).

The 555 is the cheapest and the others cost about double.

The normal 555 oscillates up to 300kHz. A CMOS version can oscillate to 3MHz.

You need to know the limitations as well as the advantages of these chips before substituting them for the normal 555:

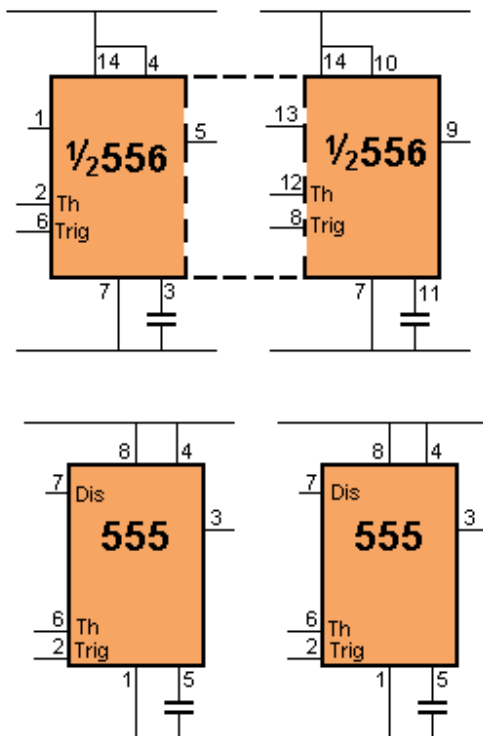
Manufacturer	Model	Remark
Custom Silicon Solutions	CSS555/CSS555C	CMOS from 1.2V, $I_{DD} < 5\mu A$
ECG Philips	ECG955M	
Exar	XR-555	
Fairchild Semiconductor	NE555/KA555	
Harris	HA555	
IK Semicon	ILC555	CMOS from 2V
Intersil	SE555/NE555/ICM7555	
Lithic Systems	LC555	
Maxim	ICM7555	CMOS from 2V
Motorola	MC1455/MC1555	
National Semiconductor	LM1455/LM555/LM555C	

National Semiconductor	LMC555	CMOS from 1.5V
NTE Sylvania	NTE955M	
Raytheon	RM555/RC555	
RCA	CA555/CA555C	
STMicroelectronics	NE555N/ K3T647	
Talking Electronics	TE555-1, -2, -3, -4	email Talking Electronics \$2.50 ea
Texas Instruments	SN52555/SN72555; TLC555	CMOS from 2V
Zetex	ZSCT1555	down to 0.9V (9v max)

[to Index](#)

REPLACING A 556 WITH TWO 555's

Here is a handy reference to replace a 556 dual timer with two 555's:



The table shows the pin numbering for each timer:

	555	556 - Timer 1	556 - Timer 2
Ground (-)	1	7	7
Trigger	2	6	8
Output	3	5	9
Reset	4	4	10
Control	5	3	11
Threshold	6	2	12
Discharge	7	1	13
Vcc (+)	8	14	14

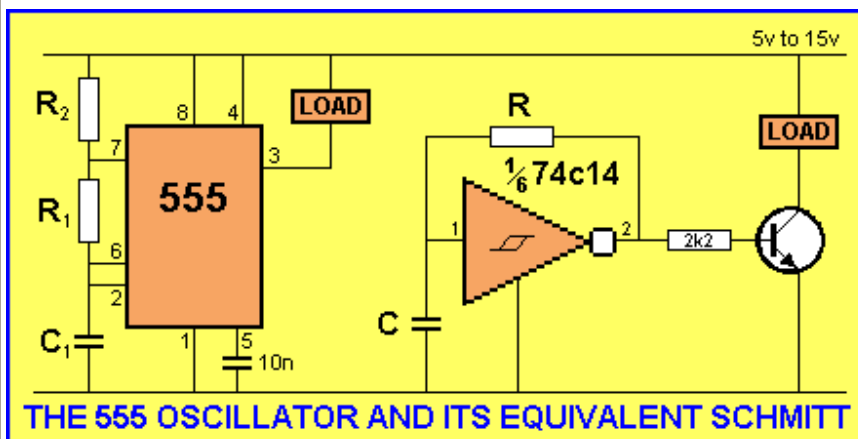
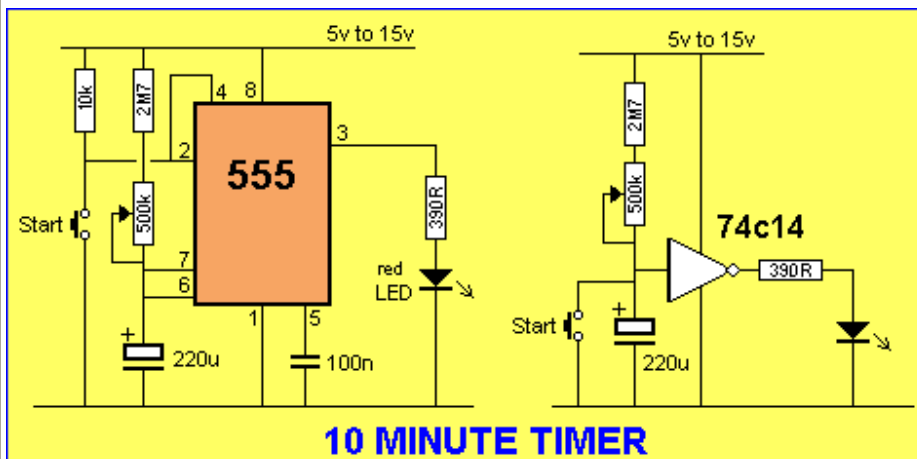
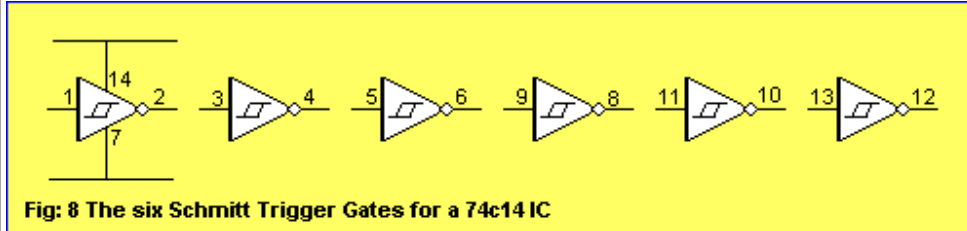
SUBSTITUTING A 555 - part 1

Although a 555 is a wonderful chip, it may not be the best choice for some applications.

You may require an oscillator frequency higher than 1MHz, or a very low quiescent

current. You may also need 4 or more 555's to get the timing and delays you require. Here are some circuits to help you substitute a 555.

The 74c14 IC contains 6 Schmitt Trigger gates and each gate can be used to replace a 555 in SOME circuits. The voltage for a 74c14 is 3v to 15v. Maximum output current per gate is 15mA. Max frequency of operation: 2MHz - 5MHz. Quiescent current is 1uA if all inputs are 0v or rail voltage.



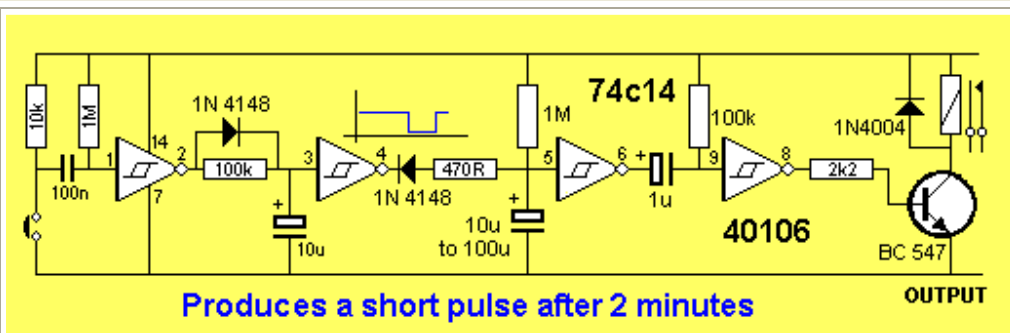
SUBSTITUTING A 555 - part 2

If you need a special function or special effect, it may take 2, 3 or more 555's to do the job. The 74c14 has 6 gates and can create 6 "building blocks."

Here are some circuits to show its versatility:

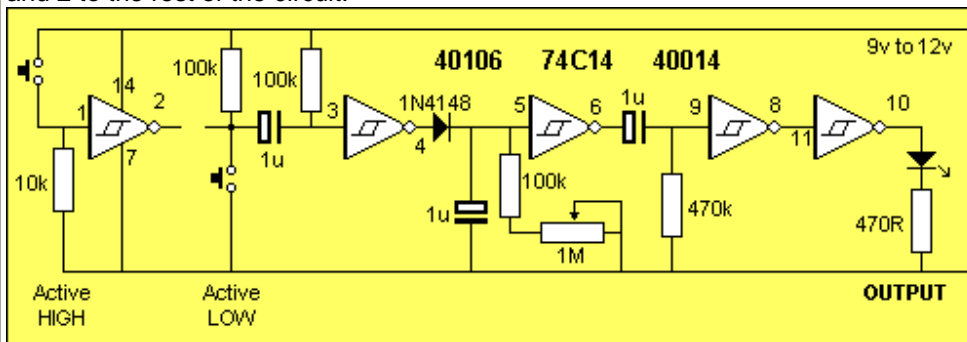
2 MINUTE TIMER

The relay is energized for a short time, 2 minutes after the push-button is pressed. The push-button produces a brief LOW on pin 1, no matter how long it is pushed and this produces a pulse of constant length via the three components between pin 2 and 3. This pulse is long enough to fully discharge the 100u timing electrolytic on pin 5. The 100k and electrolytic between pins 6 and 9 are designed to produce a brief pulse to energize the relay.



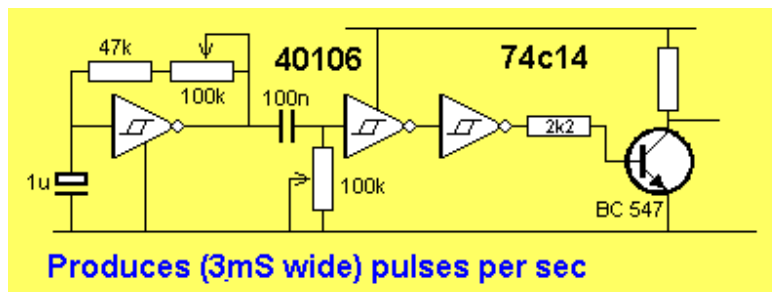
OUTPUT AFTER 2 MINUTES

Here is another very similar circuit. Use either the active HIGH or Active LOW switch and if the Active LOW switch is used, do not connect the parts or gate between pins 1 and 2 to the rest of the circuit.



PULSER

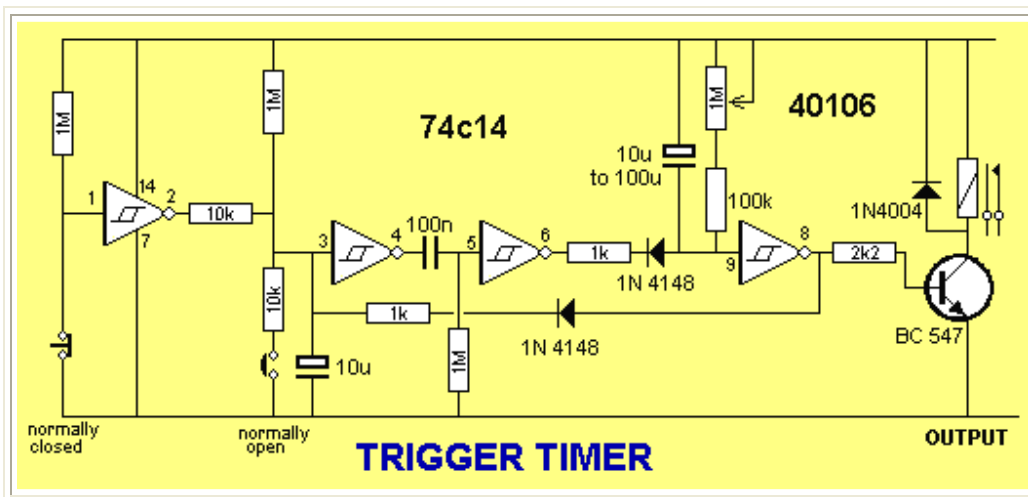
The 74c14 can be used for lots of different circuits. In the following design, the output produces 3mS pulses every second. The circuit is adjustable to a wide range of requirements.



TRIGGER TIMER

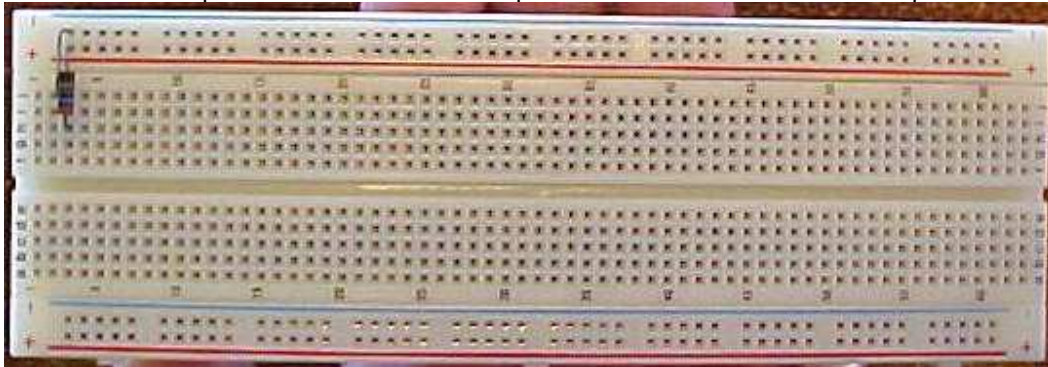
The next design interfaces a "Normally Open" and "Normally Closed" switch to a delay circuit.

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



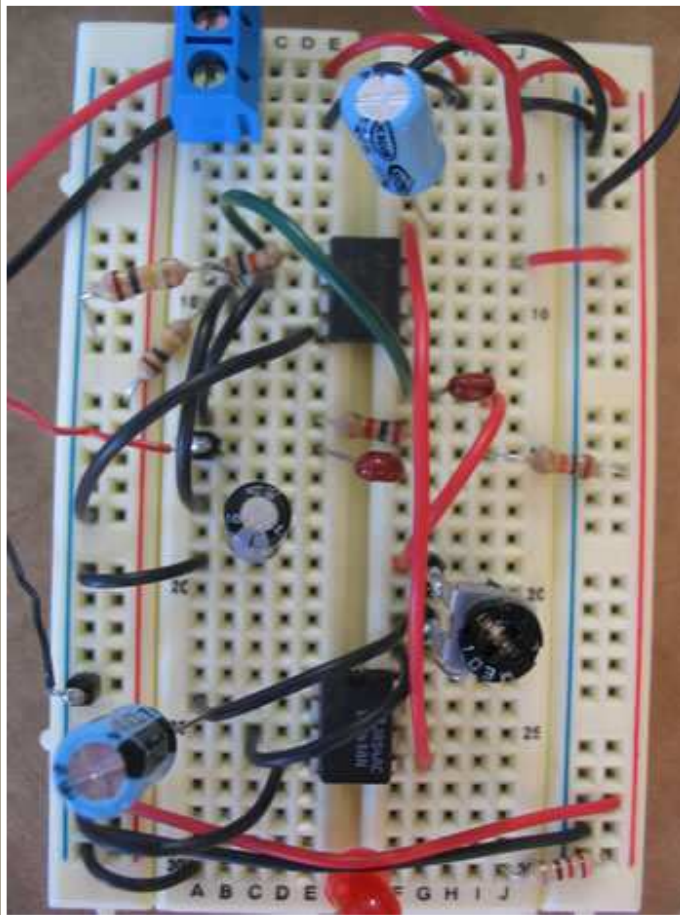
BUILDING THE CIRCUITS

The fastest way to put a circuit together is on BREADBOARD. The cheapest and best bread-board has power-rails and sets of "tie-points" or "holes" as shown in this photo:



Connect the components with hook-up wire (called jumpers) by stripping the ends to expose the wire at both ends. Or you can use 0.5mm tinned copper wire (make sure the jumpers do not touch each other).

Do not cut the leads of the components as you may want long leads on another project.



Neatness is not important. The important thing is to build as many circuits as possible as each one will help you understand how the 555 works and how the external circuitry modifies the signal to produce the resulting effect. There is a point-to-learn in every circuit.

POWERING A PROJECT

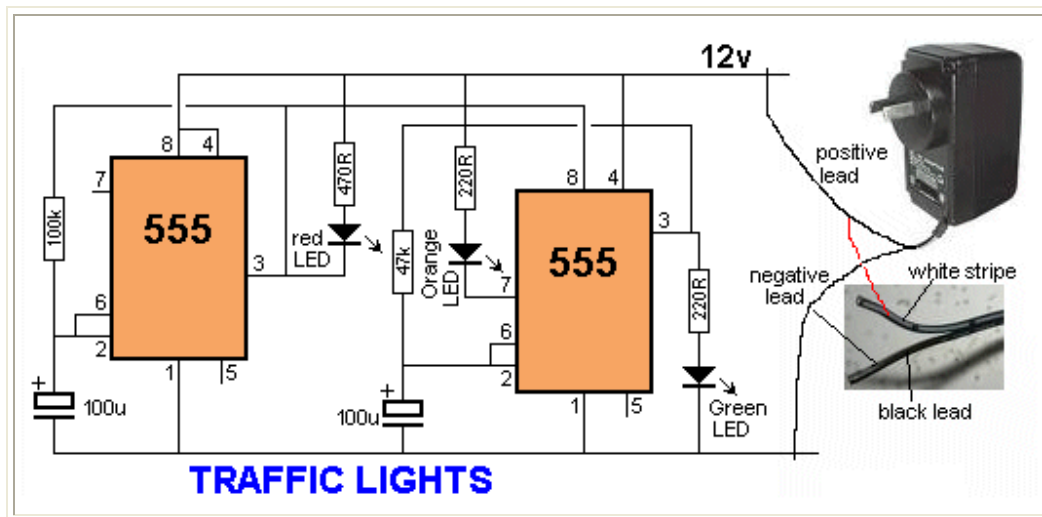
The safest way to power a project is with a battery. Use 4 x AA cells in a holder or a 9v battery if you only want to use the project for a short period of time.

If you want to use a 555 project for a long period of time you will need a "power supply." The safest power supply is a Plug Pack (wall-wort, wall wart, wall cube, power brick, plug-in adapter, adapter block, domestic mains adapter, power adapter, or AC adapter). The adapter shown in the diagram has a switchable output voltage: 3v, 6v, 7.5v, 9v, 12v) DC and is rated at 500mA. The black lead is negative and the other lead with a white stripe (or a grey lead with a black stripe) is the positive lead.

This is the safest way to power a project as the insulation (isolation) from the mains is provided inside the adapter and there is no possibility of getting a shock.

The rating "500mA" is the maximum the Plug Pack will deliver and if your circuit takes just 50mA, this is the current that will be supplied. Some pluck packs are rated at 300mA or 1A and some have a fixed output voltage. All these plug packs will be suitable.

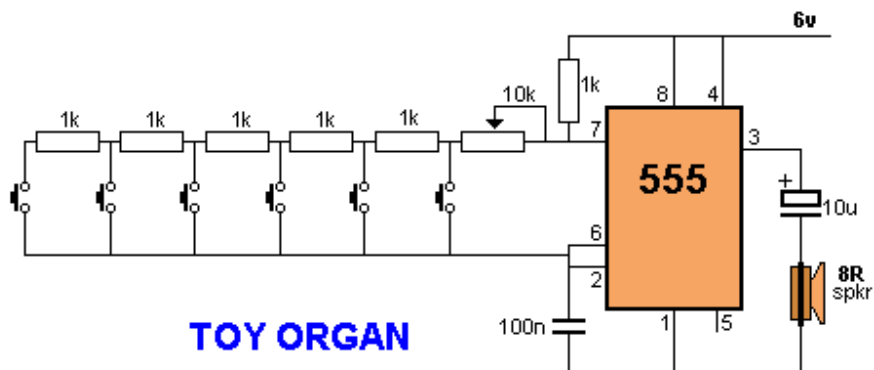
Some Plug Packs are marked "12vAC." This type of plug pack is not suitable for these circuits as it does not have a set of diodes and electrolytic to convert the AC to DC. All the circuits in this eBook require DC.



PROJECTS

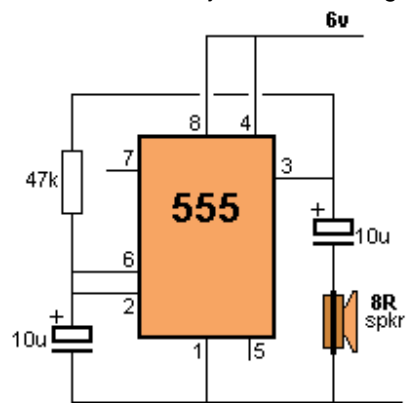
TOY ORGAN

This circuit produces a tone according to the button being pressed. Only 1 button can be pressed at a time, that's why it is called a monophonic organ. You can change the 1k resistors to produce a more-accurate scale.



TICKING BOMB

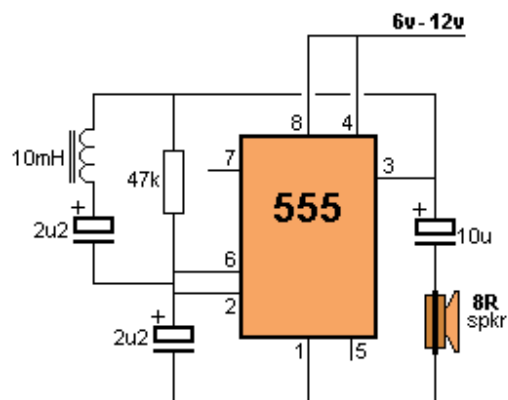
This circuit sound just like a ticking bomb.



TICKING BOMB

METAL DETECTOR

This circuit detects metal and also magnets. When a magnet is brought close to the 10mH choke, the output frequency changes.

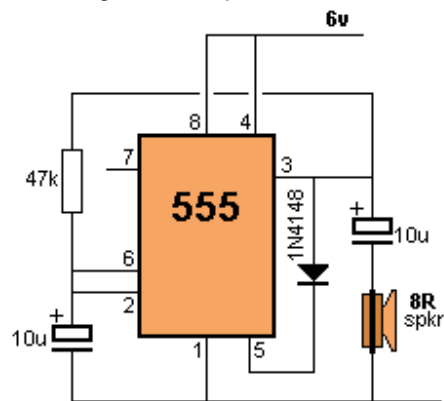


METAL DETECTOR

UNEVEN CLICKS

This circuit produces two clicks then a short

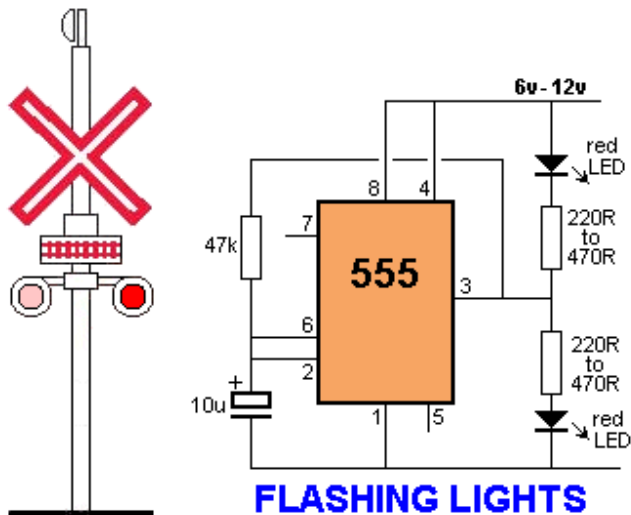
space before two more clicks etc. Changing the voltage on pin, 5 via the diode, adjusts the timing of the chip.



UNEVEN CLICKS

FLASHING RAILROAD LIGHTS

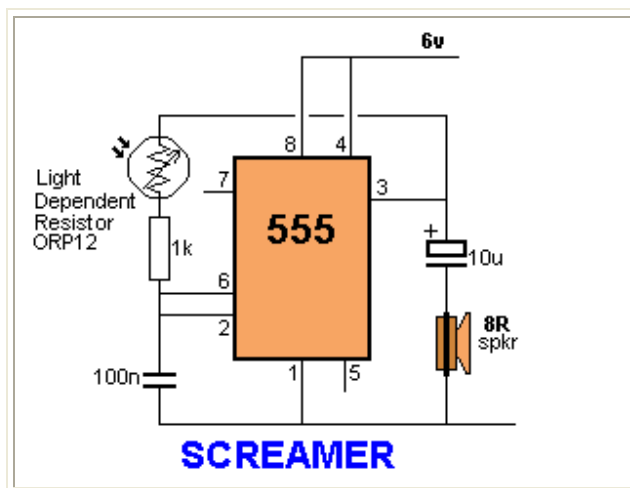
This circuit flashes two red LEDs for a model railway crossing.



FLASHING LIGHTS

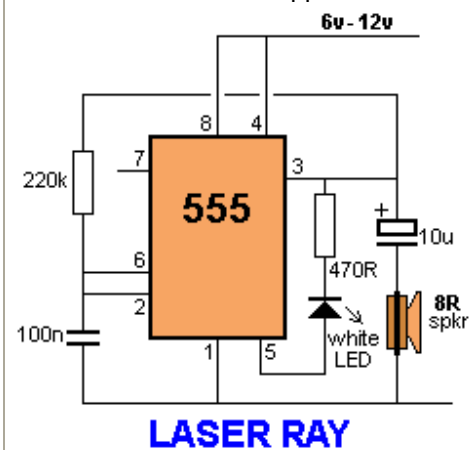
SCREAMER

This circuit will produce an ear-piercing scream, depending on the amount of light being detected by the Light Dependent Resistor.



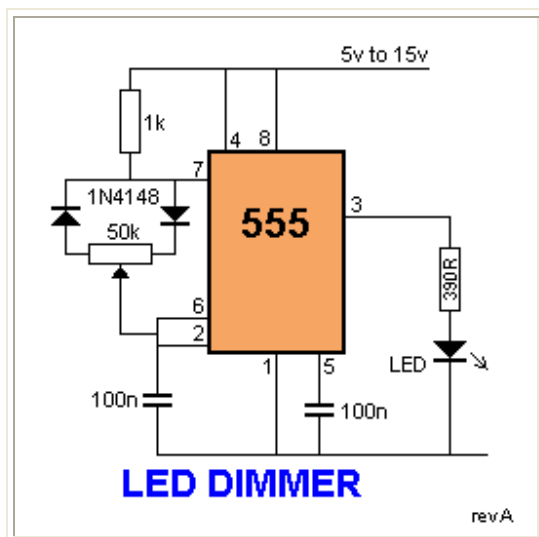
LASER RAY

This circuit produces a weird "Laser Ray" sound and flashes a white LED at approx 5Hz:



LED DIMMER

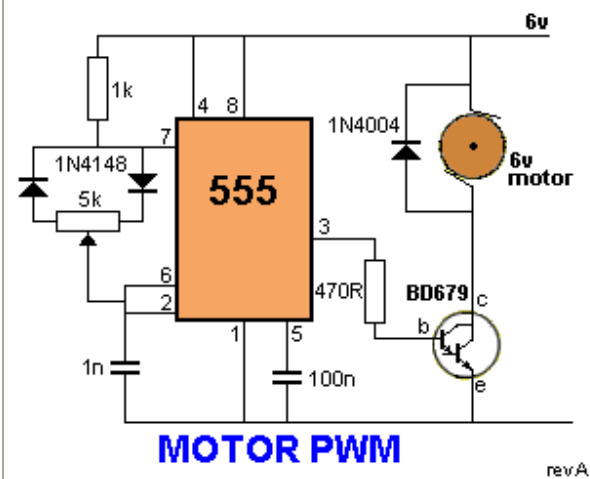
This circuit will adjust the brightness of one or more LEDs from 5% to 95%.



MOTOR PWM

See also: [PWM Controller](#)

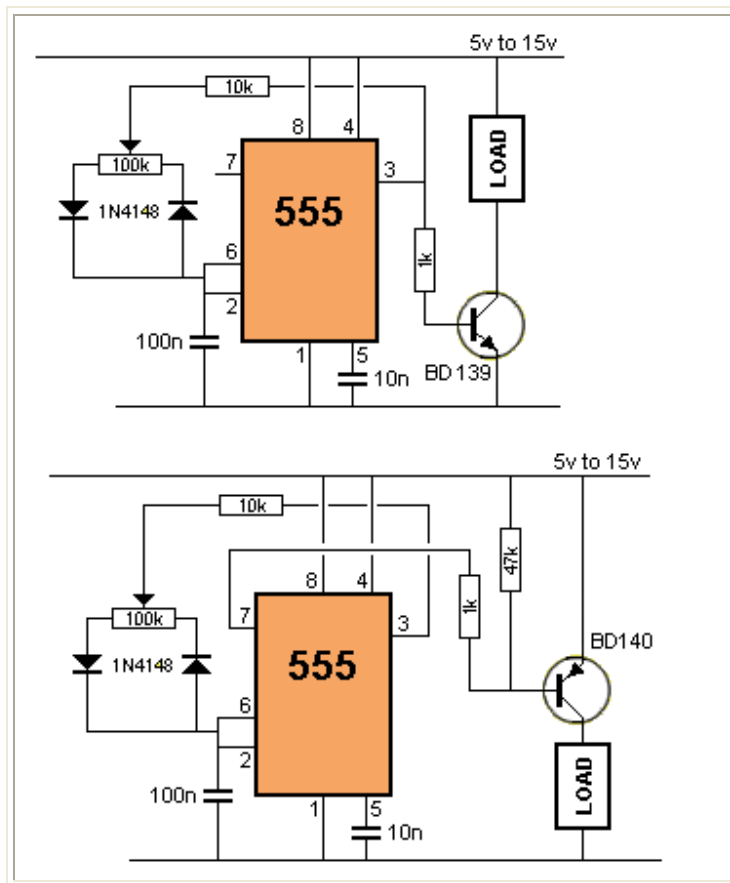
The speed of a motor can be adjusted by this circuit, from 5% to 95%.



PWM

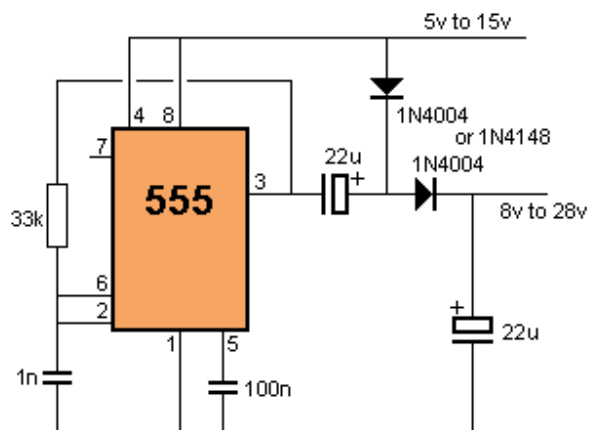
See also: [PWM Controller](#)

The output of these circuits can be adjusted from 5% to 95%.



VOLTAGE DOUBLER

A voltage higher than the supply can be created by a "Charge-Pump" circuit created with a 555, diodes and capacitors as shown in the following circuit. The output will deliver about 50mA

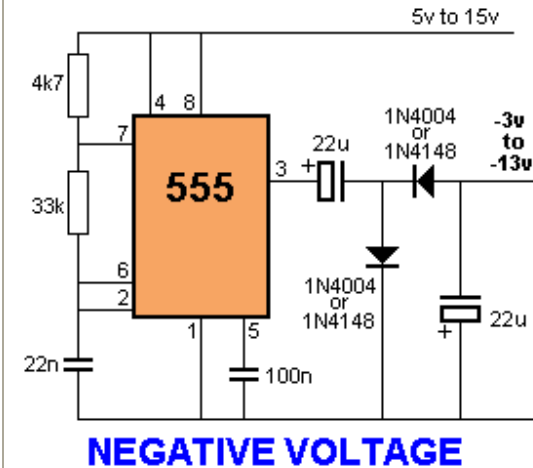


VOLTAGE DOUBLER

NEGATIVE VOLTAGE

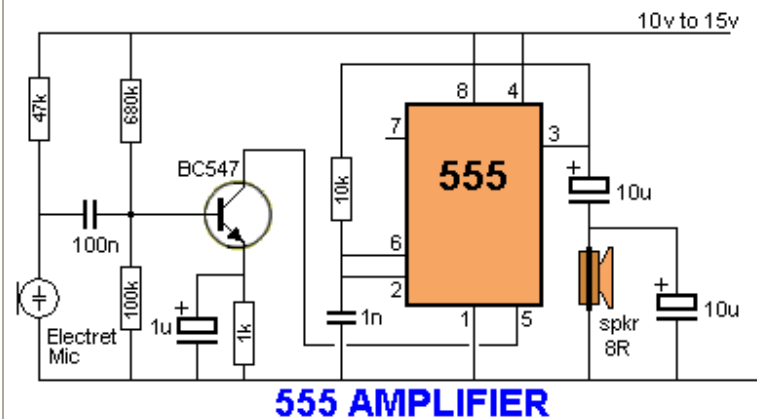
A negative supply can be produced by a "Charge-Pump" circuit created with a 555, diodes and

capacitors as shown in the following circuit. The output will deliver about 50mA.



555 AMPLIFIER

The 555 can be used as an amplifier. It operates very similar to pulse-width modulation. The component values cause the 555 to oscillate at approx 66kHz and the speaker does not respond to this high frequency. Instead it responds to the average CD value of the modulated output and demonstrates the concept of pulse-width modulation. The chip gets very hot and is only for brief demonstrations.

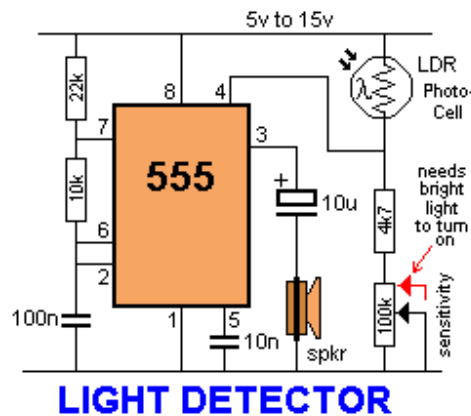


LIGHT DETECTOR

This circuit detects light falling on the Photo-cell (Light Dependent Resistor) to turn on the 555 and create a tone that is delivered to the speaker. Pin 4 must be held below 0.7V to turn the 555 off. Any voltage above 0.7V will activate the circuit. The adjustable sensitivity

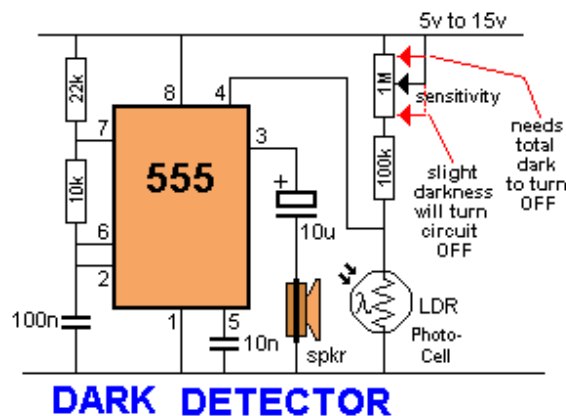
control is needed to set the level at which the circuit is activated. When the sensitivity pot is turned so that it has the lowest resistance (as shown in red), a large amount of light must be detected by the LDR for its resistance to be low. This produces a voltage-divider made up of the LDR and 4k7 resistor. As the resistance of the LDR decreases, the voltage across the 4k7 increases and the circuit is activated.

When the sensitivity control is taken to the 0v rail, its resistance increases and this effectively adds resistance to the 4k7. The lower-part of the voltage-divider now has a larger resistance and this is in series with the LDR. Less light is needed on the LDR for it to raise the voltage on pin 4 to turn the 555 on.



DARK DETECTOR

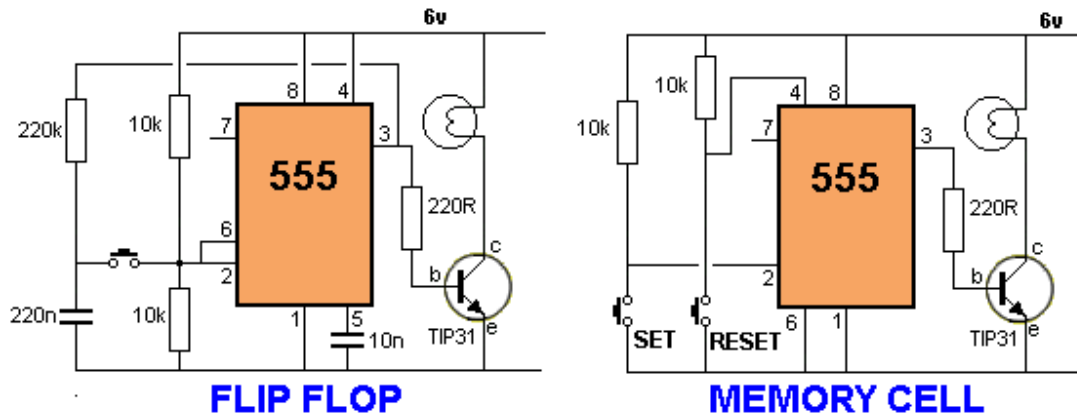
When the level of light on the photo-cell decreases, the 555 is activated. Photo-cells (Photo-resistors) have a wide range of specifications. Some cells go down to 100R in full sunlight while others only go down to 1k. Some have a HIGH resistance of between 1M and others are 10M in total darkness. For this circuit, the LOW resistance (the resistance in sunlight) is the critical value. More accurately, the value for a particular level of illumination, is the critical factor. The sensitivity pot adjusts the level at which the circuit turns on and allows almost any type of photo-cell to be used.



FLIP FLOP and MEMORY CELL

When output pin 3 is HIGH, the 220nF charges through the 220k to 6v. When pin 3 is LOW, the 220nF

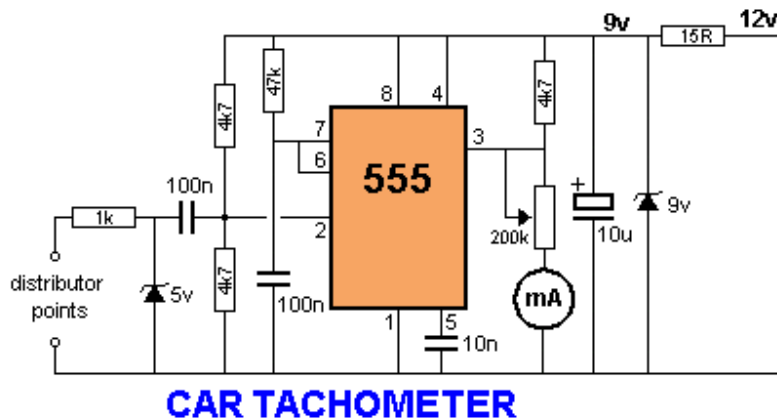
discharges through the 220k to 0v. Pressing the switch upsets the 3v created by the two 10k voltage dividers, triggering the flip flop inside the 555 and changing the state of the output from HIGH to LOW or vice-versa. The output of the 555 drives a transistor to turn a globe on and off. The second circuit is a Memory cell and is the basis of the memory in a computer. The SET button turns on the globe and the RESET button turns the globe off. It works like this: When the circuit is turned on, pin 6 does not see a high and pin 2 does not see a low, so the 555 starts in reset mode.



CAR TACHOMETER

A 555 is configured as a monostable or one shot in this project. The period of the 555 is determined by the 47k and the capacitor from pin 6 to ground (100n). Time "T" = $1.1 RC$ or $1.1 \times 50,000 \times 0.1 \times 10^{-6} = 0.0055$ or 5.5 ms (milli-seconds).

The 555 receives trigger pulses from the distributor points. These are limited by the 1k and 5v zener diode. These are AC coupled to the trigger input through the 100n coupling capacitor. The 50mA meter receives pulses of current through the 200k pot to show a reading.



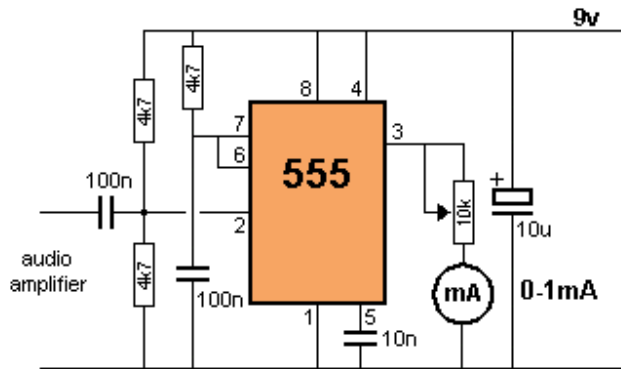
Integration of the current pulses produces a visible indication of the cars engine speed on the 0-1mA meter.

Supply is taken from the cars 12v system and for the 555 it is reduced to a regulated 9v by the 15 ohm resistor in conjunction with the 9v zener diode. Note: the 10u electrolytic must be placed physically as close as possible to supply pin 8.

FREQUENCY METER

This circuit will detect audio frequencies and display them on

a meter (actually called a "movement"). Connect the circuit to the output of an amplifier. It is best to detect one frequency at a time.



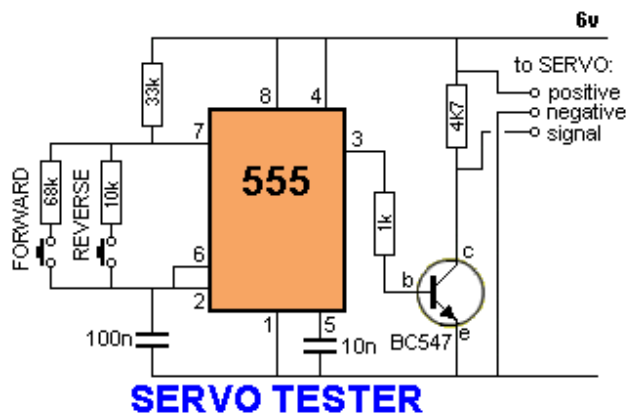
FREQUENCY METER

Integration of the audio frequency produces a visible indication on the 0-1mA meter.

SERVO TESTER

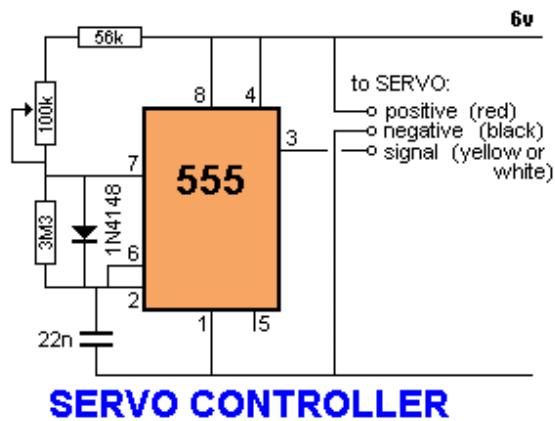
This circuit can be used to manually turn a servo clockwise and anti-clockwise. By pushing the forward or reverse button for a short period of time you can control the rotation of the servo. It will also test a servo.

Here is a photo of a kit from **Cana Kit** for \$10.00 plus postage (it is a slightly different circuit) and a motor and gearbox, commonly called a "servo." The output shaft has a disk or wheel containing holes. A linkage or push-rod is fitted to a hole and when the disk rotates, the shaft is pushed and pulled. The shaft only rotates about 180° to actuate flaps or ailerons etc.



SERVO TESTER



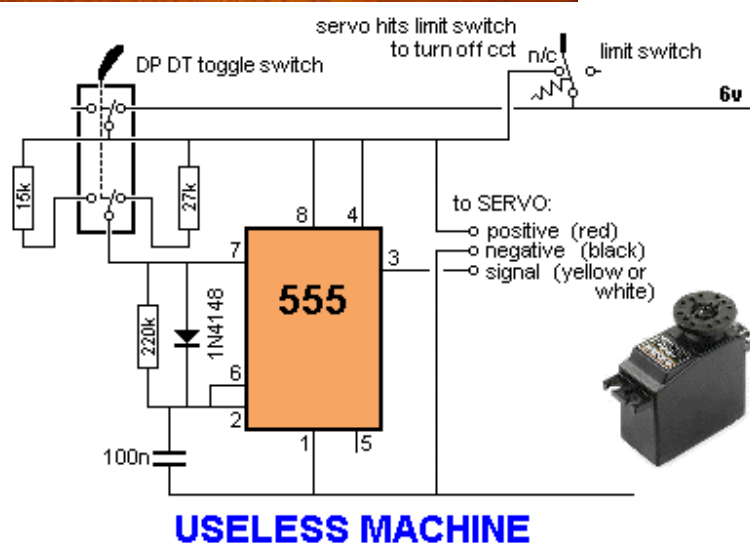


A pot can be used to control the position of the servo by using the following circuit. It produces a positive pulse between about 0.9 milliseconds and 2.1 milliseconds. The off period between pulses is about 40 milliseconds. This can be shortened by reducing the value of the 3M3 resistor.

USELESS MACHINE

Here is a fun project using a servo motor and a circuit similar to the SERVO TESTER project above. It is available on the INSTRUCTABLES website. Before you do anything, watch the video:

<http://www.instructables.com/id/The-Most-Useless-Machine>

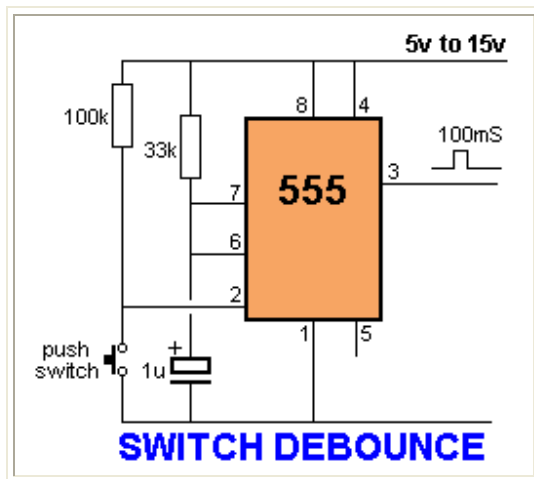


The Instructables website contains all the construction details. The circuit diagram shows the toggle switch is clicked towards the lid of the box and this starts the servo motor. The servo has an arm that comes out of the box and clicks the switch to the opposite position. This reverses the servo

As the website says: "It's the most useless invention, but everyone wants one."

The 555 operates at 2Hz. Output pin 3 drives the circuit with a positive then zero voltage. The other end of the circuit is connected to a voltage divider with the mid-point at approx 4.5v. This allows the red and green LEDs to alternately flash when no transistor is connected to the tester. If a good transistor is connected, it will produce a short across the LED pair when the voltage is in one direction and only one LED will flash. If the transistor is open, both LED's will flash and if the transistor is shorted, neither LED will flash.

The output goes HIGH for 100mS when the switch is pressed.



INCREASING OUTPUT CURRENT

The 555 will deliver 200mA to a load but the chip gets extremely hot (12v supply). The answer is to use a buffer transistor.

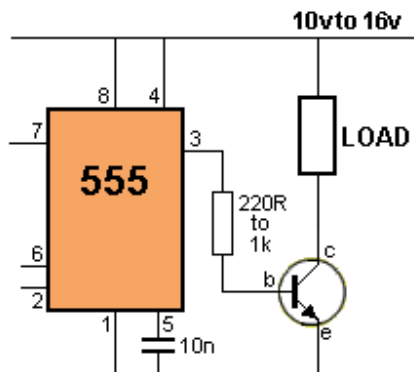
For 200mA, use a BC547 or equivalent.

For 500mA use a BC337 or equivalent

For 1A, use a TIP31 or equivalent.

For 3A - 5A use a BD679 or equivalent with heatsink

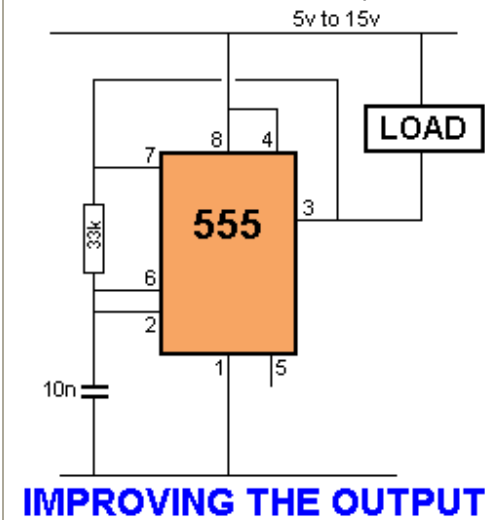
For 5A to 10A use TIP3055 with heatsink



IMPROVING THE SINKING OF A 555

The output of a 555 goes low to deliver current to a load connected as shown in the circuit below. But when the chip is sinking 200mA, pin

3 has about 1.9v on it. This means the chip does not provide full rail voltage to the load. This can be improved by connecting pin 7 to pin 3. Pin 7 has a transistor that connects it to 0v rail at the same time when pin 3 is LOW. They can both be connected together to improve sinking capability. In this case the low will be 800mV for 200mA instead of 1900mV, an improvement of 1100mV. This will add 1v1 to the load and also make the chip run cooler.



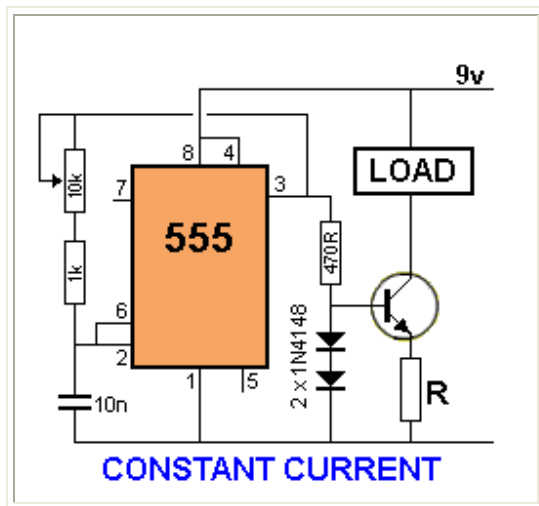
CONSTANT CURRENT

The 555 will deliver 200mA to a load but this might be too much. You can add a dropper resistor (current limiting resistor) but the current will reduce as the supply voltage drops.

To provide a constant output current to a device such as an IR LED, the following circuit can be used. The current will be constant for any supply voltage but the best range will be 7v to 12v.

The current is determined according to the value of R. You can use this table:

R	Current
5R6	100mA
10R	60mA
22R	30mA
47R	15mA
100R	6mA



INCREASING OUTPUT PUSH-PULL CURRENT

Some 555's do not swing rail-to-rail when 200mA is being delivered and the chip gets very hot when trying to deliver 200mA.

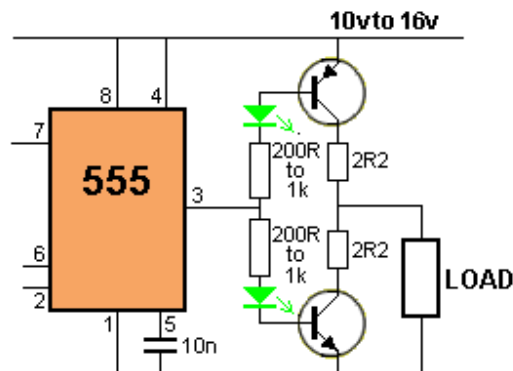
The solution is to add a push-pull output. The following arrangement has been chosen as it swings almost rail-to-rail but two faults need to be addressed.

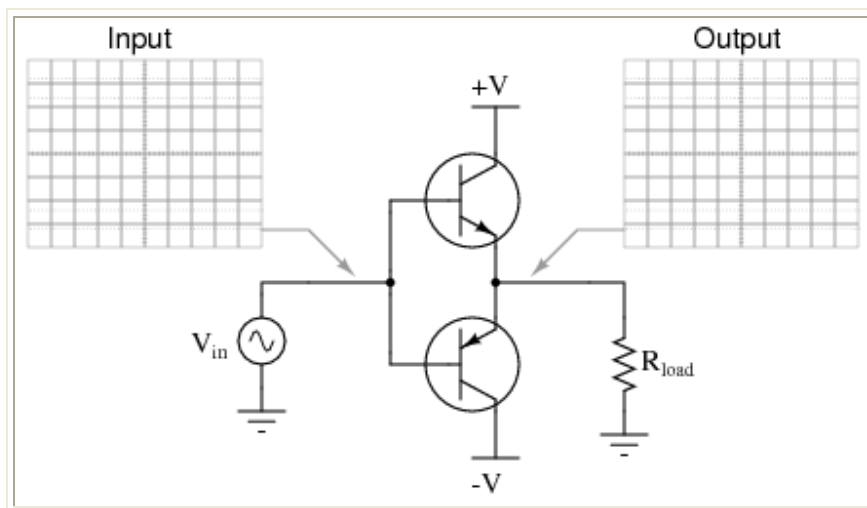
Both transistors turn on during the brief interval when pin 3 is travelling from high to low or low to high.

This means the two transistors will put a "short" across the power rail.

The addition of the 4R4 will allow a high current to flow but the transistors will not be damaged. In addition, green LEDs on the base of each transistor reduces the time when both transistors are ON.

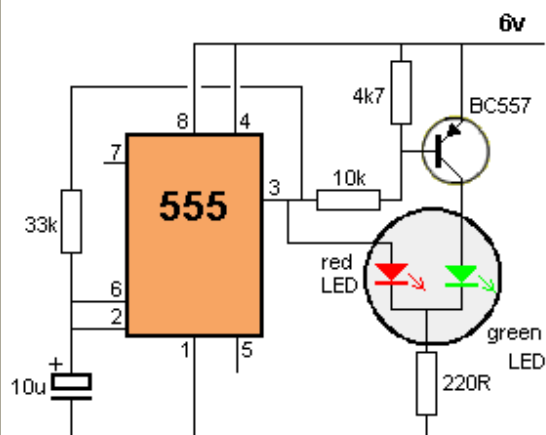
The animation shows how the transistors are turned on and off and deliver a high current to the load. The animation shows how NPN and PNP transistors follow an input signal in a push-pull arrangement using positive and negative supply rails. This is not the same as our circuit however the basic effect applies. The output is inverse of pin3 but pin3 only needs to deliver 10-50 milliamp and the transistors can deliver 1 amp or more to the load. This allows the 555 to be kept cool.





DRIVING A BI-COLOUR LED

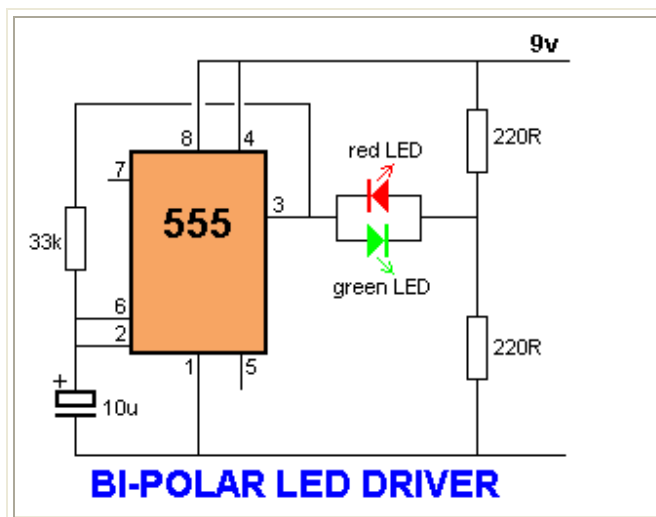
Some 3-leaded LEDs produce red and green. This circuit alternately flashes a red/green bi-coloured LED:



DRIVING A BI-COLOUR LED

BI-POLAR LED DRIVER

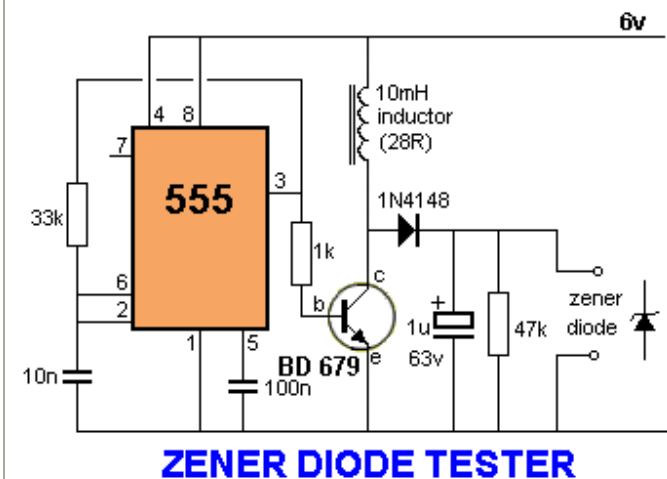
Some 2-leaded LEDs produce red and green. These are called Bi-polar LEDs. This circuit alternately flashes a red/green bi-polar LED:



ZENER DIODE TESTER

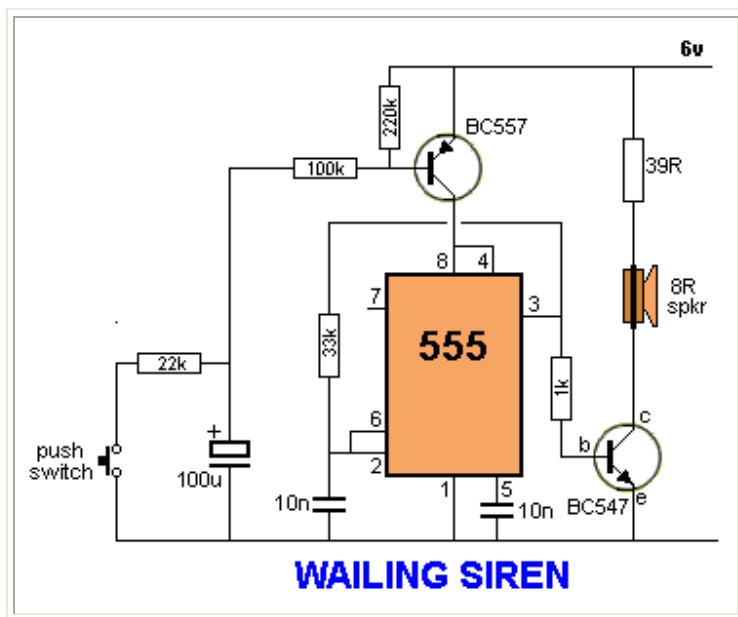
This circuit will test zener diodes up to 56v. See Talking Electronics website, left index, 200 Transistor Circuits (circuits 1-100) and go to Zener Diode (making) to see how to make a zener diode and how to create a zener voltage from a combination of zeners.

Place the zener across the terminals in the circuit below and read the value across it with a multimeter set to 50v range.



WAILING SIREN

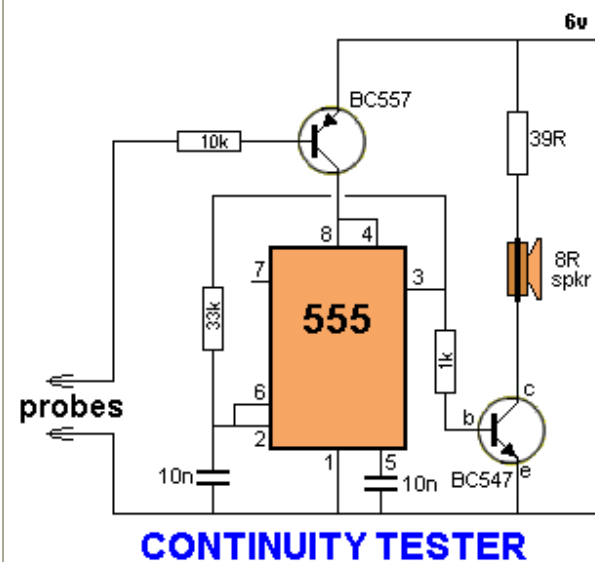
By pressing the button, the wailing sound increases. Releasing the button decreases the wailing. The circuit automatically turns off after about 30 seconds.



CONTINUITY TESTER

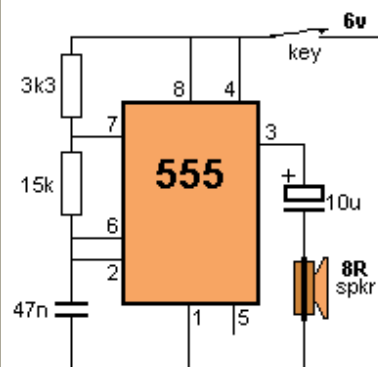
This circuit will detect low resistances and high resistances to produce a tone from the speaker.

It will detect up to 200k and the circuit automatically turns off when the probes are not used.



MORSE KEYER

This circuit will help you master the art of keying Morse Code:



MORSE KEYER

Morse Code:

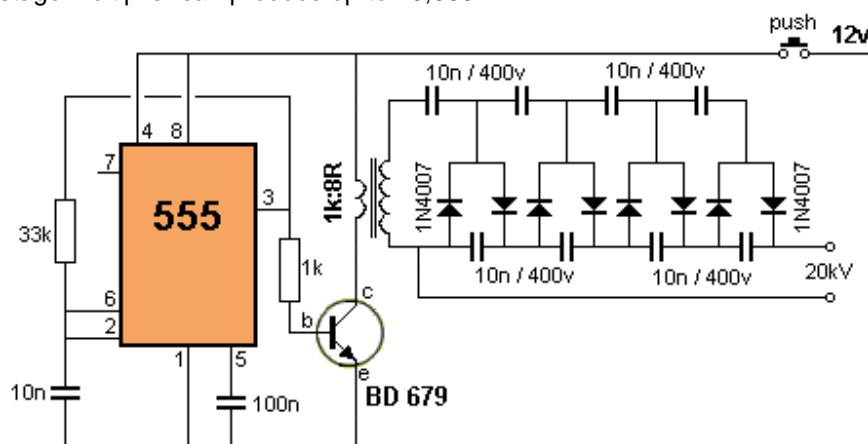
A ..	E .	I ..	M _ _	Q _ _ _ _	U _ _ _	Y _ _ _ _
B _ _ _ _	F _ _ _ _	J _ _ _ _	N _ .	R _ .	V _ _ _	Z _ _ _ _
C _ _ _ _	G _ _ _	K _ _	O _ _ _	S _ _	W _ _ _	
D _ _	H _ _ _	L _ _ _	P _ _ _	T _	X _ _ _	

International Phonetic Alphabet:

Alva	Echo	India	Mike	Quebec	Uniform	Yankee
Bravo	Foxtrot	Juliet	November	Romeo	Victor	Zulu
Charley	Golf	Kilo	Oscar	Sierra	Wiskey	
Delta	Hotel	Lima	Papa	Tango	X ray	

STUN GUN - Voltage Multiplier

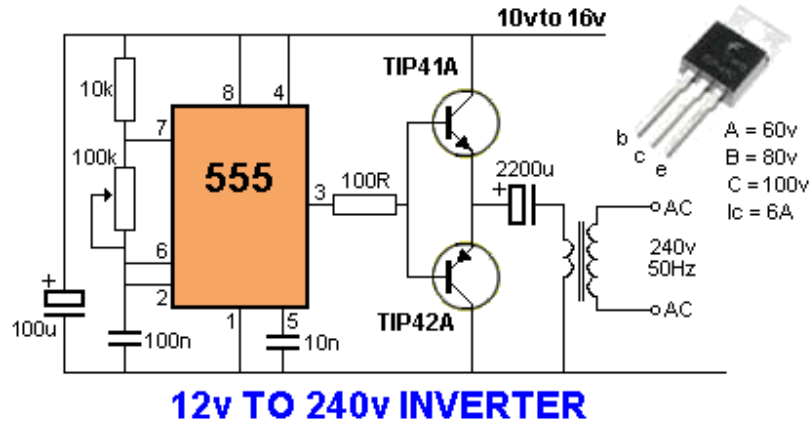
This circuit produces a very high voltage and care must be used to prevent getting a nasty shock. The transformer can produce over 1,000v and the 8-stage multiplier can produce up to 20,000v



STUN GUN

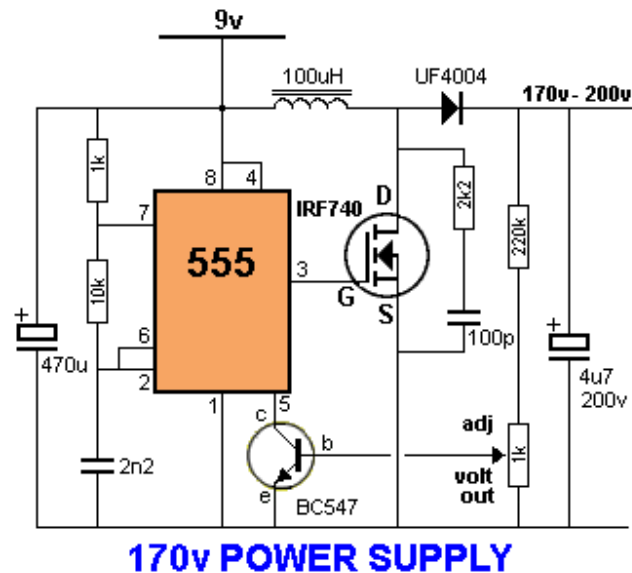
12v to 240v INVERTER

This circuit will produce 240v at 50Hz. The wattage will depend on the driver transistors and transformer.



170v SUPPLY FOR NIXIE TUBES

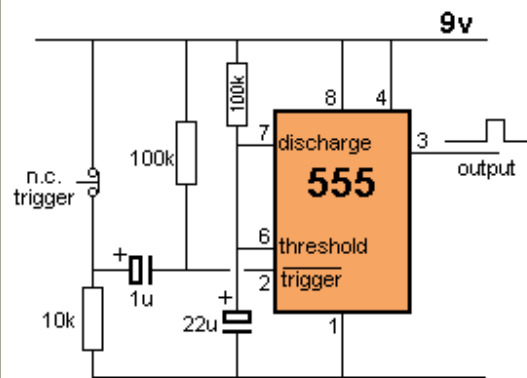
This circuit produces approx 170v for Nixie tubes and other neon tubes. It is a switch-mode boost circuit.



ACTIVE LOW TRIGGER

This circuit sits LOW and the output goes HIGH when the push-button is pressed. When the normally-closed push button is pressed, it opens and the uncharged 1u will be pulled to nearly 0v rail via the 10k and this will take pin 2 LOW to make output pin 3 HIGH for the duration determined by the 22u and 100k. If the push-switch stays open, the 1u will charge via the 100k and eventually the output of the 555 will go low.

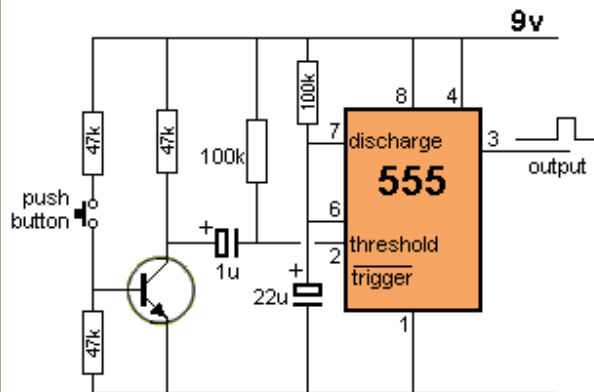
But normally the switch must be pressed for a short period of time so that the timing components (100k and 22u) make the output go HIGH for a short period of time. This circuit is called an ACTIVE LOW TRIGGER



NORMALLY CLOSED TRIGGER
(also called ACTIVE LOW TRIGGER)

ACTIVE HIGH TRIGGER

This circuit produces a HIGH output via a HIGH trigger:

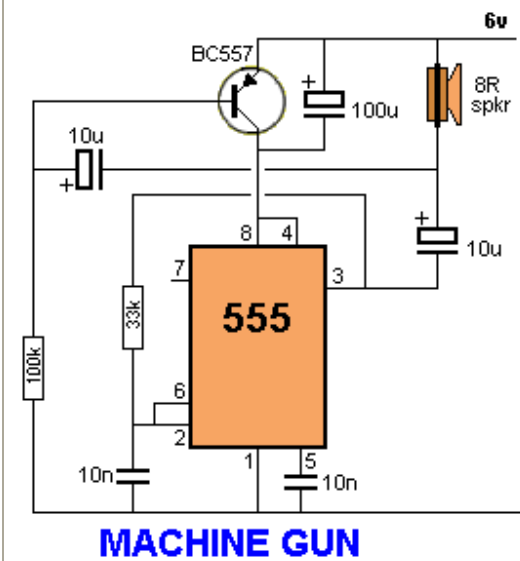


ACTIVE HIGH TRIGGER

MACHINE GUN

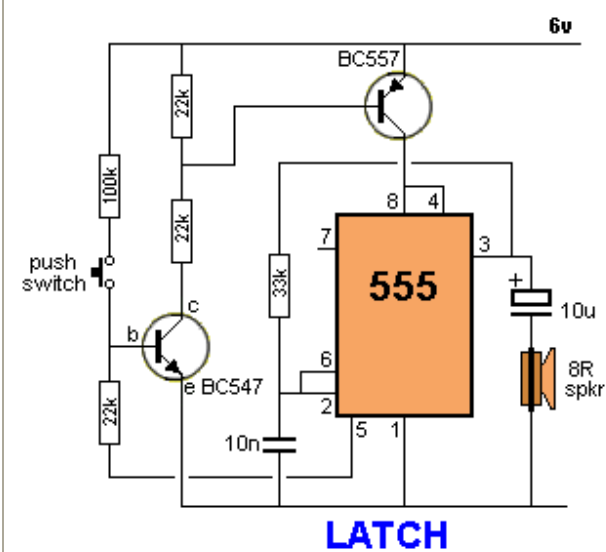
This circuit produces a sound very similar to a

machine gun:



LATCH

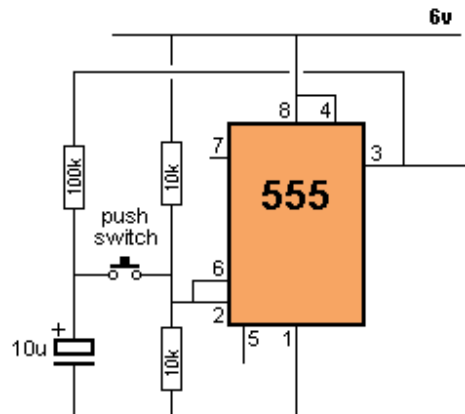
This circuit is a LATCH and remains ACTIVE when the push-button has been pressed for an INSTANT and released.



TOGGLE 555

This circuit will toggle the output each time the switch is pressed. The action cannot be repeated until the

10u charges or discharges via the 100k.



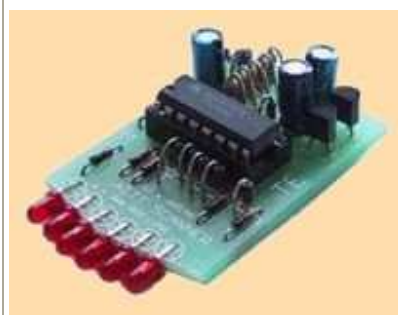
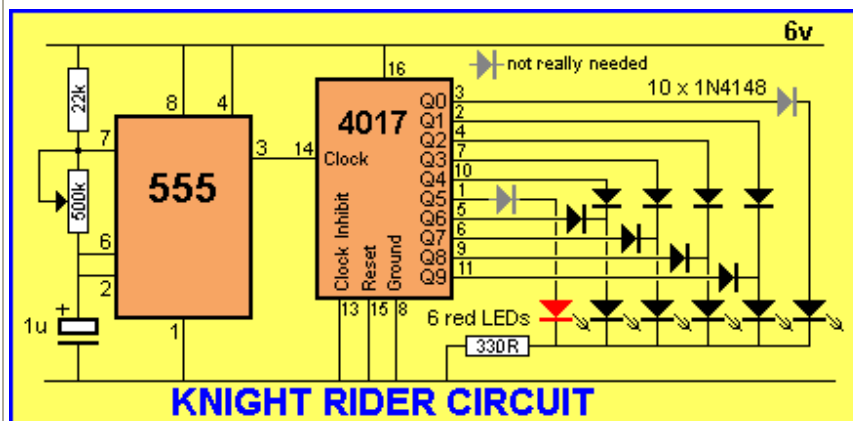
KNIGHT RIDER

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.

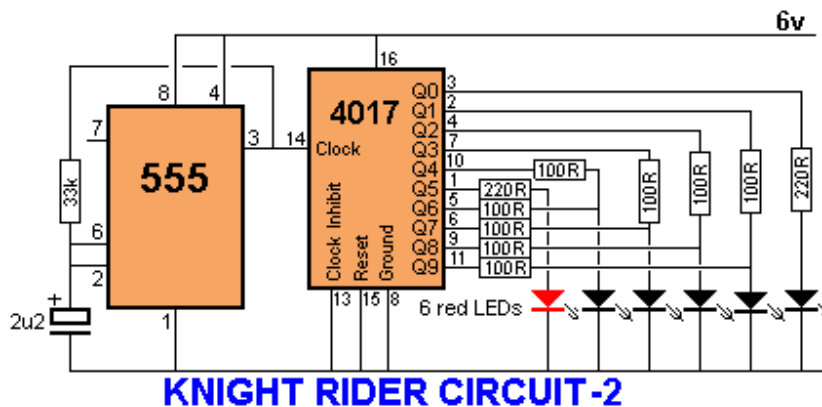
Using six 3mm LEDs, the display can be placed in the front of a model car to give a very realistic effect. The same outputs can be taken to driver transistors to produce a larger version of the display.



BUY NOW

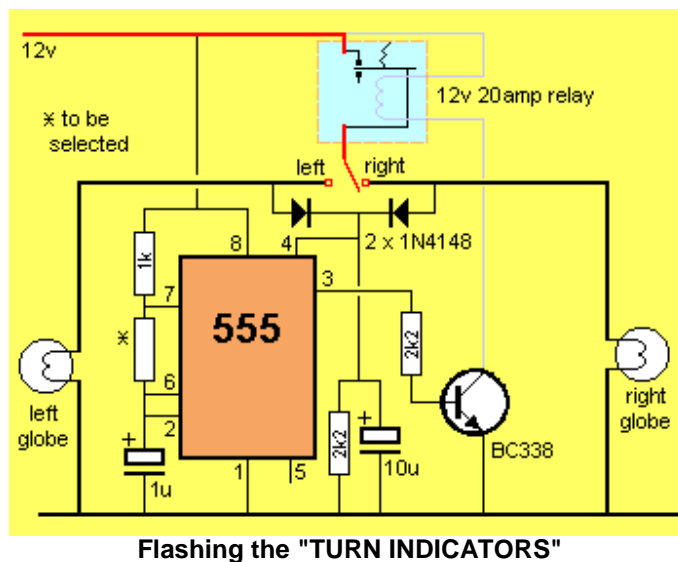
The **Knight Rider** circuit is available as a kit for less than \$15.00 plus postage as **Kitt Scanner**.

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 Q0 and Q5).



FLASHING INDICATORS

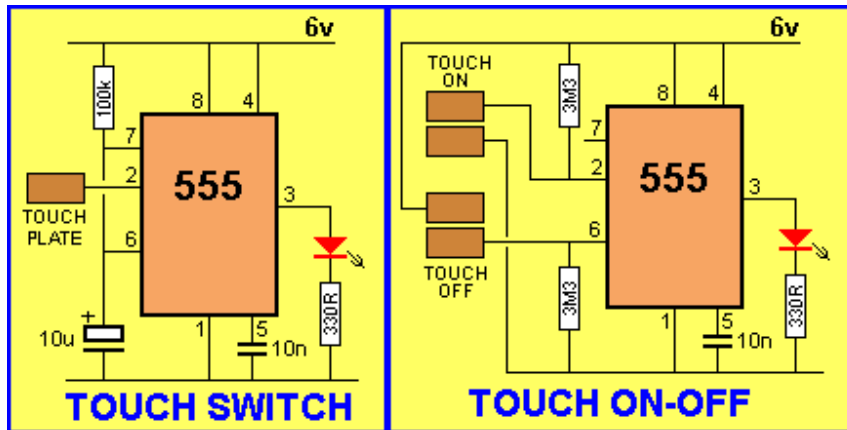
This is a request from [Daniel](#), one of our subscribers. He needed to flash "turn indicators" using a 555 and a single 20 amp relay. Here is our suggestion. The timing resistor needs to be selected for the appropriate flash-rate.



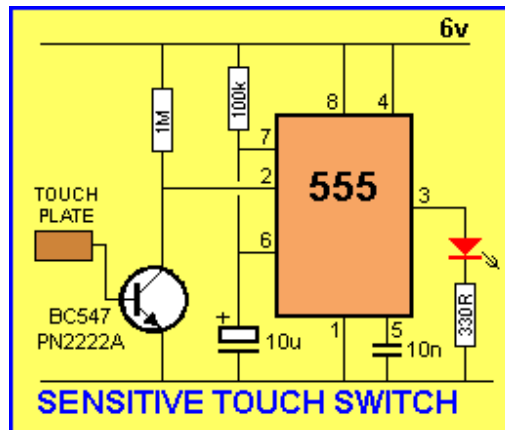
TOUCH SWITCH and TOUCH ON-OFF

The **Touch Switch** circuit will detect stray voltages produced by mains voltages and electrostatic build-up in a room. In the first circuit, pin 2 must see a LOW for the circuit to activate. If sufficient static voltage is detected by the plate, the chip will change state. If not, you will need to touch the plate and the 0v rail. In the second circuit, two touch plates are provided and the resistance of your finger changes the voltage on pin 2 or 6

to toggle the 555.



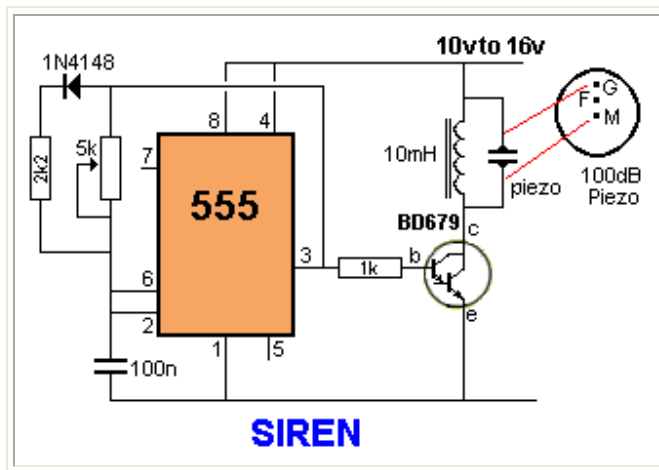
The circuit can be made 100 times more sensitive by adding a transistor to the front-end as shown in the diagram below:



SIREN 100dB

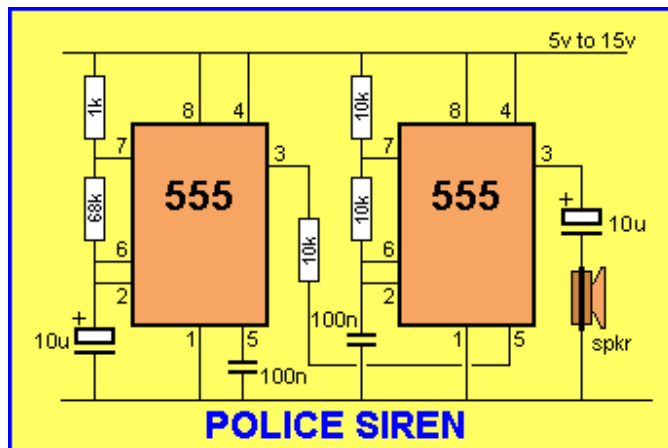
This is a very loud siren and if two or more piezo's are located in a room, the burglar does not know where the sound is coming from.

A robber will not stay anywhere with an ear-piercing sound as he cannot hear if someone is approaching. It's the best deterrent you can get. The "F" contact on the piezo is "feedback" and is not needed in this circuit.



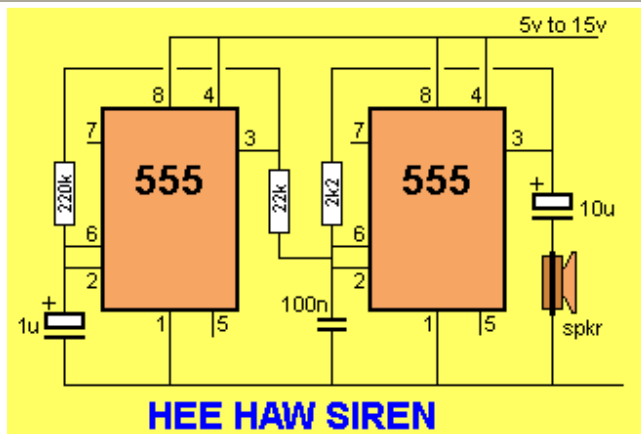
POLICE SIREN

The **Police Siren** circuit uses two 555's to produce an up-down wailing sound. The first 555 is wired as a low-frequency oscillator to control the **VOLTAGE CONTROL** pin 5 of the second 555. The voltage shift on pin 5 causes the frequency of the second oscillator to rise and fall.



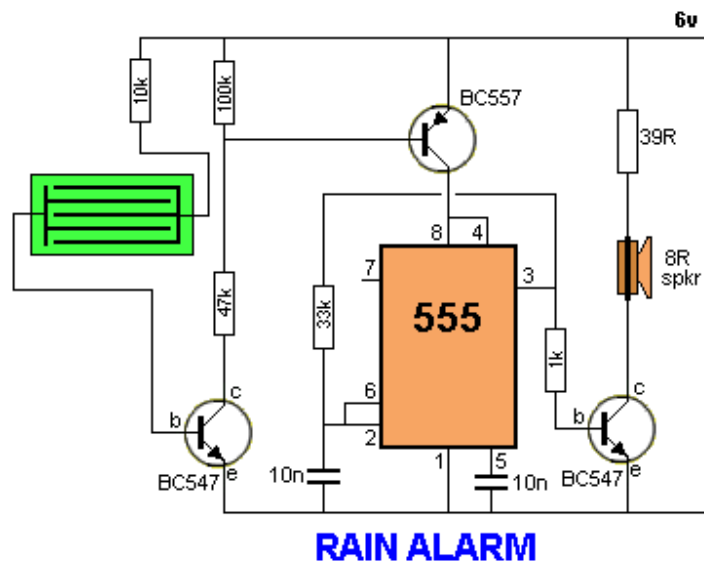
HEE HAW SIREN

Build the circuit and listen. Change the resistors and capacitors to get all sorts of different results.



RAIN ALARM

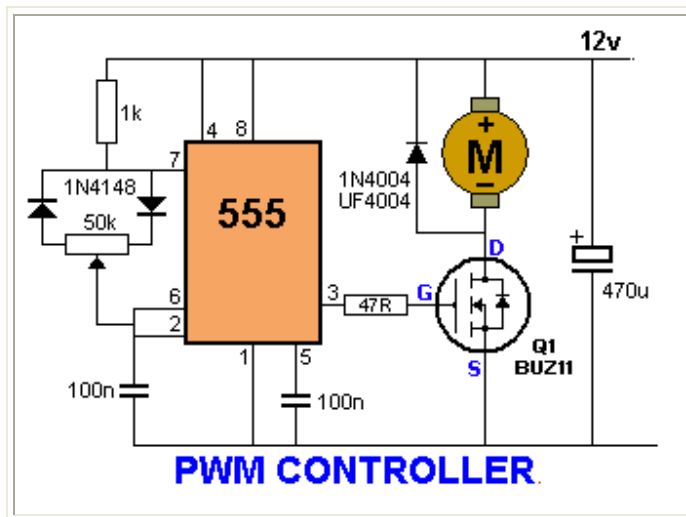
This circuit consumes no current until moisture is detected on the rain plate.



PWM CONTROLLER

See also: [PWM](#)

This controller will deliver up to 30 amps and control the motor from 5% to 95%.



SOLAR TRACKER

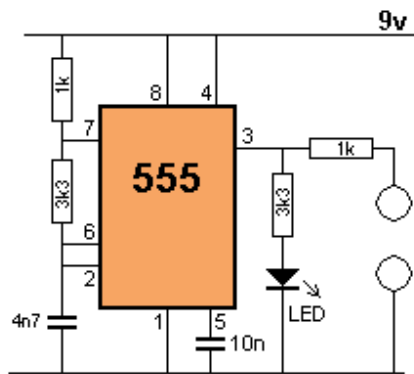
Some ideas are simply not suited for a 555. This is one. A solar tracker should consume little or no current when waiting for a the sun to change position. A 555 takes 10mA+ and suitable circuits using other chips will take less than 1mA. That's why we have not designed a 555 circuit.

HULDA CLARK ZAPPER

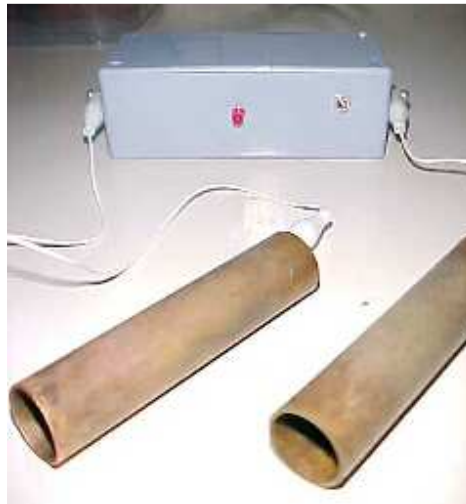
This is the circuit for Dr. Hulda Clark's Zapper, designed in 2003. The frequency is approximately 30kHz positive offset square wave. It has a red LED light that lights up when the unit is on. Perfect for regular zapping, extended zapping and other Hulda Clark related experiments.

This device is used to cure, treat and prevent any disease. It will cure anything. Simply hold the two probes (one in each hand) for 5-10 minutes then rest for 20 minutes, then repeat two more times. Do this each day and you will be cured. Here is the .pdf of her book: [A Cure For All Diseases](#). Website: <http://clarktestimonials.com/> Hundreds of people have been cured of everything from herpes to AIDS.

On the other side of the coin is the claim that Dr Hulda Clark is a complete quack. Here is a website called: [Quackwatch](#). The second diagram shows the two copper tubes and the circuit in a plastic box. I am still at a loss to see how any energy can transfer from this quack machine, through the skin (50k skin resistance and 9v supply) and zap a bug in your intestine. It's a bit like saying I will kill all the mice in a haystack by stabbing the stack with a needle.

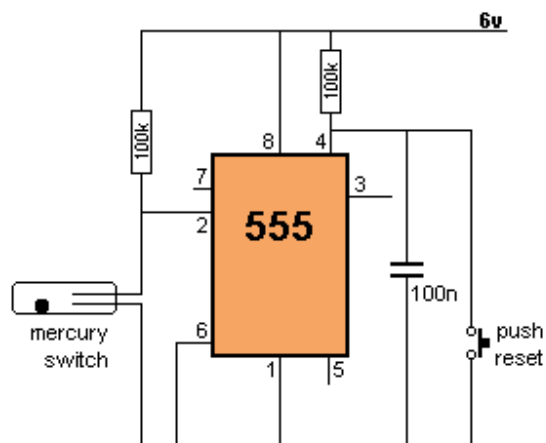


Dr CLARK'S ZAPPER



TILT SWITCH

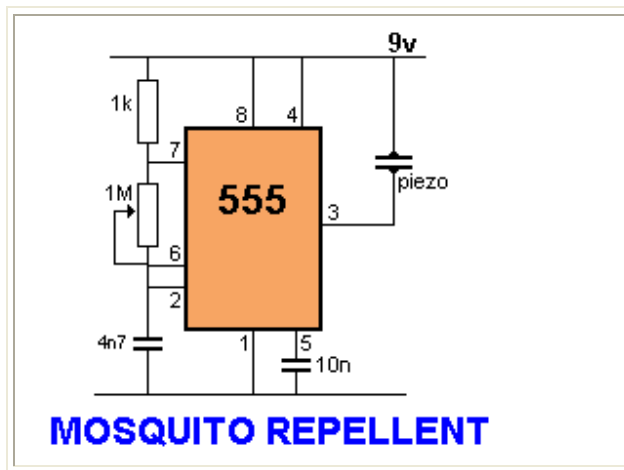
The output is LOW at start-up due to the capacitor on pin 4. When the mercury switch closes, the output goes HIGH and remains HIGH until the reset button is pressed. This circuit is called a LATCH. See [Latch circuit](#) and [Memory Cell](#) above.



TILT SWITCH

MOSQUITO REPELLER

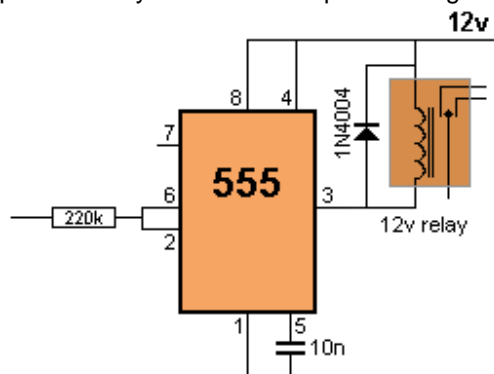
This circuit produces a tone above the human audible range and this is supposed to keep the mosquitoes away. You need a piezo diaphragm that will respond to 15kHz and these are very difficult to find.



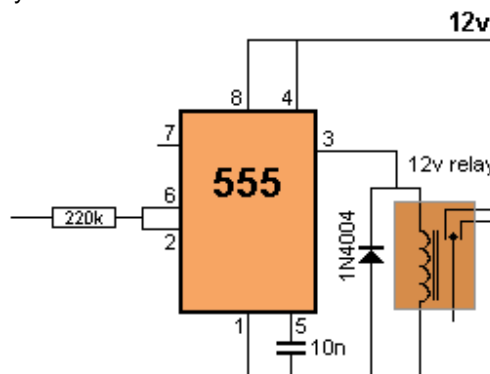
DRIVING A RELAY

The 555 will activate a relay. When pins 2 and 6 are connected as an input, the chip requires only about 1uA to activate the output. This is equivalent to a gain of about 200,000,000 (200 million) and represents about 4 stages of amplification via transistors.

In the first circuit, the output will be opposite to the input. The relay can be connected "high" or "low" as show in the second diagram. One point to note: The input must be higher than 2/3V for the output to be low and below 1/3V for the output to be high. This is called HYSTERESIS and prevents any noise on the input creating "relay chatter."



DRIVING A RELAY



DRIVING A RELAY

NEGATIVE LOGIC

An interesting point to remember.

In the first diagram above, the relay is connected so that it is active when the output is low. This is called NEGATIVE or NEGATIVE LOGIC. It has the same reasoning as $-5 - (-5) = 0$.

Or in English: "I am not NOT going."

When the input is low in the first diagram, the output is HIGH and the relay is OFF. The circuitry creates two reversals and makes it easy to see that when the input is LOW, the relay is OFF.

SCHMITT TRIGGER (Hysteresis) also called AN INVERTER also called A SCHMITT INVERTER

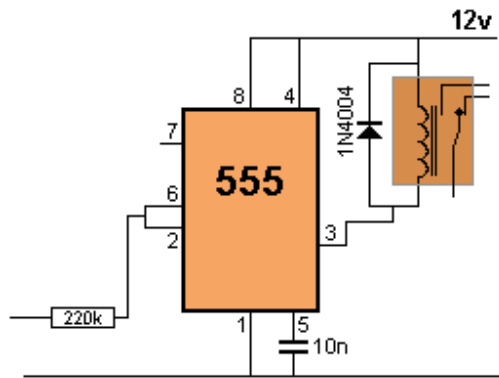
This circuit is the same as **Driving A Relay** circuit above. It is the same circuit with a different name.

We have also animated the circuit to show how the output goes high or low according to the input level. The animation shows a wide gap between the input

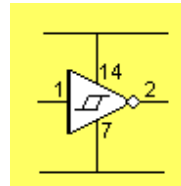
levels when the time when the output goes HIGH or LOW and this gap is called the HYSTERESIS GAP.

This circuit is called a SCHMITT TRIGGER and it is used in many building-blocks (using a different chip - such as 74c14) to prevent false triggering.

It prevents false triggering because as the input rises, the output does not change until the input voltage is fairly high. If the input voltage falls, the output does not change until the input falls about 30%. This means small fluctuations (noise) on the input do not have any effect on the output. The output is the INVERSE of the input - in other words the 555 is a SCHMITT INVERTER. The second diagram shows a Schmitt Trigger building block.



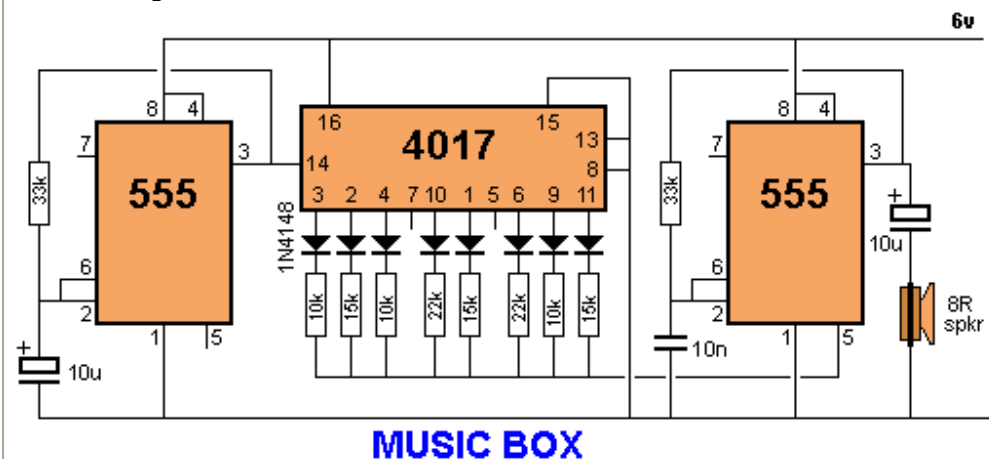
DRIVING A RELAY



SCHMITT TRIGGER BUILDING BLOCK

MUSIC BOX

This circuit produces 10 different tones and by selecting suitable values to change the voltage on pin 5, the result can be quite pleasing. Note: the two unused outputs of the 4017 produce a tone equal to that produced by the 555 when pin 5 has no external control voltage.



MUSIC BOX

REACTION TIMER GAME

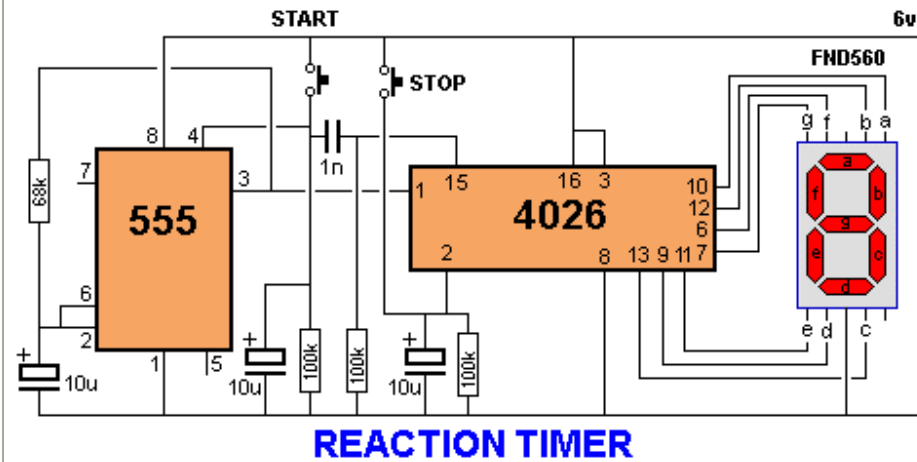
This is a game for two players.

Player 1 presses the **START** button. This resets the 4026 counter chip and starts the 555 oscillator.

The 555 produces 10 pulses per second and these are counted by the 4026 chip and displayed on the 7-Segment display.

The second player is required to press the **STOP** button. This freezes the display by activating the **Clock Inhibit** line of the 4026 (pin 2).

Two time-delay circuits are included. The first activates the 555 by charging a 10u electrolytic and at the same time delivering a (high) pulse to the 4026 chip to reset it. The second timer freezes the count on the display (by raising the voltage on pin 2) so it can be read.



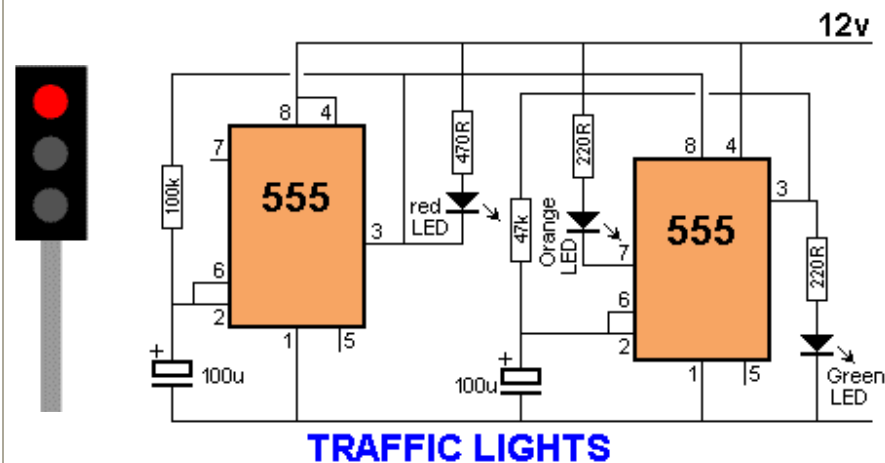
TRAFFIC LIGHTS

Here's a clever circuit using two 555's to produce a set of traffic lights for a model layout.

The animation shows the lighting sequence and this follows the Australian-standard.

The red LED has an equal on-off period and when it is off, the first 555 delivers power to the second 555. This illuminates the Green LED and then the second 555 changes state to turn off the Green LED and turn on the Orange LED for a short period of time before the first 555 changes state to turn off the second 555 and turn on the red LED.

A supply voltage of 9v to 12v is needed because the second 555 receives a supply of about 2v less than rail. This circuit also shows how to connect LEDs high and low to a 555 and also turn off the 555 by controlling the supply to pin 8. Connecting the LEDs high and low to pin 3 will not work and since pin 7 is in phase with pin 3, it can be used to advantage in this design.



Here is a further description of how the circuit works:

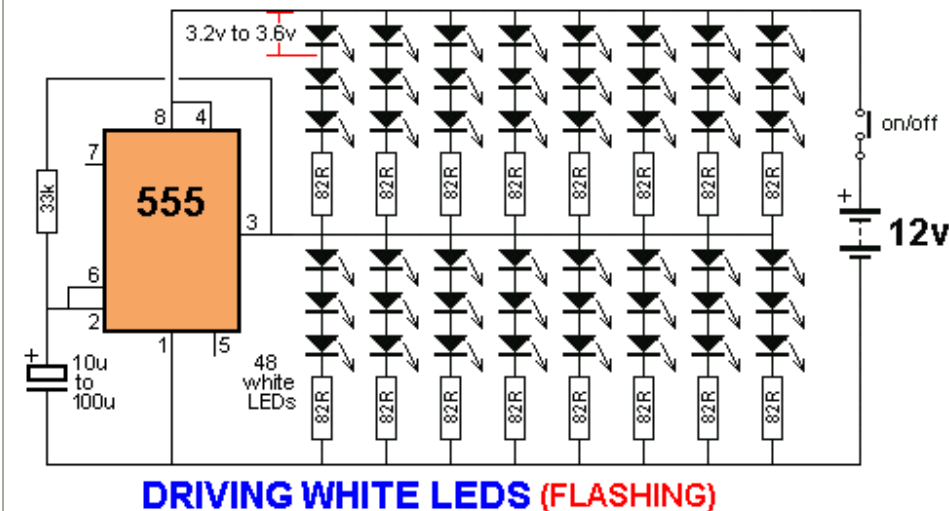
Both 555's are wired as oscillators in astable mode and will oscillate ALL THE TIME when they are turned ON. But the second 555 is not turned on all the time!

The first 555 turns on and the 100u is not charged. This makes output pin 3 HIGH and

The secret of the timing is the long cycle-time of the first 555 due to the 100k and the short cycle due to the 47k on the second 555.

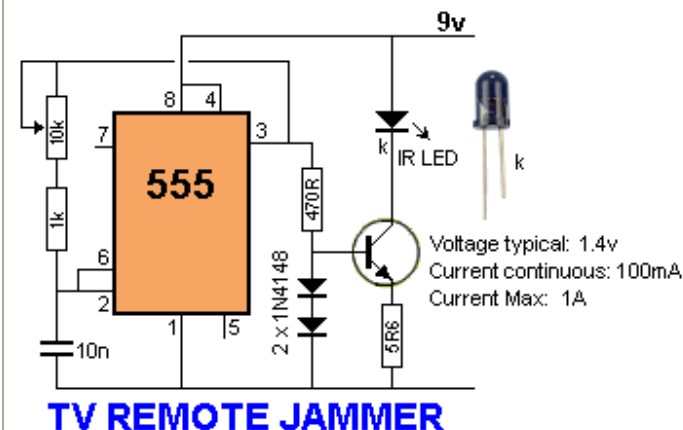
The following circuit shows the maximum number of white LEDs that can be

realistically driven from a 555 and we have limited the total current to about 130mA as each LED is designed to pass about 17mA to 22mA maximum. A white LED drops a characteristic 3.2v to 3.6v and this means only 3 LEDs can be placed in series.



TV REMOTE CONTROL JAMMER

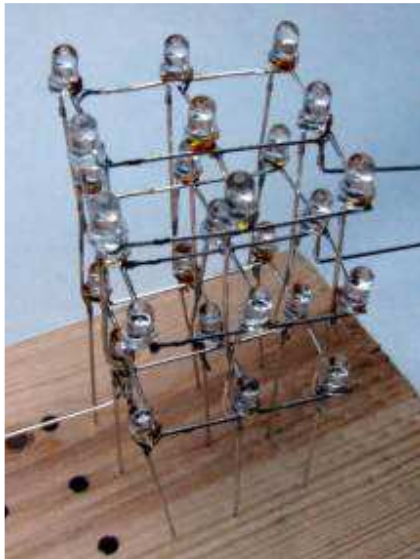
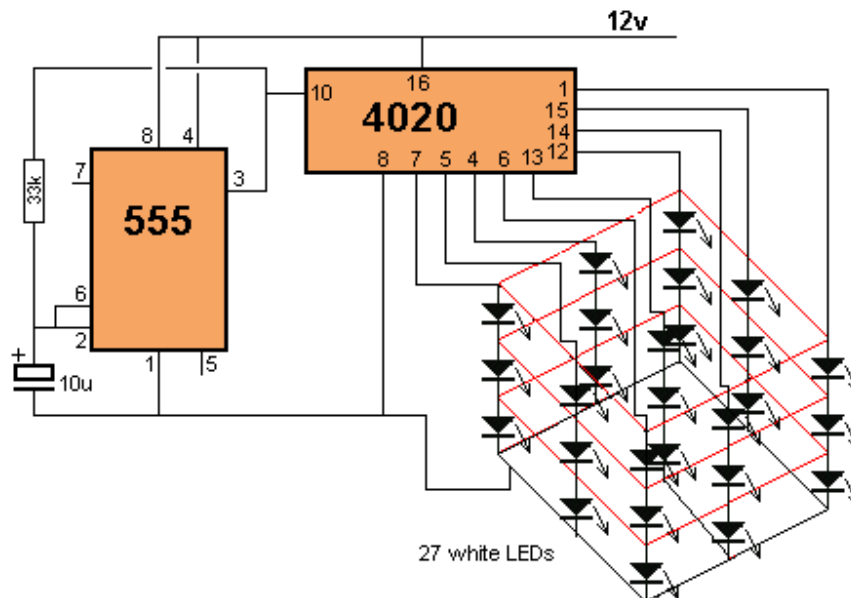
This circuit confuses the infra-red receiver in a TV. It produces a constant signal that interferes with the signal from a remote control and prevents the TV detecting a channel-change or any other command. This allows you to watch your own program without anyone changing the channel !! The circuit is adjusted to produce a 38kHz signal. The IR diode is called an Infra-red transmitting Diode or IR emitter diode to distinguish it from a receiving diode, called an IR receiver or IR receiving diode. (A **Photo diode** is a receiving diode). There are so many IR emitters that we cannot put a generic number on the circuit to represent the type of diode. Some types include: CY85G, LD271, CQY37N(45¢), INF3850, INF3880, INF3940 (30¢). The current through the IR LED is limited to 100mA by the inclusion of the two 1N4148 diodes, as these form a constant-current arrangement when combined with the transistor and 5R6 resistor.



3x3x3 CUBE

This circuit drives a 3x3x3 cube consisting of 27 white LEDs. The 4020 IC is a

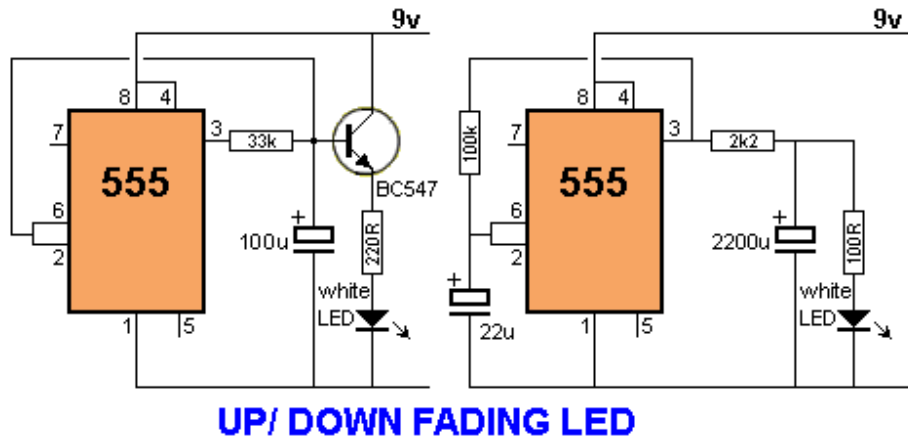
14 stage binary counter and we have used 9 outputs. Each output drives 3 white LEDs in series and we have omitted a dropper resistor as the chip can only deliver a maximum of 15mA per output. The 4020 produces 512 different patterns before the sequence repeats and you have to build the project to see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



UP/DOWN FADING LED

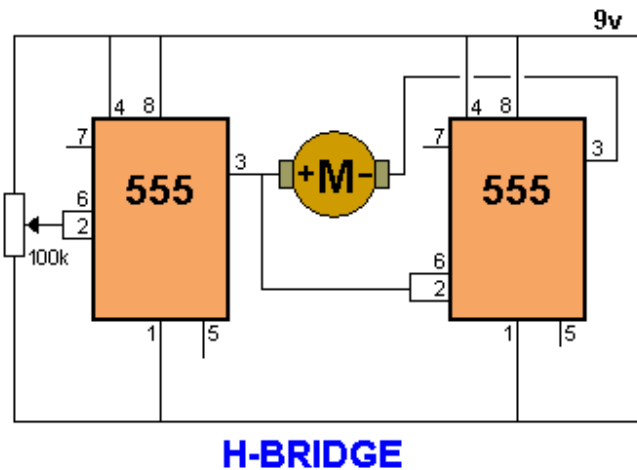
These two circuits make a LED fade on and off. The first circuit charges a 100u and the transistor amplifies the current entering the 100u and delivers 100 times this value to the LED via the collector-emitter pins. The circuit needs 9v for operation since pin 2 of the 555 detects $2/3V_{cc}$ before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

same effect.



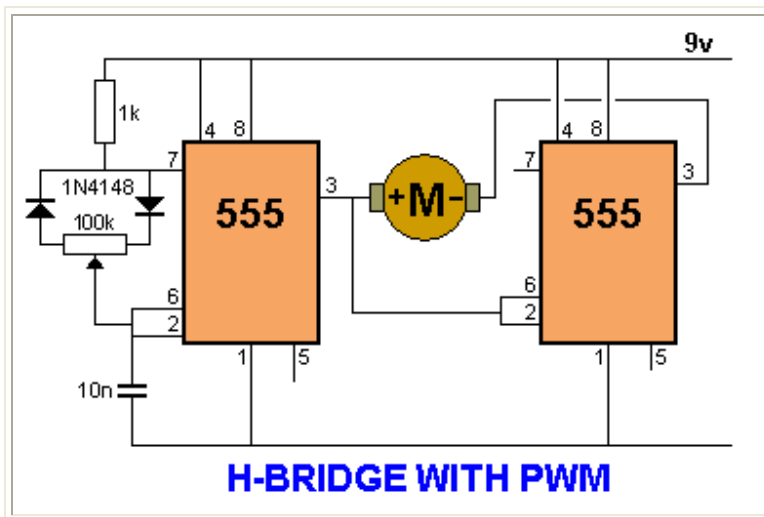
H-BRIDGE

This circuit drives a motor clockwise / anticlockwise via a 10k to 100k pot.



H-BRIDGE WITH PWM

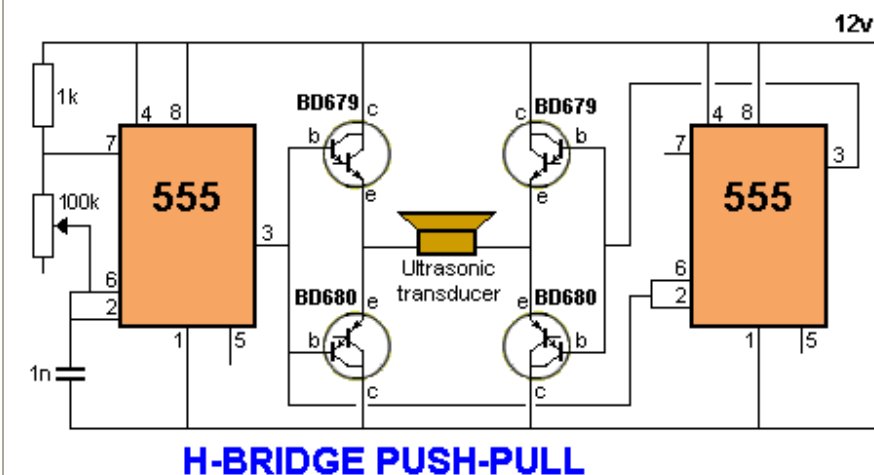
This circuit drives a motor clockwise / anticlockwise via a pot and reduces the speed to zero when the pot is in mid-position. The current is limited to 200mA and the voltage across the motor is less than 6V, but the circuit shows the principle of Pulse Width Modulation (providing powerful bursts of current to the motor to create a high or low RPM under load) and both forward / reverse RPM via the H-bridge arrangement.



H-BRIDGE PUSH-PULL DOG-BARK STOPPER

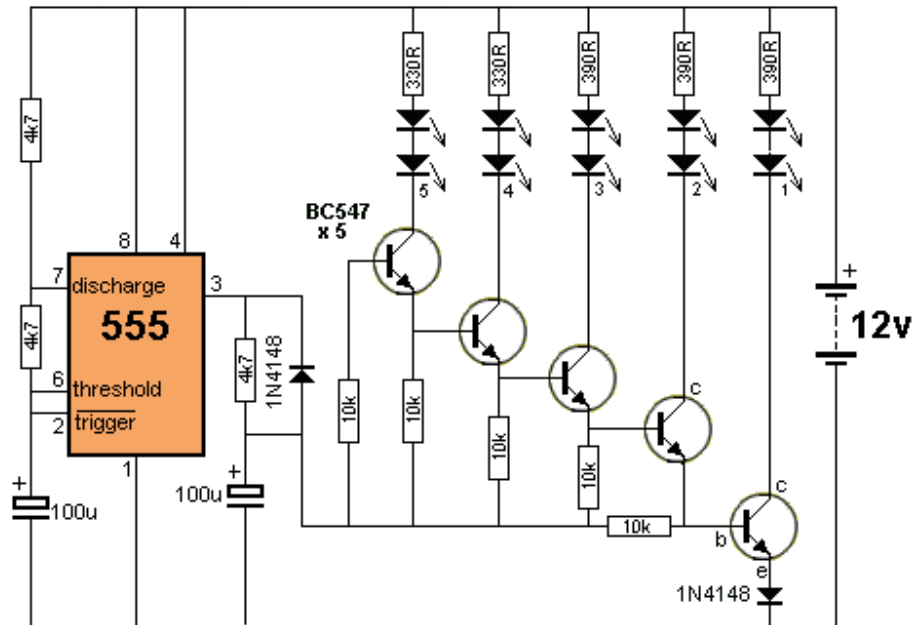
The two circuits above are also **H-Bridge Push-Pull** outputs, however the current is limited to 200mA or less. In this design the current can be 3 amps or more, depending on the supply voltage, the resistance of the load and the type of driver transistors. About 2V5 is lost between "c and e" due to the output of the 555 and the base-emitter voltage of the driver transistors. This circuit drives an ultrasonic transducer (speaker) at 20kHz to 40kHz to subdue dog barking.

If the unit is turned on by remote control every time the dog barks, the animal will soon learn to cease barking.



BIKE TURNING SIGNAL

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

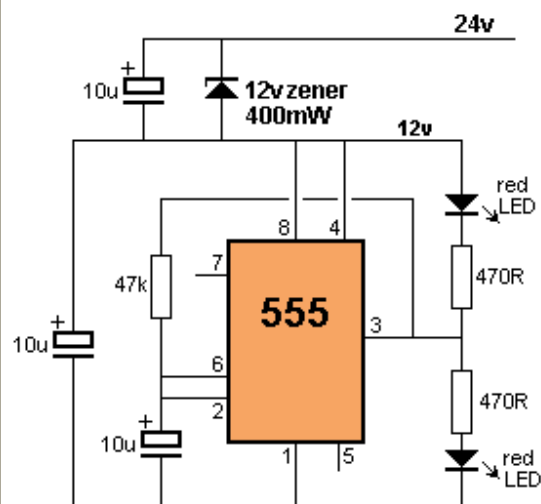


555 ON 24v

If you need to operate a 555 on 24v, you will need to reduce the voltage to less than 18v. The following circuits reduce the voltage to 12v:

30mA:

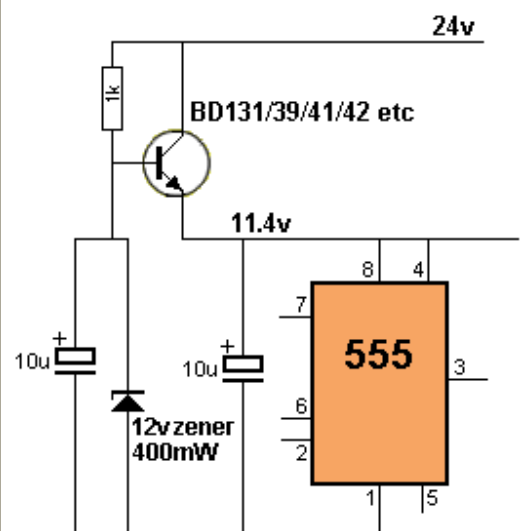
If the 555 circuit takes less than 30mA (the 555 takes 10mA) you can use a 400mW zener diode to drop the 24v supply to 12v for the 555. In other words, 12v is dropped across the zener.



FLASHING LEDs

Up to 500mA:

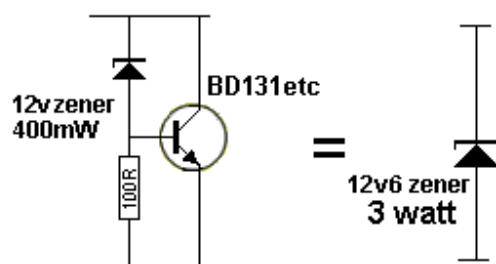
The next circuit will allow up to 500mA. The transistor will need to be placed on a large heatsink. It is an emitter-follower-regulator transistor and can be used with a 400mW zener. The output voltage is 0.6v lower than the zener voltage.



using a transistor

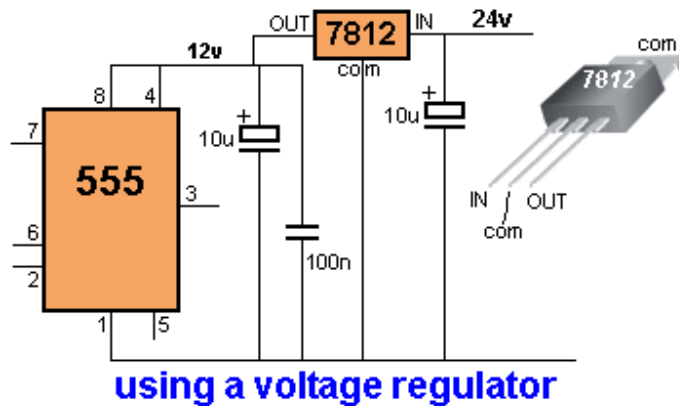
Up to 500mA with "Amplifier Zener"

A 400mW zener can be converted to a "Power Zener" by combining with a transistor as shown in the following circuit: 12.6v will be dropped across the rails. In other words, if the top rail is 24v, the bottom rail will be 11.4v.



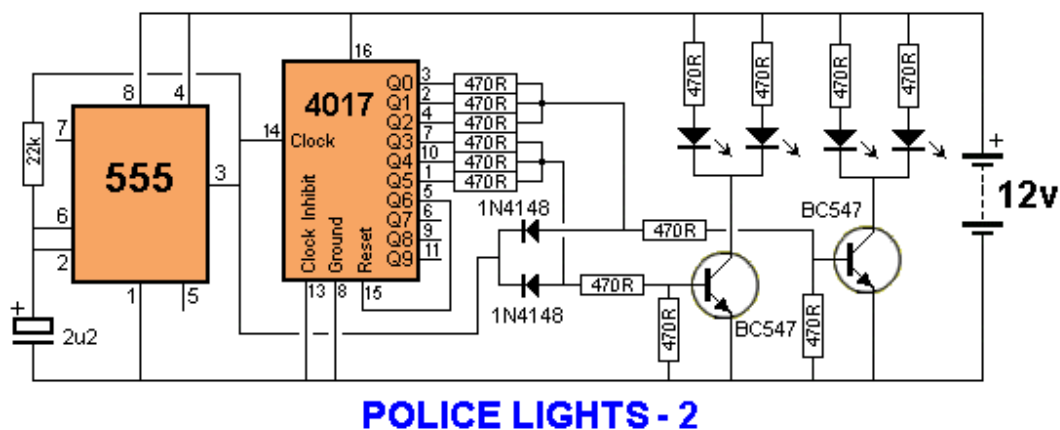
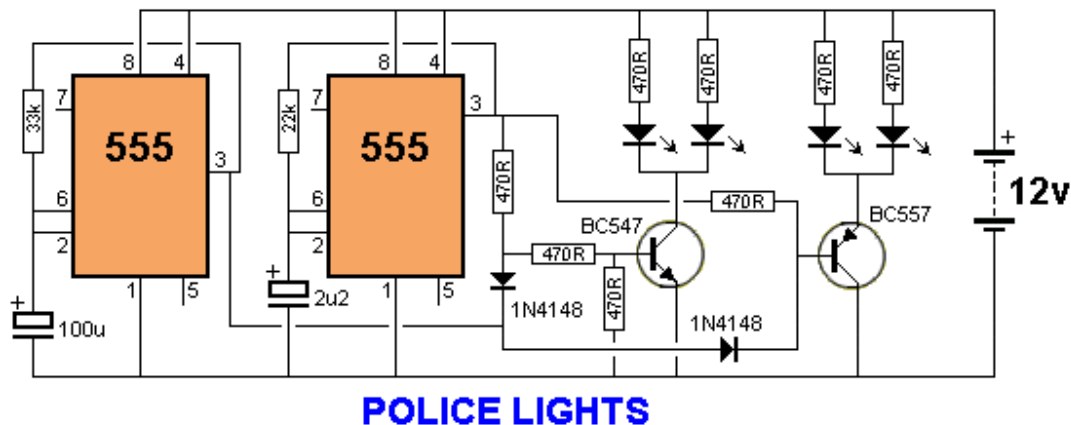
Up to 1A:

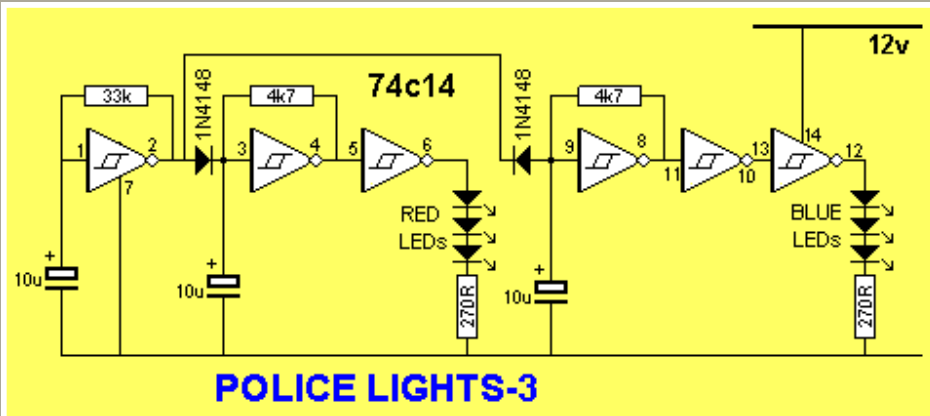
Using the next circuit will allow the 555 to take 200mA and the load to take 800mA. The 7812 will need to be placed on a large heatsink. The 7812 is called a 3-terminal VOLTAGE REGULATOR.



POLICE LIGHTS

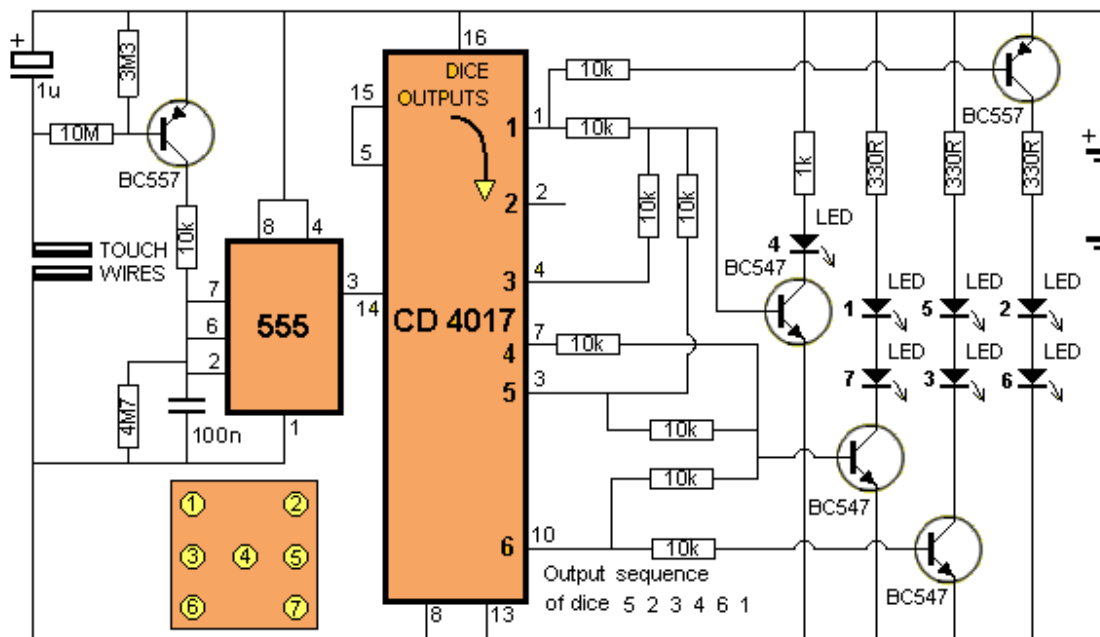
These three circuits flash the left LEDs 3 times then the right LEDs 3 times, then repeats. The only difference is the choice of chips.





LED DICE with Slow Down

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



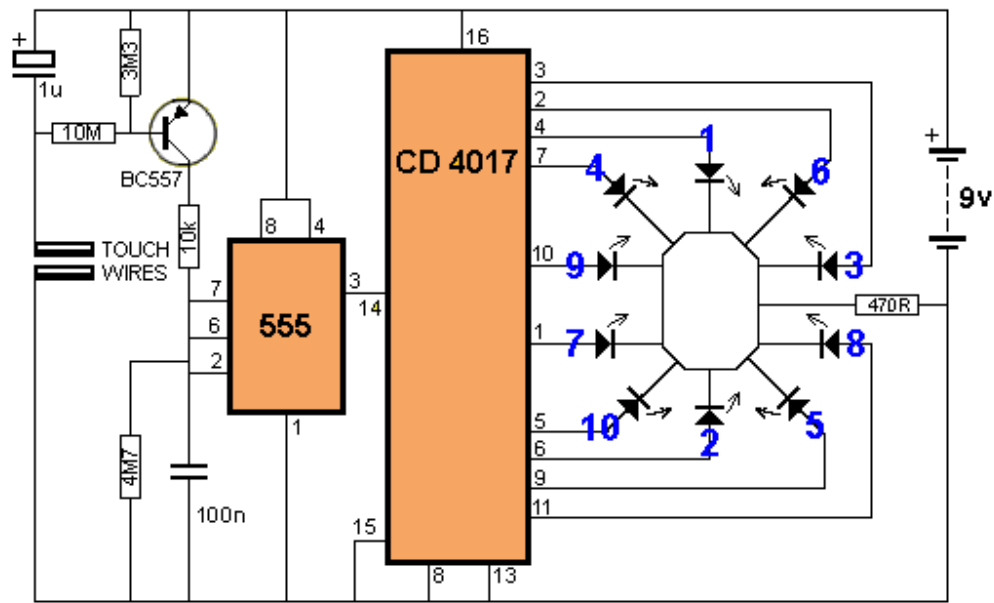
BUY NOW

The **LED Dice with Slow Down kit** is available for \$16.00 plus \$6.50 postage.

The kit includes the parts and PC board.

ROULETTE

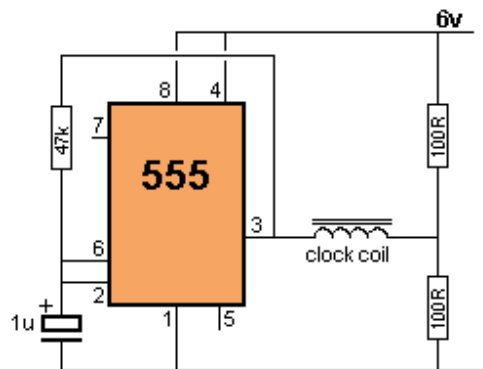
This circuit creates a rotating LED that starts very fast when a finger touches the TOUCH WIRES. When the finger is removed, the rotation slows down and finally stops.



MODEL RAILWAY TIME

Here is a circuit that will convert any clock mechanism into Model Railway Time.

For those who enjoy model railways, the ultimate is to have a fast clock to match the scale of the layout. This circuit will appear to "make time fly" by turning the seconds hand once every 6 seconds. The timing can be adjusted by changing the 47k. The electronics in the clock is disconnected from the coil and the circuit drives the coil directly. The circuit takes a lot more current than the original clock (1,000 times more) but this is one way to do the job without a sophisticated chip.

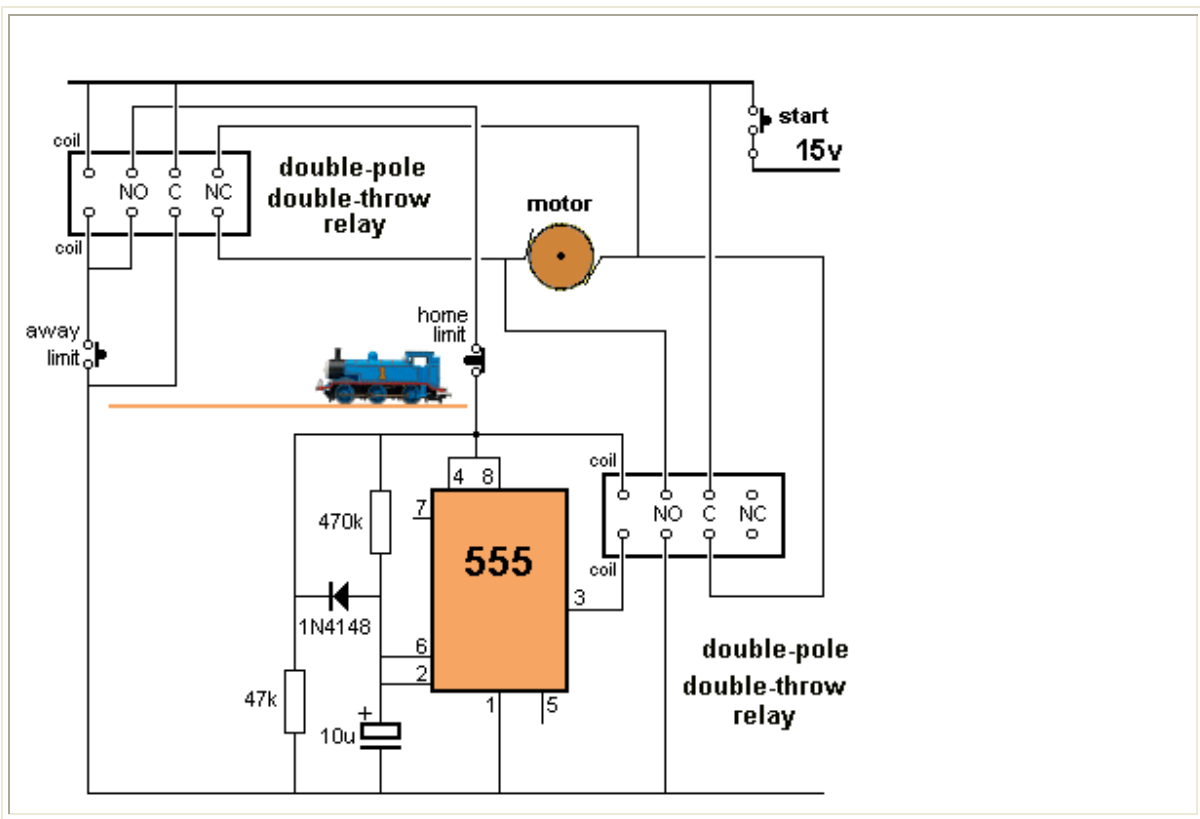


MODEL RAILWAY TIME



REVERSING A MOTOR-4 (see 1, 2, 3 in 200 Transistor Circuits)

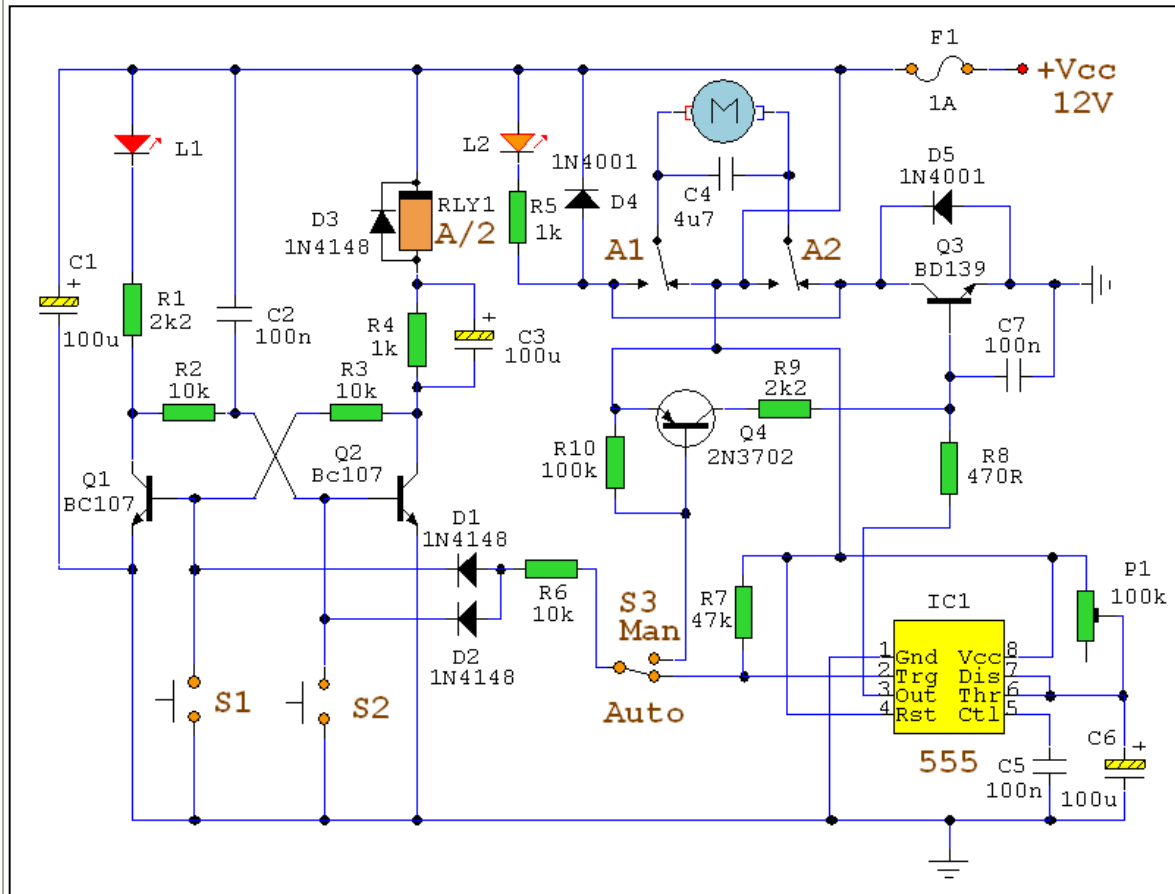
In this example the power is applied via the start switch and the train moves to the away limit switch and stops. The 555 creates a delay of 1 minute and the train moves to the home limit and stops. Turn the power on-off to restart the action.



AUTOMATIC CURTAIN CLOSER

Circuit : Andy Collinson

Email: anc@mitedu.freesevice.co.uk



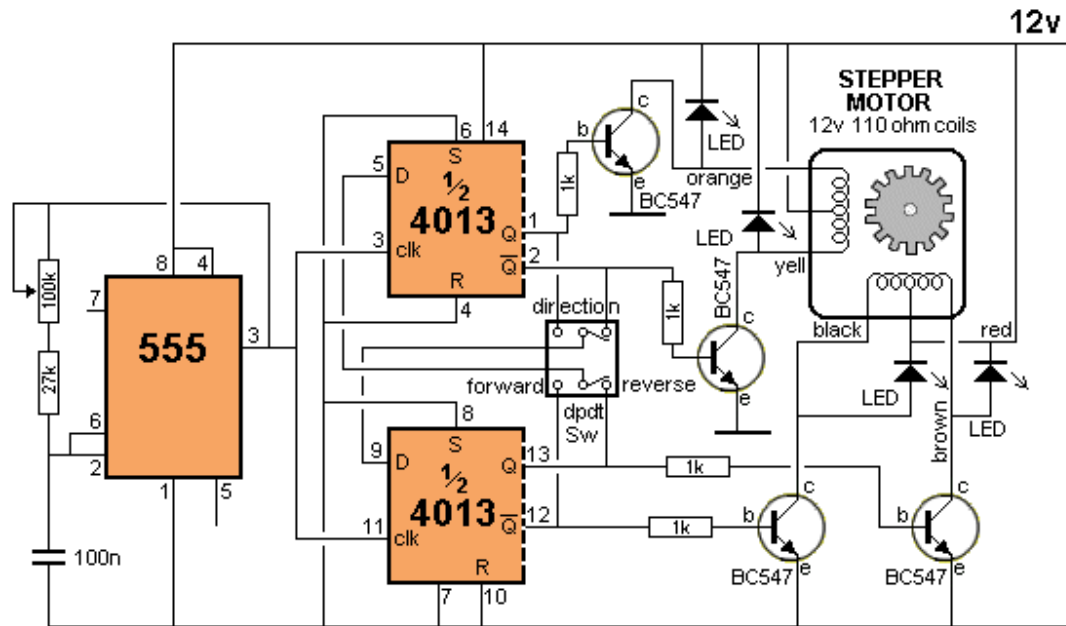
This circuit uses a mixture of transistors, an IC and a relay and is used to automatically open and close a pair of curtains. Using switch S3 also allows manual control, allowing curtains to be left only partially open or closed. The circuit controls a motor that is attached to a simple pulley mechanism, to move the curtains.

Automatic Operation

The circuit can be broken into three main parts; a bi-stable latch, a timer and a reversing circuit. Toggle switch S3 determines manual or automatic mode. The circuit as shown above is drawn in the automatic position and operation is as follows. The bi-stable is built around Q1 and Q2 and associated circuitry and controls relay A/2. S1 is used to open the curtains and S2 to close the curtains. At power on, a brief positive pulse is applied to the base of Q2 via C2. Q2 will be on, and activate relay A/2.

The network of C3 and R4 form a low current holding circuit for the relay. Relay A/2 is a 12V relay with a 500 ohm coil. It requires slightly less current to keep it energized than it does to operate it. Once the relay has operated, the current through the coil is reduced by R4, saving power consumption. When Q2 is off, C3 will be discharged, but when Q2 becomes active (either at switch-on or by pressing S1) capacitor C3 will charge very quickly via the relay coil. The initial charging current is sufficient to energize the relay and current flow through R4 sufficient to keep it energized.

STEPPER MOTOR CONTROLLER



STEPPER MOTOR CONTROLLER

This circuit controls the speed of a stepper motor via the 100k pot. The direction of rotation is determined by the double-pole double-throw switch.

The stepper motor used in this circuit came from an old scanner. It had 5 wires: red-black-yellow-brown-orange. The LEDs illuminate via the back-emf of the coils and prevent the spikes entering the transistors. The LEDs will flicker to show the pulses being received by the stepper motor.

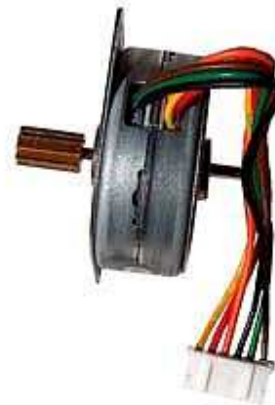
The 27k stop-resistor limits the upper-frequency of the 555 and prevents the circuit producing pulses that are too fast for the stepper motor.

If the colour coding is different on your stepper motor and it fails to work, you only need to reverse two connections thus:

A B C D

A B D C (reverse the two end connections) and if this fails,

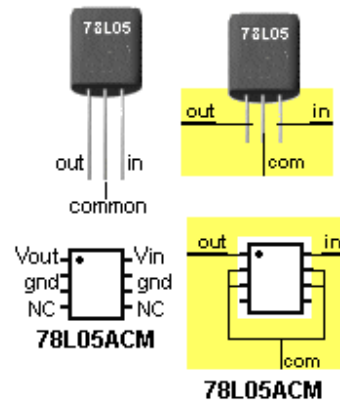
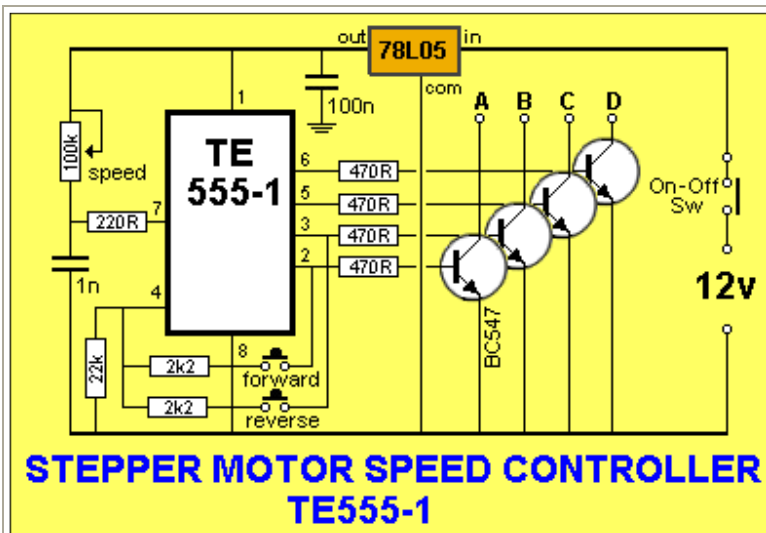
A D B C (reverse the two middle connections)



This stepper motor costs less than \$2.00 from [BG Micro](#) and has 6 wires as shown in the diagram above.

STEPPER MOTOR CONTROLLER TE555-1



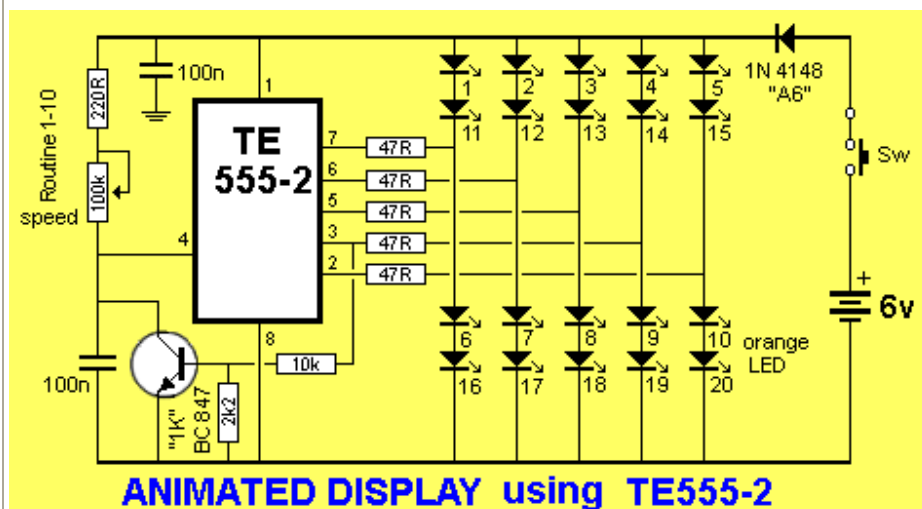


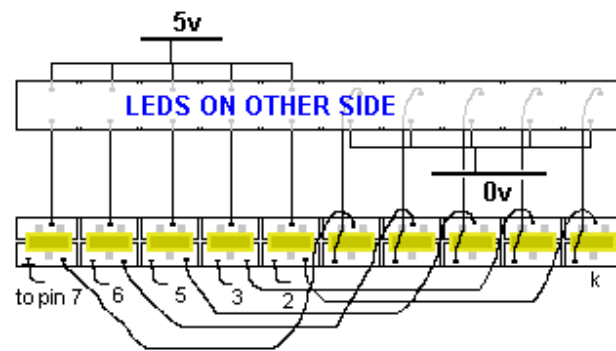
This circuit uses the latest [TE555-1](#) STEPPER MOTOR SPEED CONTROLLER chip from Talking Electronics. It is available for \$2.50 and controls the speed of a stepper motor via the 100k pot. The direction of rotation is determined by the FORWARD and REVERSE switches and the motor does not take any current when a switch is not pressed.

ANIMATED DISPLAY CONTROLLER TE555-2



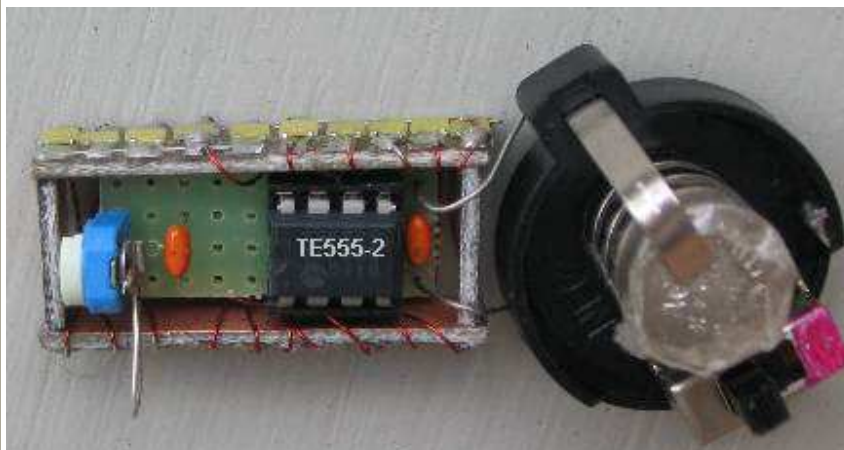
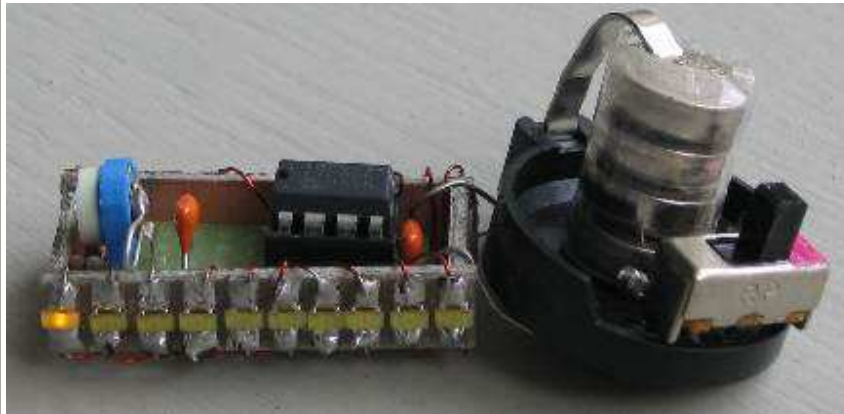
This circuit uses the latest [TE555-2](#) ANIMATED DISPLAY CONTROLLER chip from Talking Electronics. This 8-pin chip is available for \$2.50 and produces 7 different animations on a 10 LED display. The animations are selected by the position of a 100k pot and when the animation is showing, the pot can be adjusted to increase the speed of the animation. "Position 10" on the pot cycles through the 7 animations.



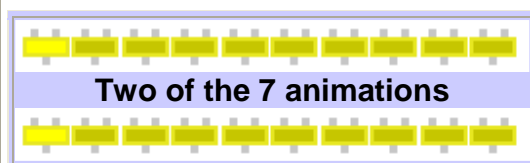


A kit of components (matrix board, PC board for LEDs, surface-mount resistors, capacitors, transistor, diode, switch, cells, battery holder, pot and 20 yellow LEDs with TE555-2 chip is available for \$15.00 plus \$5.00 postage. Click the link above and you will be sent an email with the costs. This is an ideal project you get you into surface-mount technology and you can add it to a model layout or build it into a Lego brick for a junior member.

Wiring the two ten-LED displays



The project has two 10-LED displays. One on the front and one on the back



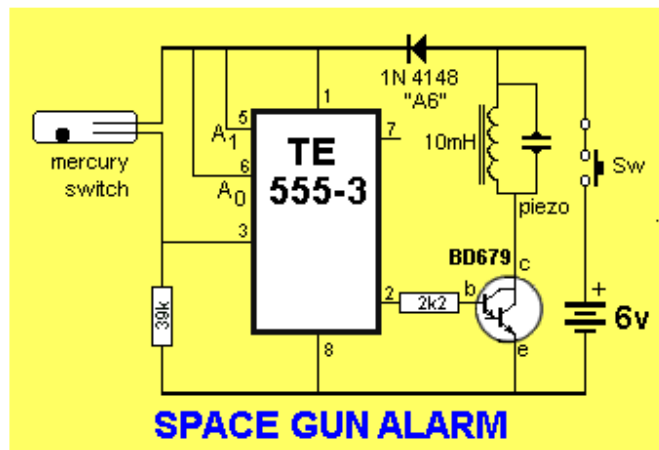
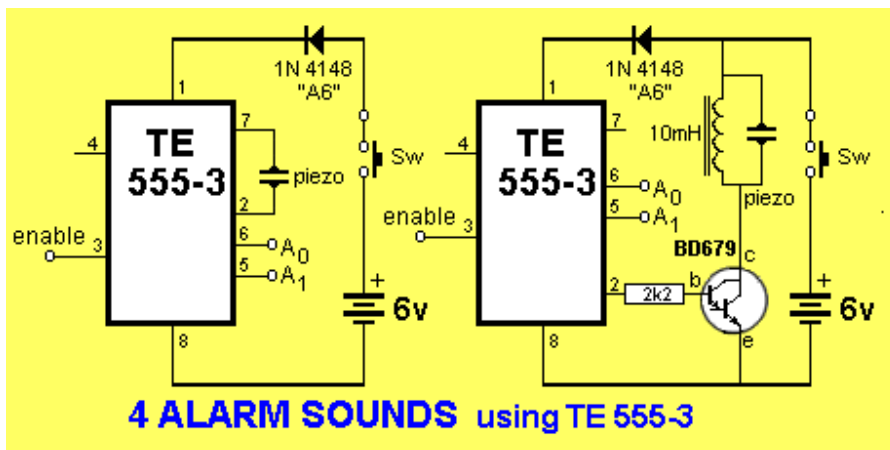
FOUR ALARMS SOUNDS TE555-3



This circuit uses the latest [TE555-3](#) **FOUR ALARM SOUNDS** chip from Talking Electronics. This 8-pin chip is available for \$2.50 and produces 4 different alarm sounds. The chip can be used as a complete alarm system. All you need is a piezo diaphragm and the output will be enough for a single room. To create a very loud output you can add a buffer transistor and piezo speaker and the sounds will be deafening.

Just think of it. A complete alarm circuit for \$2.50 plus a switch, battery and output piezo (such as a piezo tweeter). All the components are available from Talking Electronics and you just need to email Colin Mitchell: talking@tpg.com.au with your list of items.

The output is set to produce an alarm for 3 minutes then stops.



The chip set-up as an alarm

A1	A0	Alarm Output
0	0	Continuous 2.4kHz tone
0	1	Chirps
1	0	Siren
1	1	Space Gun

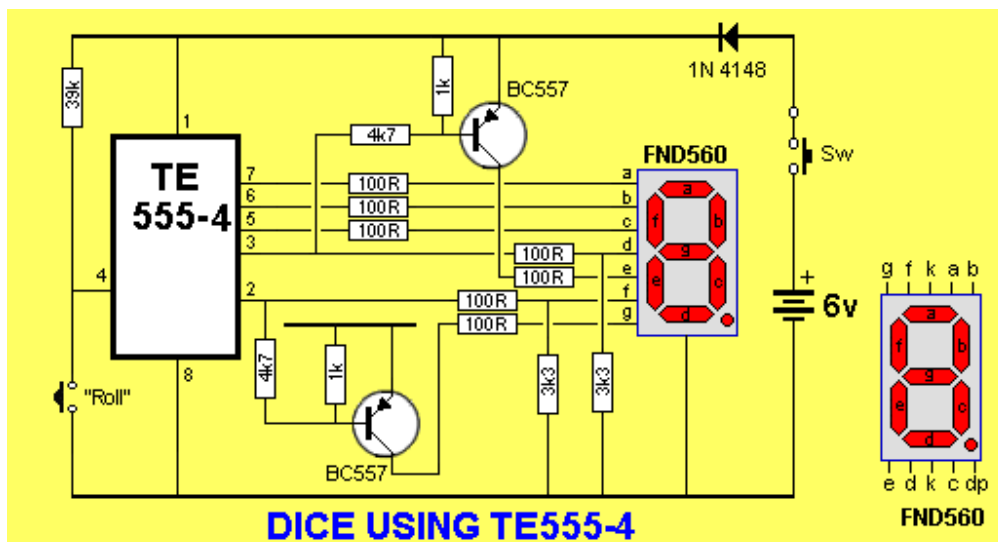
Control lines A0 and A1 are tied HIGH or LOW and when "enable" line is taken HIGH, the tone is

emitted from pins 2 and 7 (in toggle mode). Pin 2 is LOW when the chip is at rest. To get a very loud output, pin 2 drives a Darlington transistor and piezo tweeter with a 10mH choke across the piezo to produce a waveform of nearly 100v. The circuit consumes 0.1mA when at rest.

DICE TE555-4



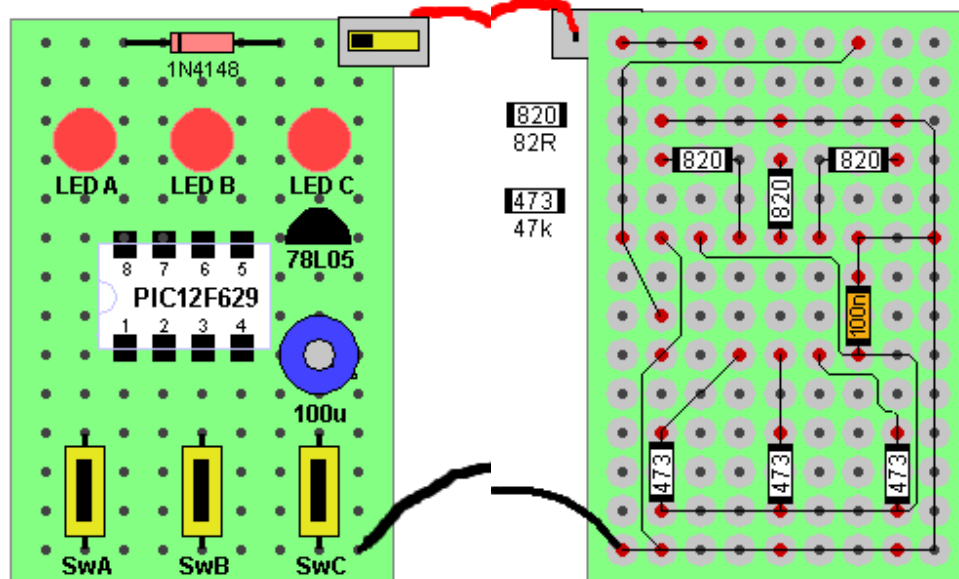
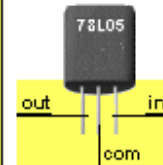
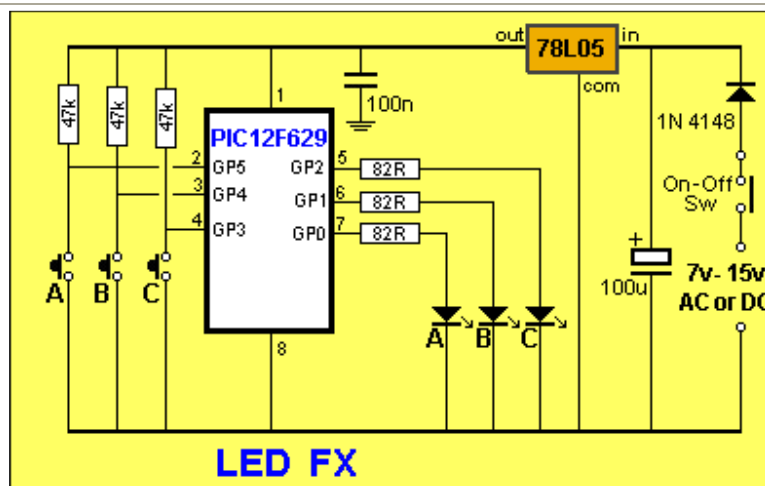
This circuit uses the latest [TE555-4](#) DICE chip from Talking Electronics. This 8-pin chip is available for \$2.50 and drives a 7-Segment display. The circuit can be assembled on proto-type board. For more help on the list of components, email Colin Mitchell: talking@tpg.com.au

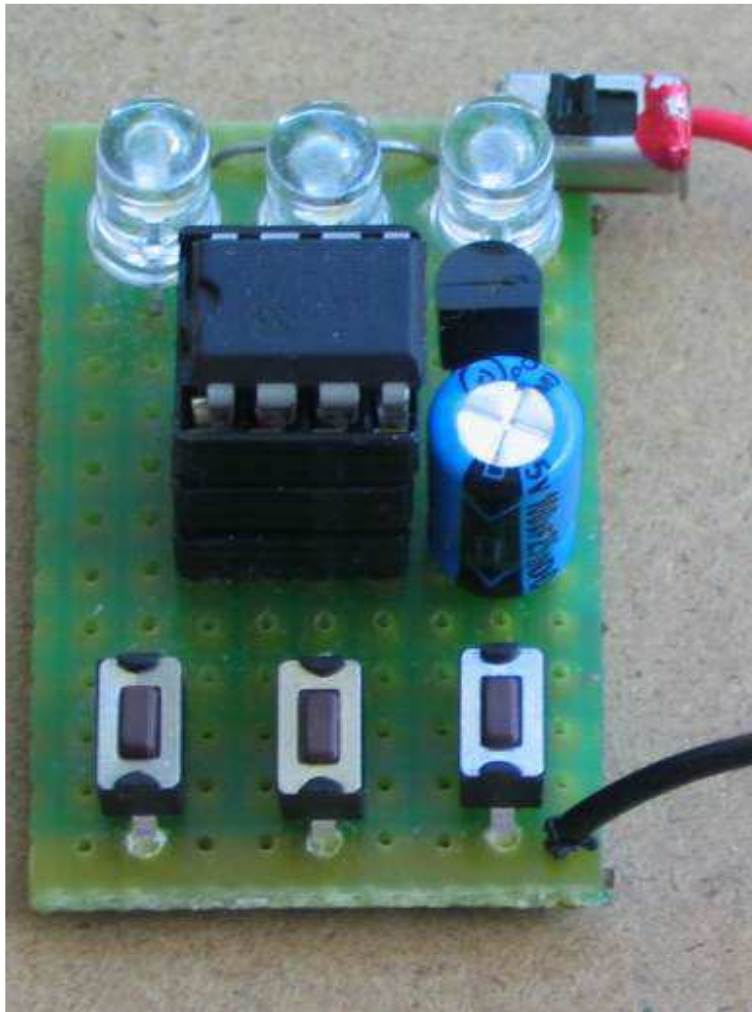


LED FX TE555-5



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



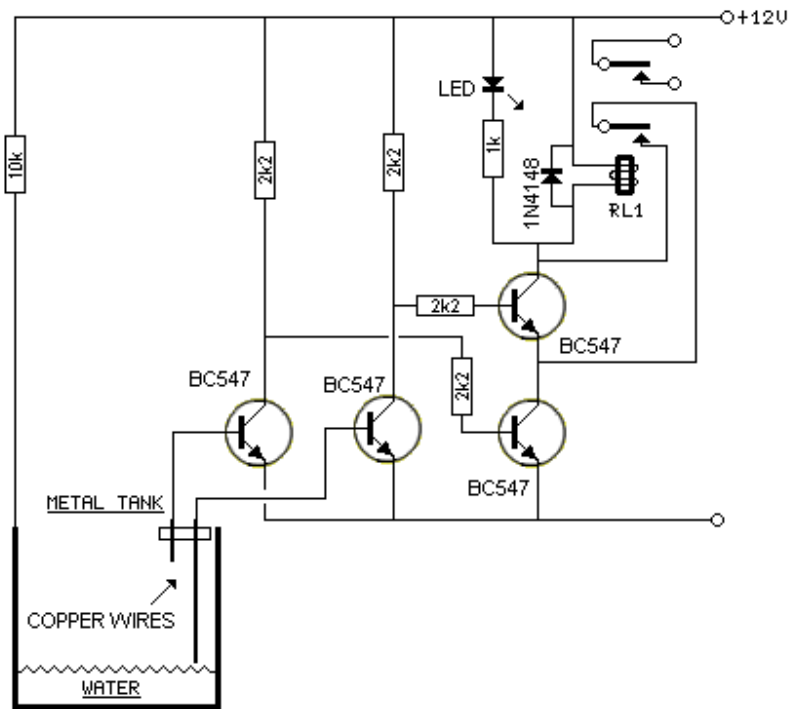


HEADLIGHT SELECTOR

This circuit was designed by a reader who needed to select between low and high beam by pressing a switch, then change back by pressing the switch again. The circuit always starts on low beam, regardless of the state it was turned off.

WATER LEVEL DETECTOR

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



Here is the circuit using a 555:

These are the facts you have to remember. In our circuit, Pins 2 and 6 detect a voltage when water is not touching the probes, due to the 100k resistors. When water touches the probes, neither pin "detects a voltage."

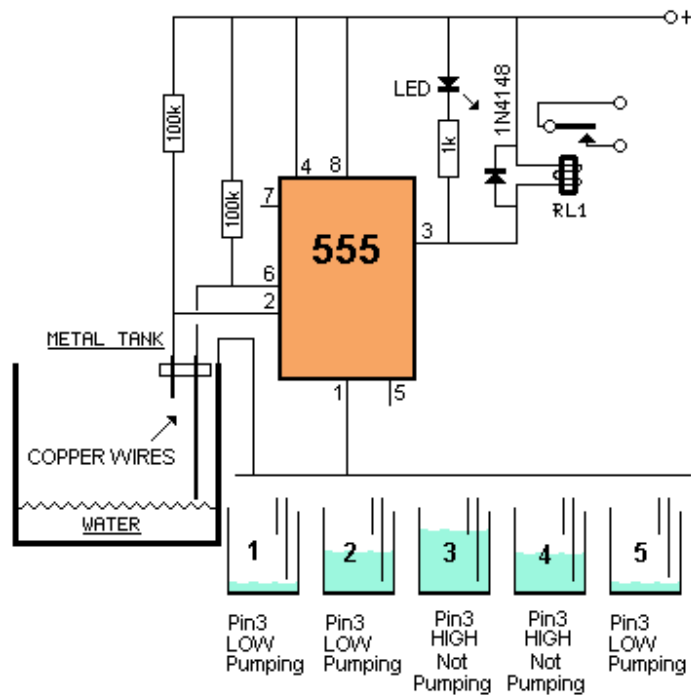
Don't worry about pin 2 detecting 1/3 of rail voltage and pin 6 detecting 2/3 of rail voltage. In our circuit the pins either detect a voltage or do not detect a voltage. Pin 2 detects a LOW and pin 6 detects a HIGH. Pin 2 does nothing when it detects a HIGH and pin 6 does nothing when it detects a LOW.

When the water is LOW, as shown in **fig 1**, both pins 2 and 6 are HIGH and the output of the 555 is LOW.

As the water rises, as shown in **fig 2**, Pin 6 goes low but nothing happens to pin 3 except the chip "has been prepared via the internal flip-flop" to change when pin 2 goes LOW. When the water reaches pin 2, as shown in **fig 3**, this pin "fails to see a HIGH," the output of the chip goes HIGH and the pump turns off.

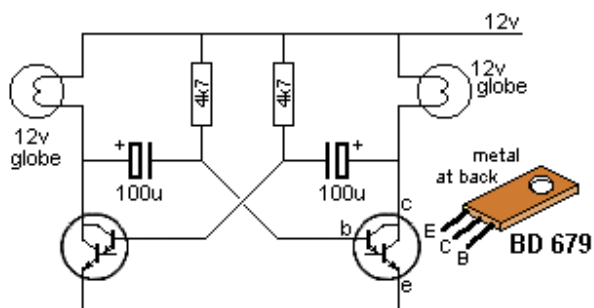
As the water level goes down, as shown in **fig 4**, pin 2 sees a HIGH but this does not change the 555 as pin 2 only has an effect when it goes LOW.

When the water level goes down further, as shown in **fig 5**, pin 6 sees a HIGH and because pin 2 is not seeing a LOW, the chip will change states. The output goes LOW.



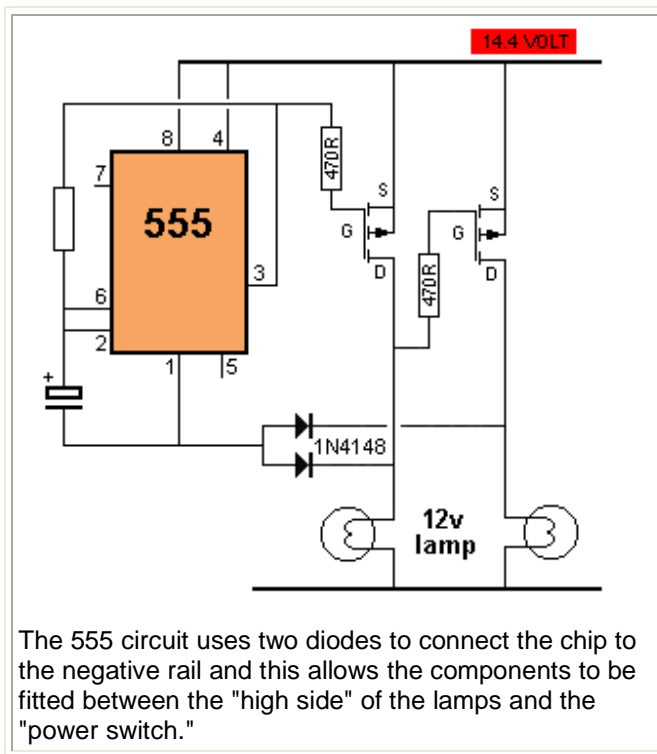
WARNING LIGHTS FLASHER

These two circuits flash two **5 watt to 21watt** car lamps. The first circuit uses BD679 Darlington transistors and the second circuit uses a 555.



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

A complete kits of parts and PC board costs \$5.00 plus postage from: Talking Electronics. Email [HERE](#) for details.



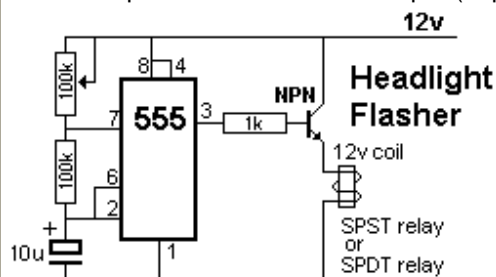
FAULTS

Here are some circuits with faults. They come from projects on the web:

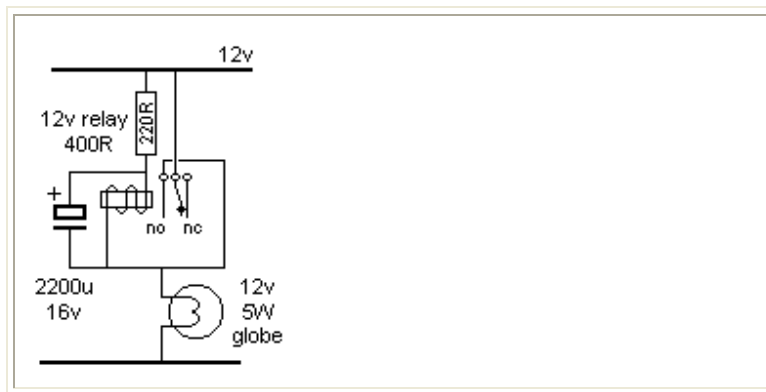
HEADLIGHT FLASHER

This circuit flashes headlights via a relay but the relay is only getting 9v4 due to the voltage-loss of the 555 and 0.6v of the transistor: The transistor should be common-emitter configuration.

In addition, the pot will be damaged if turned to zero ohms. A 1k should be placed in series with the pot (at pin7 end).

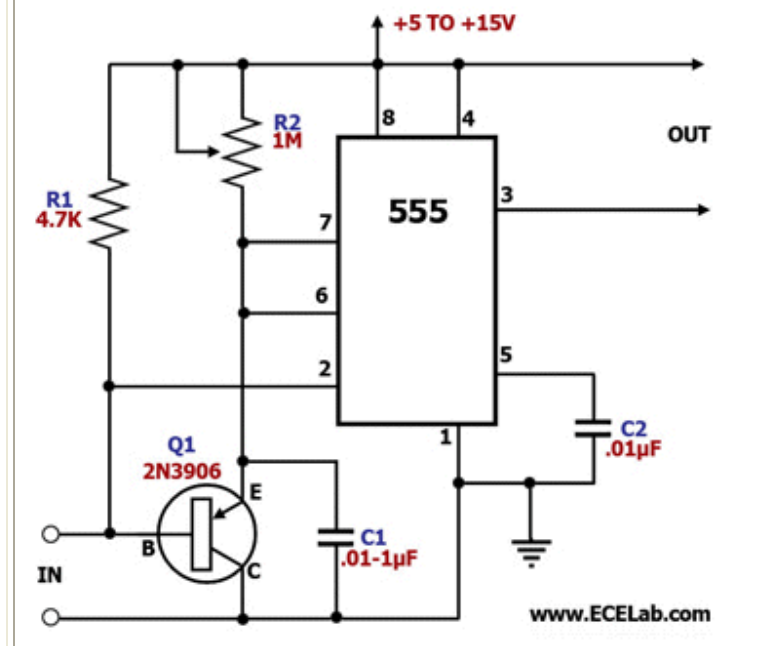


Here is a simpler circuit. It will need testing and adjusting to suit the relay you will be using:



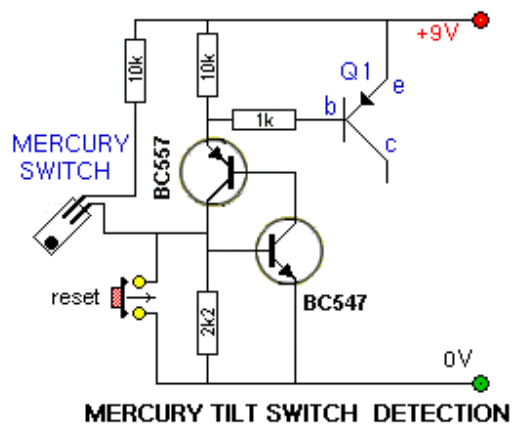
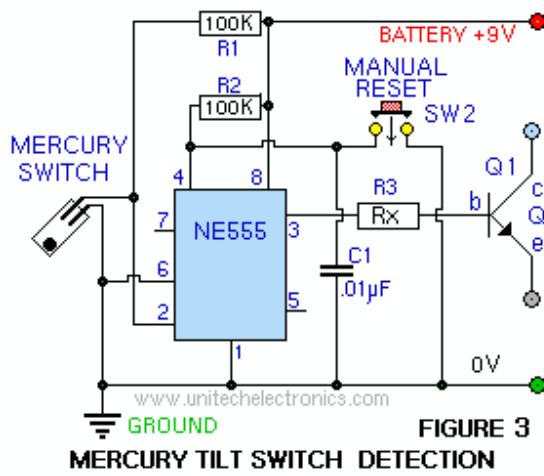
MISSING PULSE DETECTOR

This circuit is described on the web as a missing pulse detector. If the 1M pot is turned to zero ohms, it will be damaged when the transistor inside the 555 at pin 7 connects to 0v rail.



MERCURY SWITCH DETECTOR

This circuit is a LATCH CIRCUIT and it detects when the mercury switch is tilted. But it is consuming 10mA while it is sitting around waiting for the mercury switch to make contact. By replacing the 555 with two transistors, the circuit will consume zero current when waiting for the switch to close. Sometimes a 555 is not the ideal choice.



BUY NOW

555 KIT

A kit of components to make many of the circuits described in this eBook is available for \$10.00 plus \$7.00 post.
Or email Colin Mitchell: talking@tpg.com.au

The kit contains the following components:
(plus **extra** 30 resistors and 10 capacitors for experimenting), plus:

- 2 - 220R
- 2 - 1k
- 2 - 4k7
- 2 - 10k
- 2 - 33k
- 2 - 100k
- 2 - 1M
- 1 - 10k mini pot
- 1 - 100k mini pot
- 2 - 10n
- 2 - 100n
- 1 - 10u electrolytic
- 1 - 100u electrolytic
- 2 - 1N4148 signal diodes
- 2 - BC547 transistors
- 1 - BC557 transistor
- 1 - 555 timer chip
- 1 - 8 pin IC socket
- 1 - red LED
- 1 - green LED
- 1 - orange LED
- 1 - mini 8R speaker
- 1 - mini piezo
- 1 - LDR (Light Dependent Resistor)
- 1 - 10mH inductor
- 1 - push button
- 4 - tactile push buttons
- 1 - **Experimenter Board** (will take 8, 14 and 16 pin chips)

THE FUTURE

This eBook has shown the enormous number of circuits that can be produced with a 555.

However there is something we should point out.

The 555 has limitations and disadvantages.

It is not a chip you readily add to battery operated devices as its current consumption is quite high at 10mA. (There is a whole range of low-current equivalents.)

Secondly, the 555 is not a chip you add to a complex circuit as there are many other chips that can perform the task of a 555 and you will have additional gates within the chip for other sections of the circuit. The 74c14 is an example. It has 6 Schmitt trigger gates and each gate can be wired as an oscillator or delay and the chip takes less than 1mA.

Before designing a circuit around a 555, you should look at our eBook: [100 IC Circuits](#). It has many "building Blocks" to help you design your own circuits.

				If 3rd band is gold, Divide by 10 If 3rd band is silver, Divide by 100 (to get 0.22ohms etc)	
Silver Gold					
R10	1R0	10R	100R	1K0	10K
R11	1R1	11R	110R	1K1	11K
R12	1R2	12R	120R	1K2	12K
R13	1R3	13R	130R	1K3	13K
R15	1R5	15R	150R	1K5	15K
R16	1R6	16R	160R	1K6	16K
R18	1R8	18R	180R	1K8	18K
R20	2R0	20R	200R	2K0	20K
R22	2R2	22R	220R	2K2	22K
R24	2R4	24R	240R	2K4	24K
R27	2R7	27R	270R	2K7	27K
R30	3R0	30R	300R	3K0	30K
R33	3R3	33R	330R	3K3	33K
R36	3R6	36R	360R	3K6	36K
R39	3R9	39R	390R	3K9	39K
R43	4R3	43R	430R	4K3	43K
R47	4R7	47R	470R	4K7	47K
R51	5R1	51R	510R	5K1	51K
R56	5R6	56R	560R	5K6	56K
R62	6R2	62R	620R	6K2	62K
R68	6R8	68R	680R	6K8	68K
R75	7R5	75R	750R	7K5	75K
R82	8R2	82R	820R	8K2	82K
R91	9R1	91R	910R	9K1	91K
					100K
					110K
					120K
					130K
					150K
					160K
					180K
					200K
					220K
					240K
					270K
					300K
					330K
					360K
					390K
					430K
					470K
					510K
					560K
					620K
					680K
					750K
					820K
					910K
					1M0
					1M1
					1M2
					1M3
					1M5
					1M6
					1M8
					2M0
					2M2
					2M4
					2M7
					3M0
					3M3
					3M6
					3M9
					4M3
					4M7
					5M1
					5M6
					6M2
					6M8
					7M5
					8M2
					9M1
					10M
					BLUE

COLOR CODES FOR E12/E24 RANGE OF RESISTORS

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