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11 IC CIRCUITS as of 19-2-2010

Talking Electronics

See [TALKING ELECTRONICS WEBSITE](#)

email Colin Mitchell: talking@tpg.com.au

INTRODUCTION

This is the third part of our Circuits e-book series. It contains a further 100 circuits. This time we have concentrated on circuits containing one or more IC's.

It's amazing what you can do with transistors but when Integrated Circuits came along, the whole field of electronics exploded.

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

Let's explain what we mean.

The word analogue is a waveform or signal that is changing (increasing and decreasing) at a constant or non constant rate.

Examples are voice, music, tones, sounds and frequencies. Equipment such as radios, TV's and amplifiers process analogue signals.

Then digital came along.

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

The advantage of digital is two-fold.

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

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

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

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

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

Digital circuits also introduce the concept of two inputs creating a HIGH output when both are HIGH and variations of this.

This is called "logic" and introduces terms such as "Boolean algebra" (Boolean logic) and "gates."

Integrated Circuits started with a few transistors in each "chip" and increased to mini or micro computers in a single chip. These chips are called Microcontrollers and a single chip with a few surrounding components can be programmed to play games, monitor heart-rate and do all sorts of amazing things. Because they can process information at high speed, the end result can appear to have intelligence and this is where we are heading: AI (Artificial Intelligence).

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

In most cases the IC will contain 10 - 100 transistors, cost less than the individual components and take up much less board-space. They also save a lot of circuit designing and quite often consume less current than discrete components or the components they replace. In all, they are a fantastic way to get something working with the least componentry.

A list of some of the most common Integrated Circuits (Chips) is provided at the end of this book to help you identify the pins and show you what is inside the chip.

Some of the circuits are available from Talking Electronics as a kit, but others will have to be purchased as individual components from your local electronics store. Electronics is such an enormous field that

we cannot provide kits for everything. But if you have a query about one of the circuits, you can contact me.

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

MORE INTRO

We have said this before but we will say it again: There are two ways to learn electronics.

One is to go to school and study theory for 4 years and come out with all the theoretical knowledge in the world but very little practical experience. The other is to "learn on the job."

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

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

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

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

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

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

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

The market is very narrow but new designs are coming along all the time and new devices are constantly being invented and more are always needed.

Once you get past this eBook of "Chips" you will want to investigate microcontrollers and this is when your options will explode.

You will be able to carry out tasks you never thought possible, with a chip as small as 8 pins and a few hundred lines of code.

In two weeks you can start to understand the programming code for a microcontroller and perform simple tasks such as flashing a LED and produce sounds and outputs via the press of a button.

All these things are covered on [Talking Electronics website](#) and you don't have to buy any books or publications. Everything is available on the web and it is instantly accessible. That's the beauty of the web.

Don't think things are greener on the other side of the fence, by buying a text book. They aren't. Everything you need is on the web AT NO COST.

The only thing you have to do is build things. If you have any technical problem at all, simply email [Colin Mitchell](#) and any question will be answered. Nothing could be simpler and this way we guarantee you SUCCESS. Hundreds of readers have already emailed and after 5 or more emails, their circuit works. That's the way we work. One thing at a time and eventually the fault is found. If you think a circuit will work the first time it is turned on, you are fooling yourself.

All circuits need corrections and improvements and that's what makes a good electronics person. Don't give up. How do you think all the circuits in these eBooks were designed? Some were copied and some were designed from scratch but all had to be built and adjusted slightly to make sure they worked perfectly.

I don't care if you use bread-board, copper strips, matrix board or solder the components in the air as a "bird's nest." You only learn when the circuit gets turned on and WORKS!

In fact the rougher you build something, the more you will guarantee it will work when built on a printed circuit board.

However, high-frequency circuits (such as 100MHz FM Bugs) do not like open layouts and you have to keep the construction as tight as possible to get them to operate reliably.

In most other cases, the layout is not critical.

If you just follow these ideas, you will succeed.

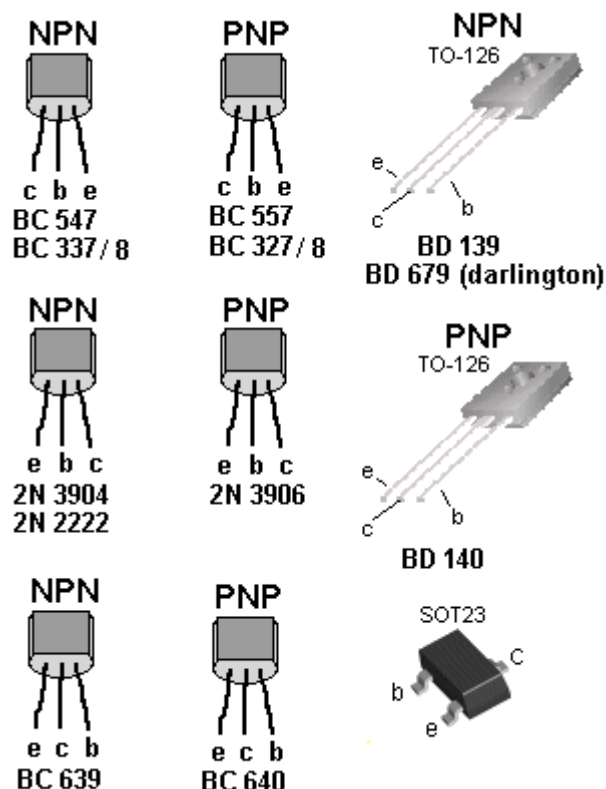
A few of the basics are also provided in this eBook, the first is transistor outlines:

TRANSISTORS

Most of the transistors used in our circuits are BC 547 and BC 557.

These are classified as "universal" or "common" NPN and PNP types with a voltage rating of about 25v, 100mA collector current and a gain of about 100.

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

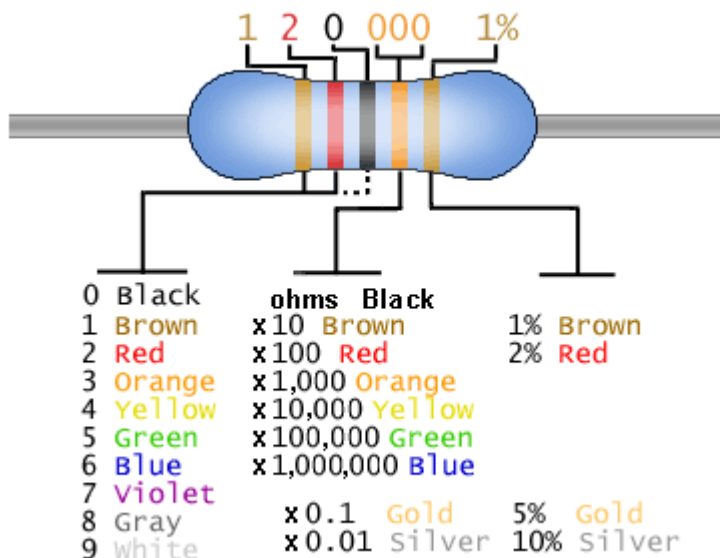


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RESISTOR COLOUR CODE



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

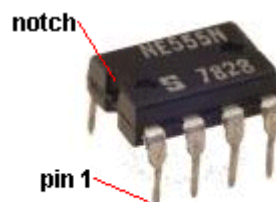
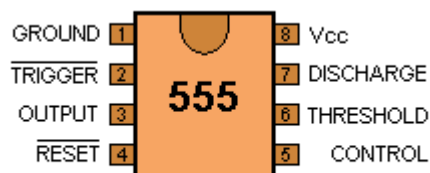
THE 555

The 555 is everywhere. It is possibly the most-frequency used chip and is easy to use. But if you want to use it in a "one-shot" or similar circuit, you need to know how the chip will "sit."

For this you need to know about the UPPER THRESHOLD (pin 6) and LOWER THRESHOLD (pin 2):

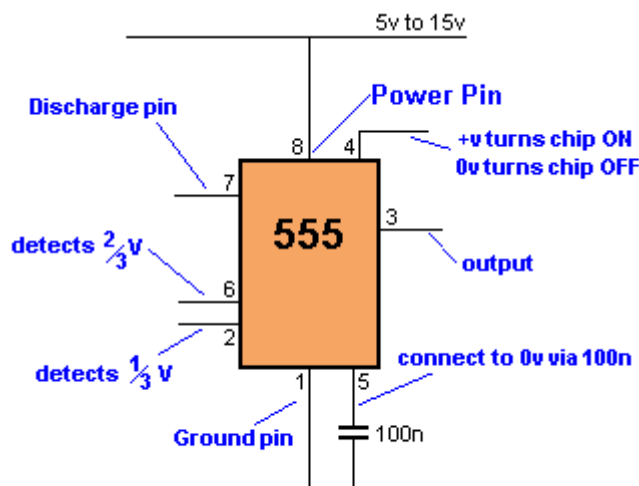
The 555 is fully covered in a 3 page article on Talking Electronics website (see left index: 555 P1 P2 P3)

Here is the pin identification for each pin:

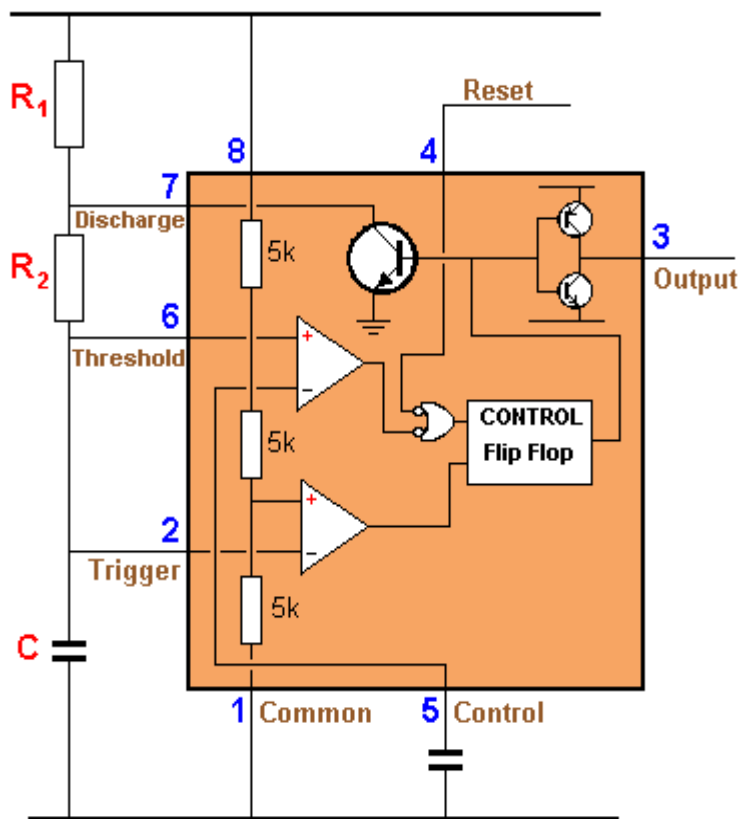


555 PINOUT

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



The Function of each PIN



INSIDE THE 555 CHIP

Note: Pin 7 is "in phase" with output Pin 3 (both are low at the same time).
Pin 7 "shorts" to 0v via the transistor. It is pulled HIGH via R1.

Maximum supply voltage 16v - 18v

Current consumption approx 10mA

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

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

Maximum operating frequency 300kHz - 500kHz

Faults with Chip:

Consumes about 10mA when sitting in circuit

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

Output is 0.5v to 1.5v above ground

Sources up to 200mA but sinks only 50mA

HOW TO USE THE 555

There are many ways to use the 55.

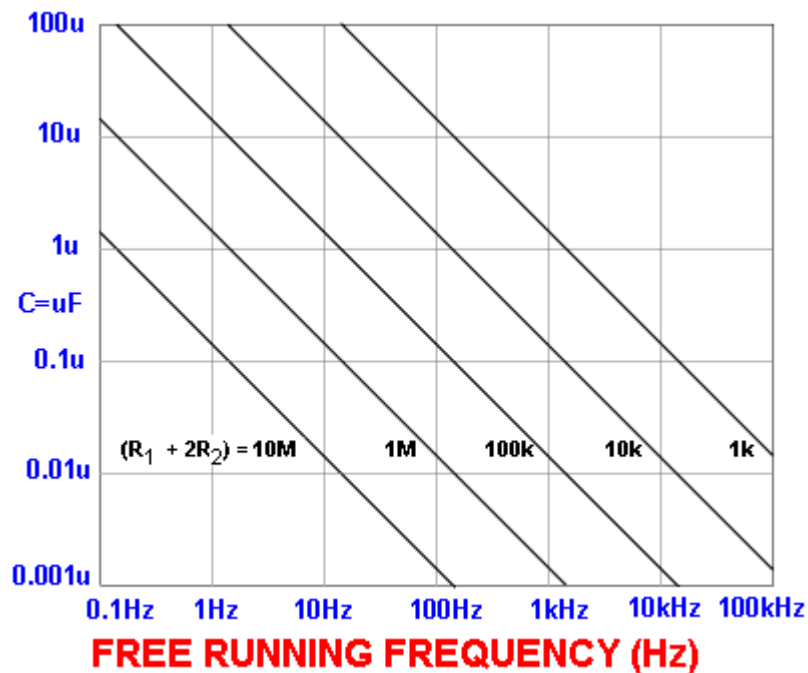
(a) Astable Multivibrator - constantly oscillates

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

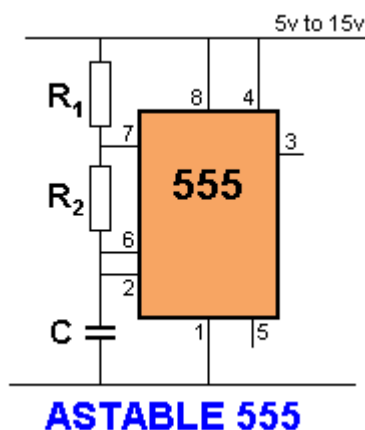
(c) Voltage Controlled Oscillator

ASTABLE MULTIVIBRATOR

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



The graph applies to the following Astable circuit:



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

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

Using the graph:

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

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

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

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

The result is approx 900Hz.

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

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

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

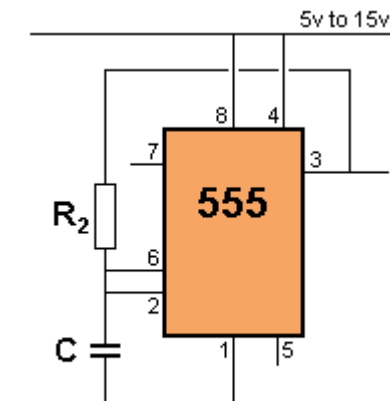
Draw a line parallel to the lines on the graph and where it crosses the 1u line, is the answer. The result is approx 9Hz.

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

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

555 astable frequencies			
C	$R_1 = 1k$	$R_1 = 10k$	$R_1 = 100k$

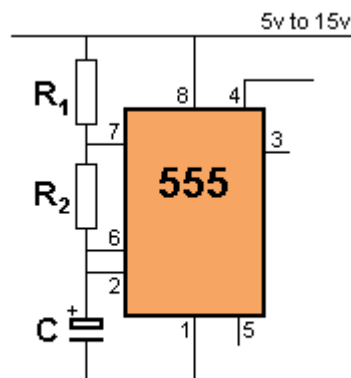
	$R_2 = 6k\Omega$	$R_2 = 68k\Omega$	$R_2 = 680k\Omega$
0.001μ	100kHz	10kHz	1kHz
0.01μ	10kHz	1kHz	100Hz
0.1μ	1kHz	100Hz	10Hz
1μ	100Hz	10Hz	1Hz
10μ	10Hz	1Hz	0.1Hz



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

SIMPLEST ASTABLE

LOW FREQUENCY OSCILLATORS



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

LOW FREQUENCY 555

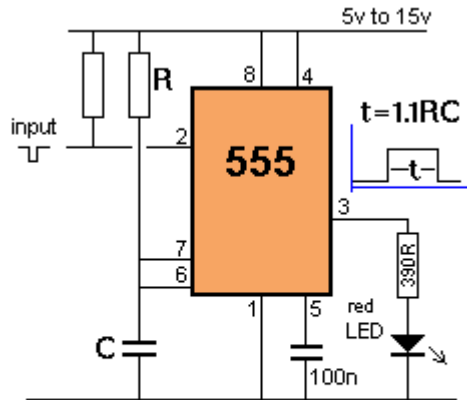
555 Delay Times:			
C	$R_1 = 100k\Omega$	$R_1 = 470k\Omega$	$R_1 = 1M\Omega$
	$R_2 = 100k\Omega$	$R_2 = 470k\Omega$	$R_2 = 1M\Omega$
10μ	2.2sec	10sec	22sec
100μ	22sec	100sec	220sec
470μ	100sec	500sec	1000sec

555 ASTABLE OSCILLATORS

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

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

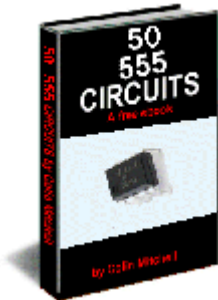
555 Monostable or "one Shot"



**MONOSTABLE
OR
"ONE-SHOT"**

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50 - 555 CIRCUITS



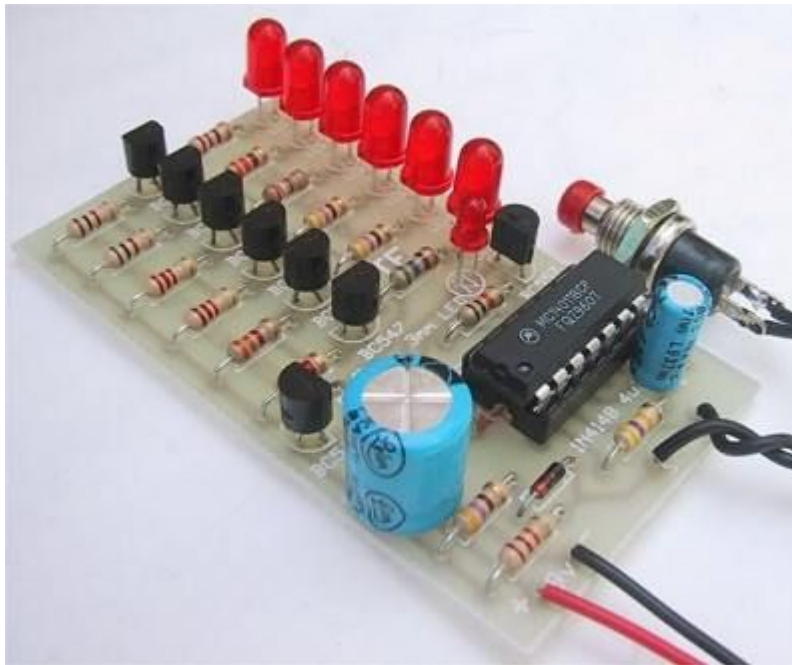
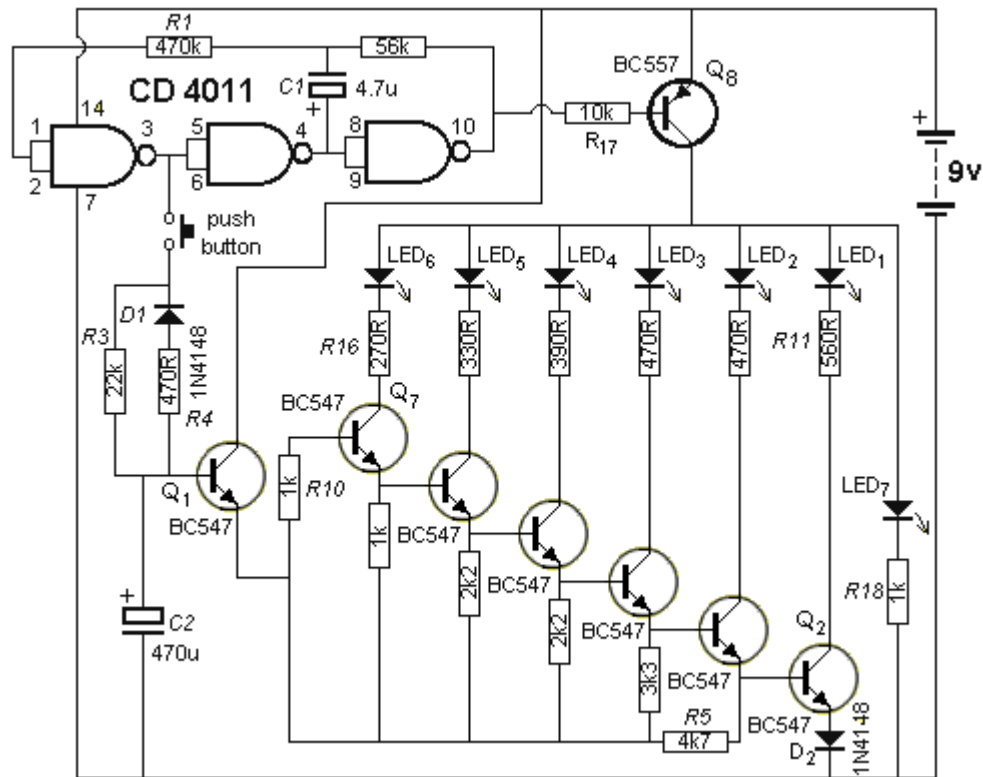
[50 555 Circuits eBook](#) can be accessed on the web or downloaded as a [.doc](#) or [.pdf](#). It has more than 50 very interesting 555 circuits and data on using a 555.

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cycles per second. A push button is the "Operations Control" and by carefully pushing the button in synchronisation with the flashing LED, the row of LEDs will gradually light up.

But the slightest mistake will immediately extinguish one, two or three LEDs. The aim of the game is to illuminate the 6 LEDs with the least number of pushes. We have sold thousands of these kits. It's a great challenge.



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BFO METAL DETECTOR

The circuit shown must represent the limits of simplicity for a metal detector. It uses a single 4093 quad Schmitt NAND IC and a search coil -- and of course a switch and batteries. A lead from IC1d pin 11 needs to be attached to a MW radio aerial, or should be wrapped around the radio. If the radio has a BFO switch, switch this ON.

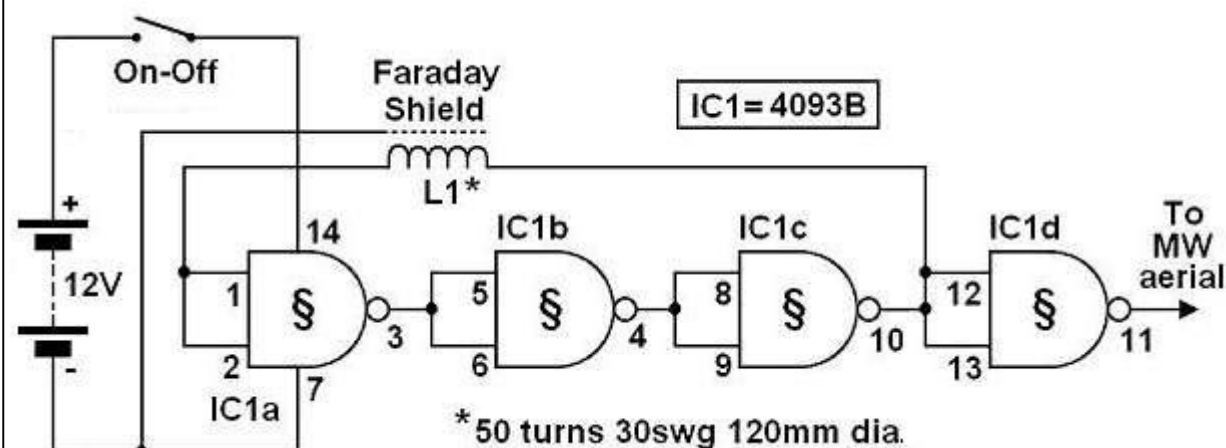
Since an inductor resists rapid changes in voltage (called reactance), any change in the logic level at IC1c pin 10 is delayed during transfer back to input pins 1 and 2. This is further delayed through propagation delays within the 4093 IC. This sets up a rapid oscillation (about 2 MHz), which is picked up by a MW radio. Any change to the inductance of L1 (through the presence of metal) brings about a change to the oscillator frequency. Although 2 MHz is out of range of the Medium Waves, a MW radio will clearly pick up harmonics of this frequency.

The winding of the coil is by no means critical, and a great deal of latitude is permissible. The prototype used 50 turns of 22 awg/30 swg (0.315 mm) enamelled copper wire, wound on a 4.7"/120 mm former. This was then wrapped in insulation tape. The coil then requires a Faraday shield, which is connected to 0V. A Faraday shield is a wrapping of tin foil around the coil, leaving a small gap so that the foil does not complete the entire circumference of the coil. The Faraday shield is again wrapped in insulation tape. A connection may be made to the Faraday shield by wrapping a bare piece of stiff wire around it before adding the tape. Ideally, the search coil will be wired to the circuit by means of twin-core or figure-8 microphone cable, with the screen being wired to the Faraday shield.

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

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The author may be contacted at scarboro@iafrica.com



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SIMPLE BFO METAL LOCATOR

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

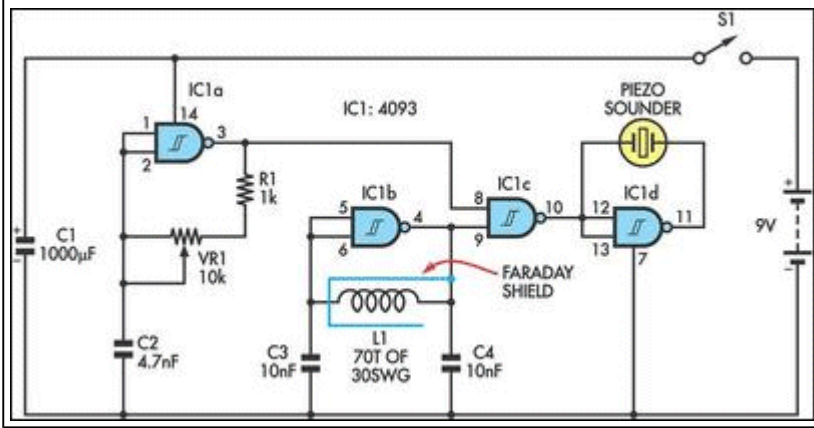
The circuit incorporates two oscillators, both operating at about 40kHz. The first, IC1a, is a standard CMOS oscillator with its frequency adjustable via VR1.

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

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

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

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



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1.5v to 5v PHONE CHARGER

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

But you will be mistaken.

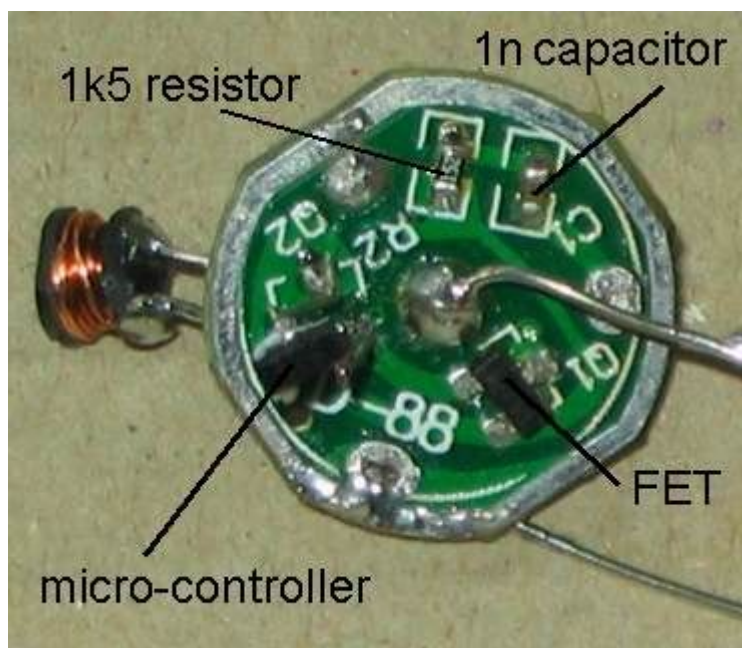
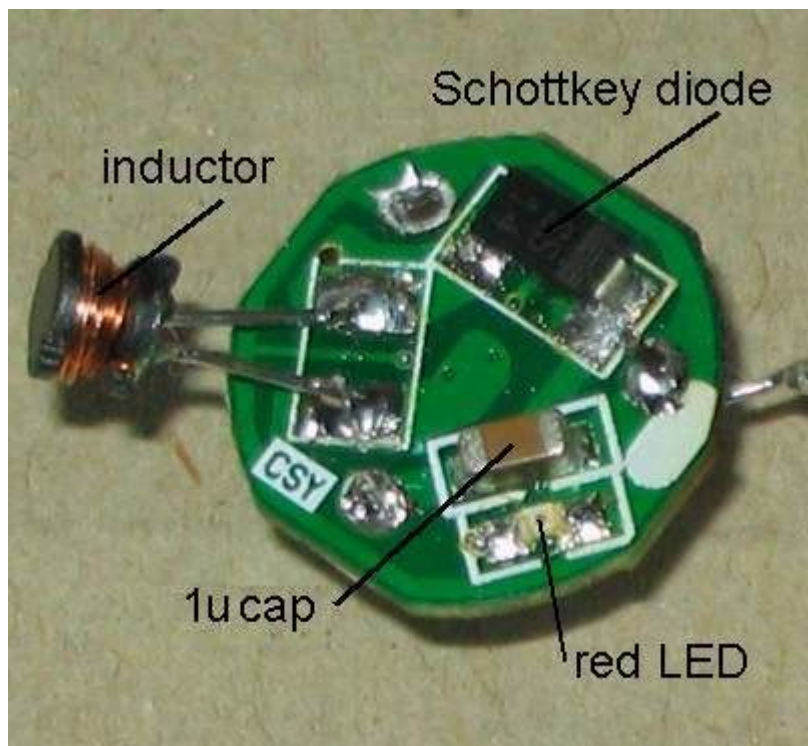
One of the "transistors" is a microcontroller and the other is a FET.

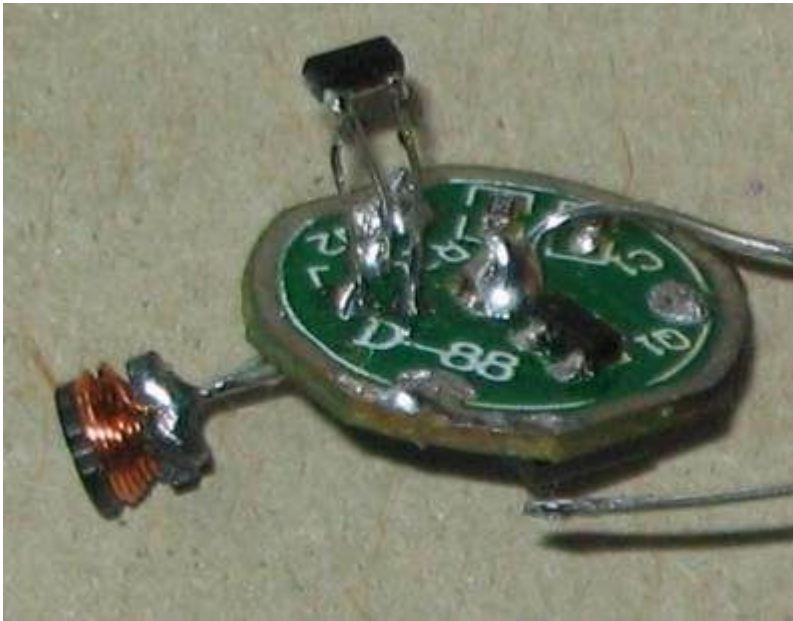
The microcontroller is powered from the output (5v) of the circuit and when it detects no-load, it shuts down to a very low level of operation.

When the 1v5 batter is connected, the micro starts up at less than 1v5 due to the Schottkey diode and charges the 1u capacitor by driving the FET and using the flyback effect of the inductor to produce a high voltage. When the output voltage is 5v, the microcontroller turns off and the only load on the 1u is the microcontroller. When the voltage drops across this capacitor, the microcontroller turns on in bursts to keep the 1u charged to exactly 5v. The charger was purchased for \$3.00 so it is cheaper to buy one and use it in your own project. It also comes with 4 adapter leads!



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

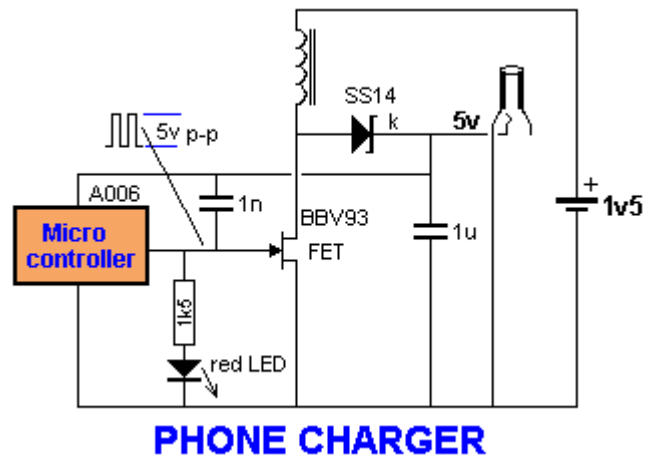




The micro has been placed on extension wires to test its operation.



The LED and 1u capacitor can be clearly seen in this photo.



Sometimes it is better to use something that is already available, rather than trying to re-invent the wheel. This is certainly the case with this project. You could not buy the components for the cost of the complete phone charger and extension leads.

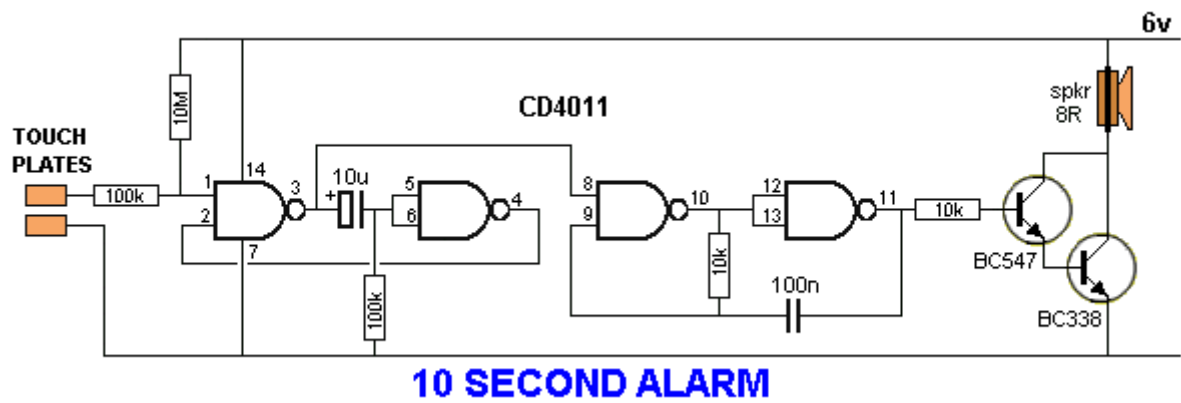
The circuit will deliver 70mA at 5v and if a higher current is drawn, the voltage drops slightly. These chargers were originally priced at \$30.00 !!

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10 SECOND ALARM

This circuit is activated for 10 seconds via the first two gates. They form a LATCH to keep the oscillator (made up of the next two gates) in operation, to drive the speaker.

The circuit consumes a few microamps in quiescent mode and the TOUCH PLATES can be any type of foil on a door knob or item that is required to be protected. The 10u sits in an uncharged condition and when the plates are touched, the voltage on pin 1 drops below 50% rail and makes pin 3 HIGH. This pulls pins 5 and 6 HIGH and makes pin 4 LOW. This keeps pin 3 HIGH, no matter if a HIGH or LOW is on pin1. This turns on the oscillator and the 10u starts to charge via the 100k resistor. After about 10 seconds, the voltage on pins 5 and 6 drops to below 50% rail voltage and pin 4 goes HIGH. If the TOUCH PLATES are not touched, pin 3 will go LOW and the oscillator will stop.



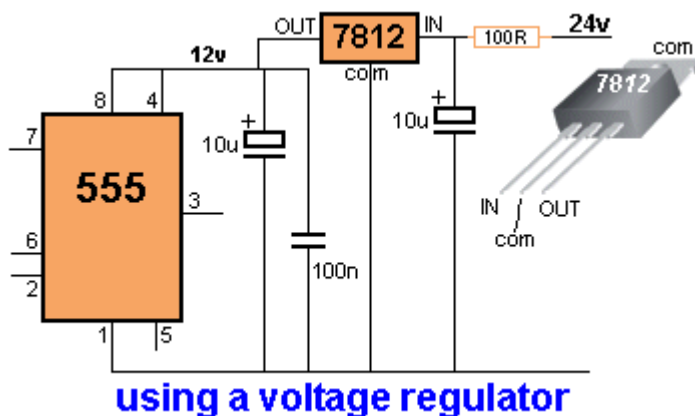
stop.

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USING A VOLTAGE REGULATOR

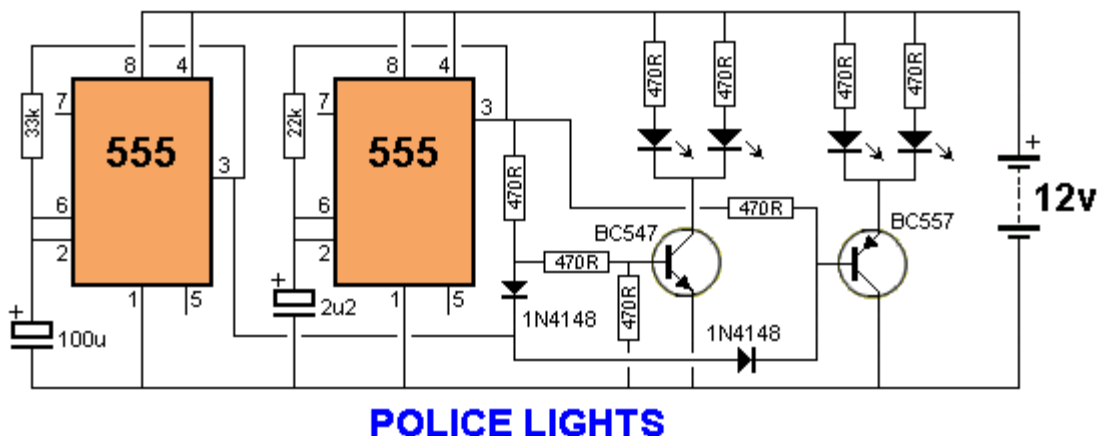
This circuit shows how to use a voltage regulator to convert a 24v supply to 12v for a 555 chip. Note: the pins on the regulator (commonly called a 3-terminal regulator) are: IN, COMMON, OUT and these must match-up with: In, Common, Out on the circuit diagram.

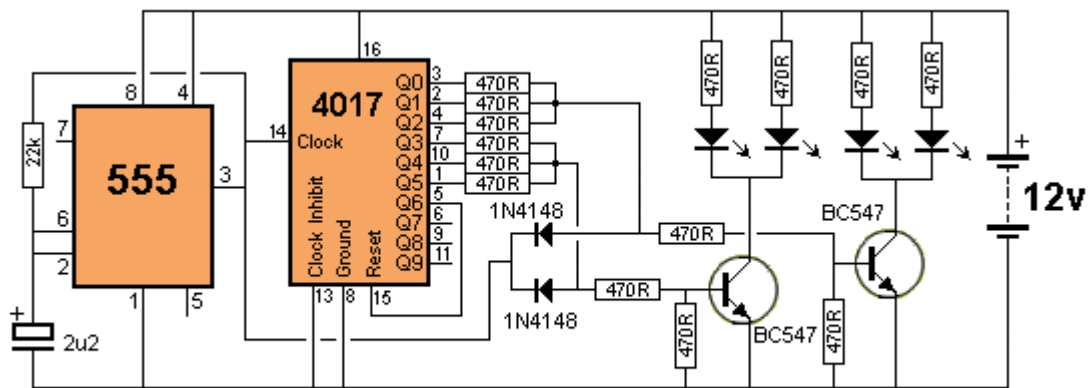
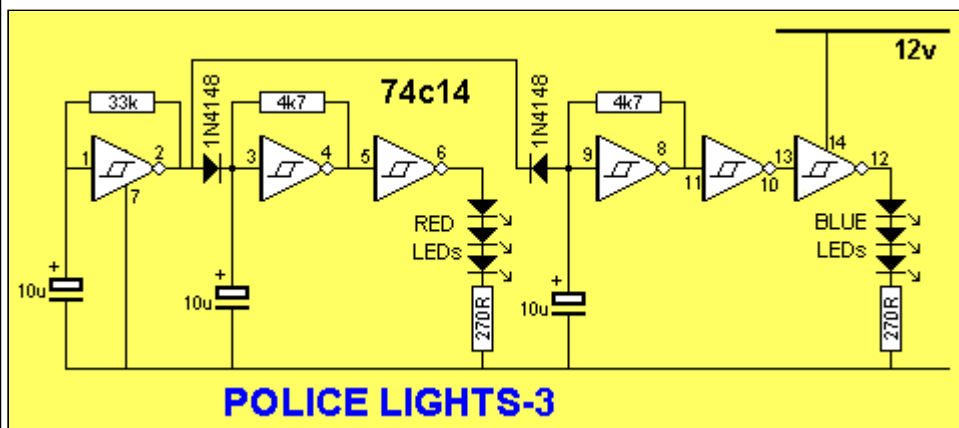
If the current requirement is less than 500mA, a 100R "safety resistor" can be placed on the 24v rail to prevent spikes damaging the regulator.

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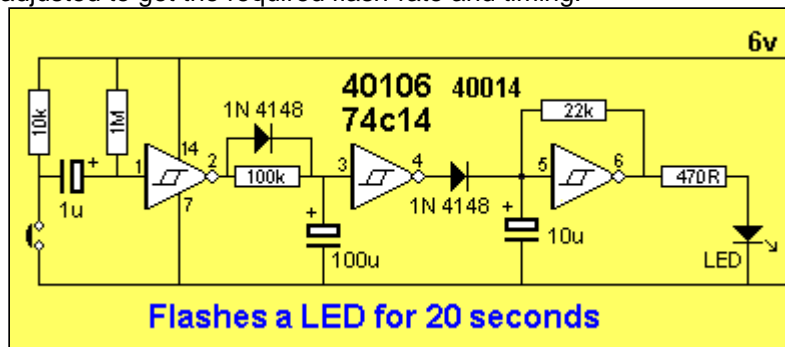
POLICE LIGHTS


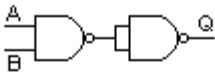

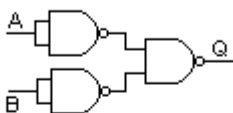
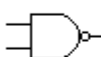
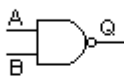

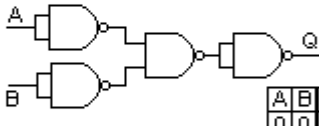
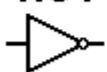
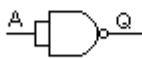

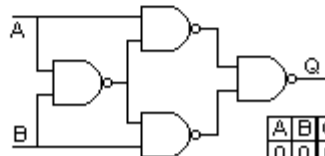
These three circuits flash the left LEDs 3 times then the right LEDs 3 times, then repeats. The only difference is the choice of chips.



**POLICE LIGHTS - 2****POLICE LIGHTS-3**[to Index](#)**FLASH LEDS FOR 20 SECONDS**

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

**Flashes a LED for 20 seconds**[to Index](#)**INTERCOM**

LOGIC GATES																	
All gates can be made from a CD4011 or equiv (quad NAND gate IC)																	
AND 		<table border="1"> <thead> <tr> <th>A</th> <th>B</th> <th>Q</th> </tr> </thead> <tbody> <tr><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>1</td><td>0</td></tr> <tr><td>1</td><td>0</td><td>0</td></tr> <tr><td>1</td><td>1</td><td>1</td></tr> </tbody> </table>	A	B	Q	0	0	0	0	1	0	1	0	0	1	1	1
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LOGIC GATES

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

LOGIC GATES

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

[to Index](#)

Circuit Symbols

The list below covers almost every symbol you will find on an electronic circuit diagram. It allows you to identify a symbol and also draw circuits. It is a handy reference and has some symbols that have never had a symbol before, such as a Flashing LED and electroluminescence panel.

Once you have identified a symbol on a diagram you will need to refer to specification sheets to identify each lead on the actual component.

The symbol does not identify the actual pins on the device. It only shows the component in the circuit and how it is wired to the other components, such as input line, output, drive lines etc. You cannot relate the shape or size of the symbol with the component you have in your hand or on the circuit-board.

Sometimes a component is drawn with each pin in the same place as on the chip etc. But this is rarely the case.

Most often there is no relationship between the position of the lines on the circuit and the pins on the component.

That's what makes reading a circuit so complex.

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















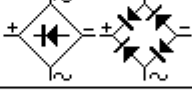










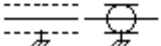







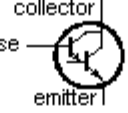







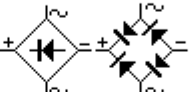





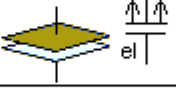







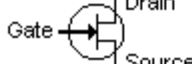


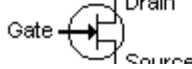


You must to refer to the manufacturer's specification sheet to identify each pin, to be sure you have identified them correctly.

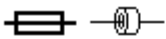
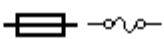
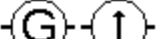

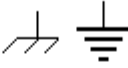

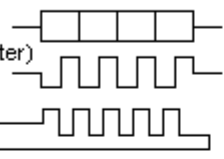
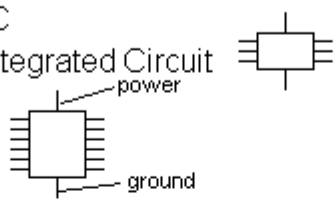





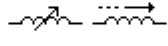
















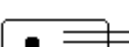
















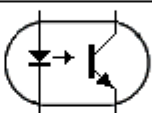
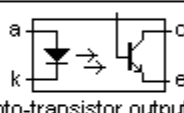
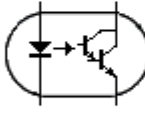
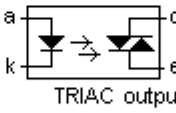










Colin Mitchell

CIRCUIT SYMBOLS

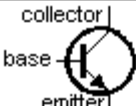






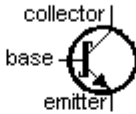
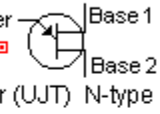
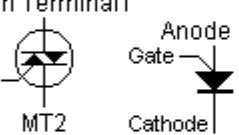
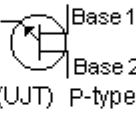

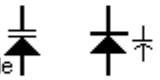
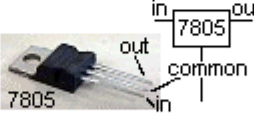




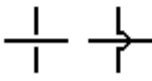



Some additional symbols have been added to the following list. See Circuit Symbols on the index of [Talking Electronics.com](http://TalkingElectronics.com).

CIRCUIT SYMBOLS by TALKING ELECTRONICS

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

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

Photovoltaic Cell (Solar Cell)		Piezo Tweeter (Piezo Speaker)		Positive Voltage Connection	
Potentiometer (variable resistor)		Programmable Unijunction Transistor PUT		Rectifier Silicon Controlled (SCR)	
Rectifier Semiconductor		Reed Switch		Relay - spst	
Relay - spdt		Relay - dpst		Relay - dpdt	
Resistor Fixed		Resistor Non Inductive		Resistor preset	
Resistor variable		Resonator 3-pin		RFC Radio Frequency Choke	
Rheostat (Variable Resistor)		Saturable Reactor		Schmitt Trigger (Inverter Gate)	
Schottky Diode (also Shottky) Low forward voltage 0.3v Fast switching also called Schottky Barrier Diode		Shielding		Shockley Diode 4-layer PNP device Remains off until forward current reaches the forward break-over voltage.	
Silicon Bilateral Switch (SBS)		Silicon Unilateral Switch (SUS)		Silicon Controlled Rectifier (SCR)	
Surface Mount		Switch - spst		Solar Cell	
		Switch - spdt		Switch - process activated normally open: normally closed:	
		Switch - dpst			
		Switch - dpdt			
		Switch - mercury tilt switch			
		Spark Gap		Speaker	
Switch - push (Push Button)		Switch - push off (used in alarms etc)		Switch - Rotary	
Test Point		Thyristors: Main Terminal1		Thermocouple	
Thermal Probe NTC: as temp rises, resistance decreases		Thyristors: Bilateral Switch		Tilt switch mercury	
		Thyristors: SCR		Touch Sensor	
Transformer Air Core		Thyristors: TRIAC		Transformer (Tapped Primary/Sec)	
		Thyristors: TRIAC			

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

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IC PINOUTS

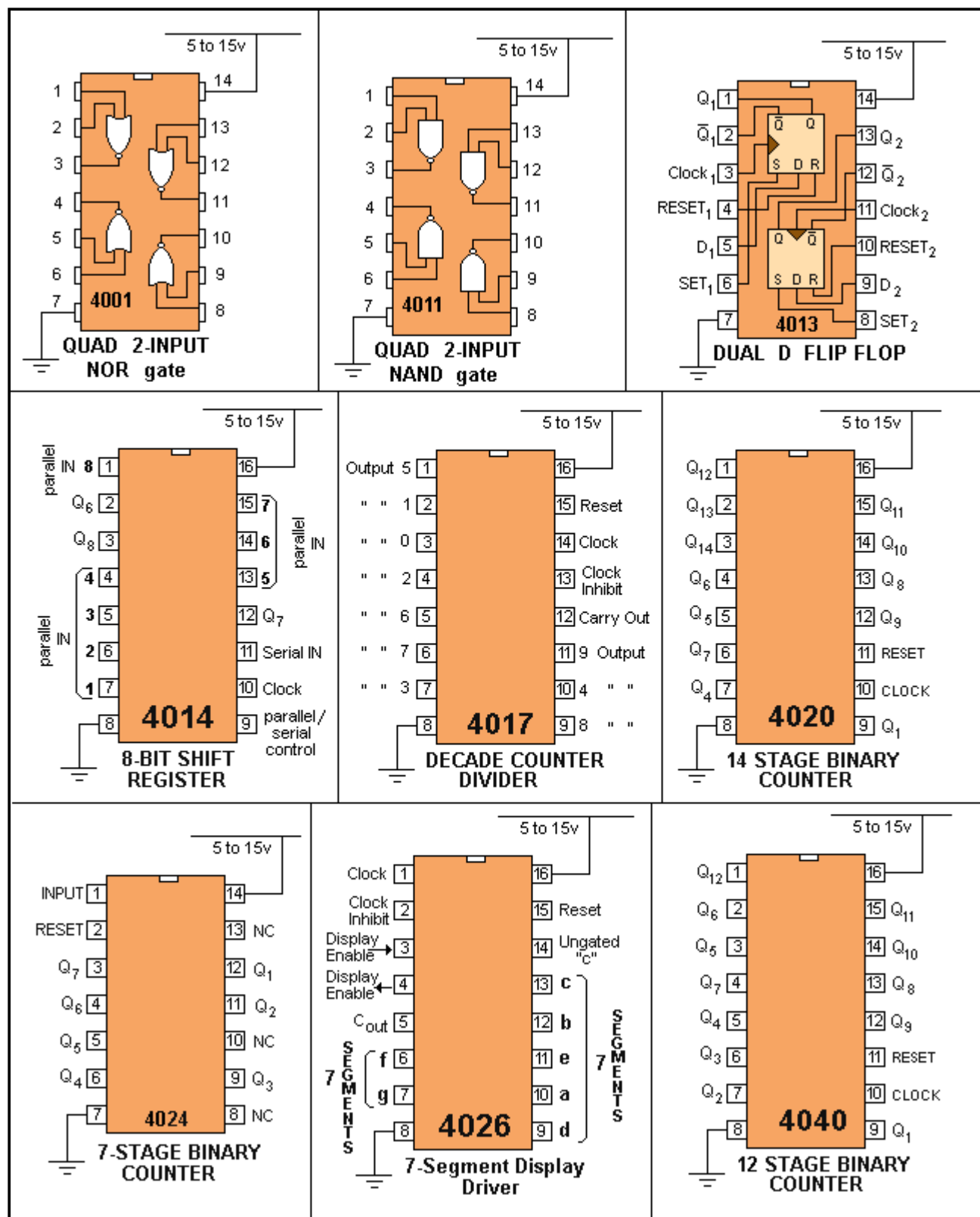
The following list covers just a few of the IC's on the market and these are the "simple" or "basic" or "digital" IC's suitable for experimenting.

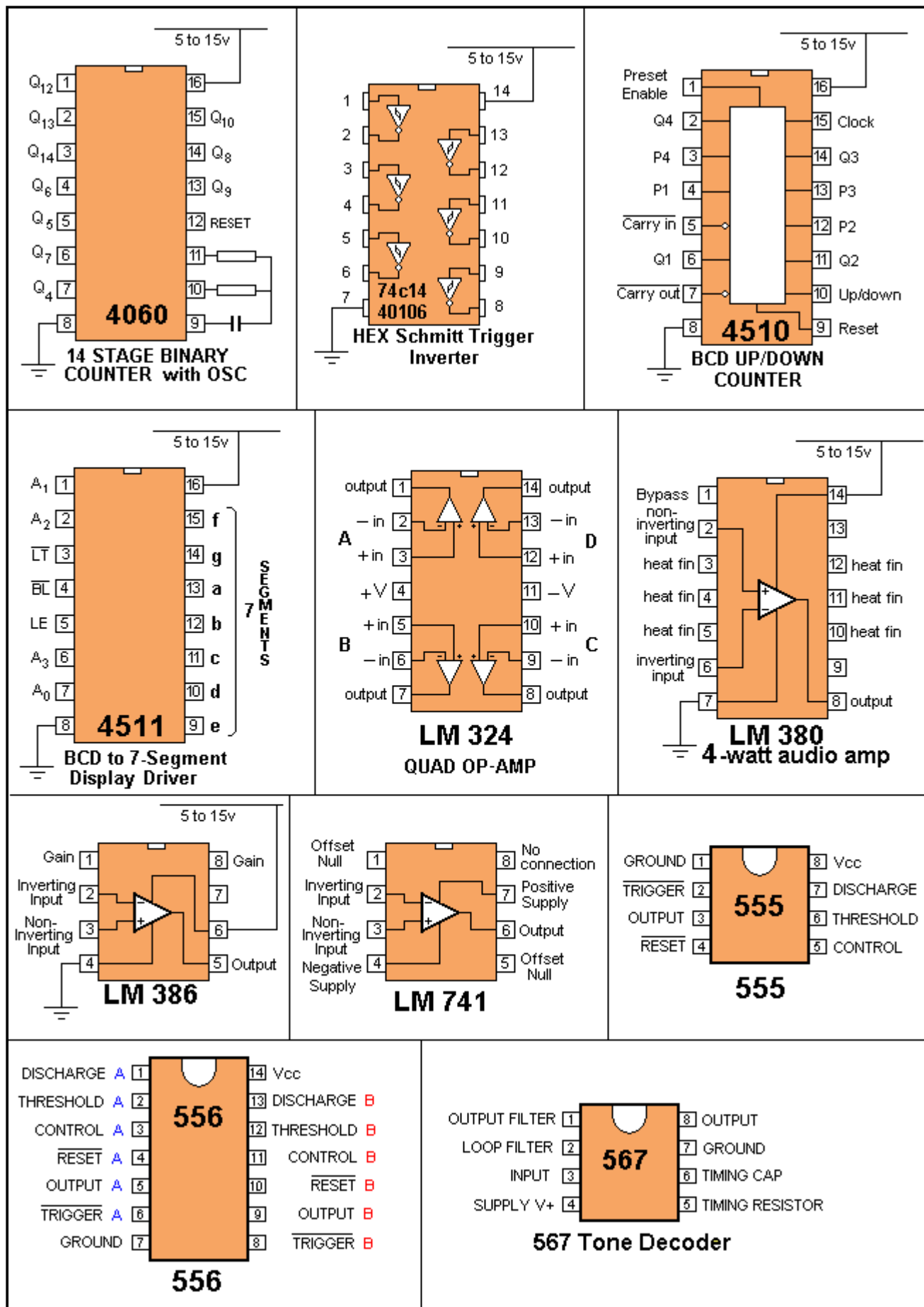
When designing a circuit around an IC, you have to remember two things:

1. Is the IC still available? and
2. Can the circuit be designed around a microcontroller?

Sometimes a circuit using say 3 or 4 IC's can be re-designed around an 8-pin or 16-pin microcontroller and it can be kept from prying eyes due to a feature called "code protection." A microcontroller project is more up to date, cheaper and can be re-programmed to alter the features.

This will be covered in the next eBook. It is worth remembering - as it is the way of the future.






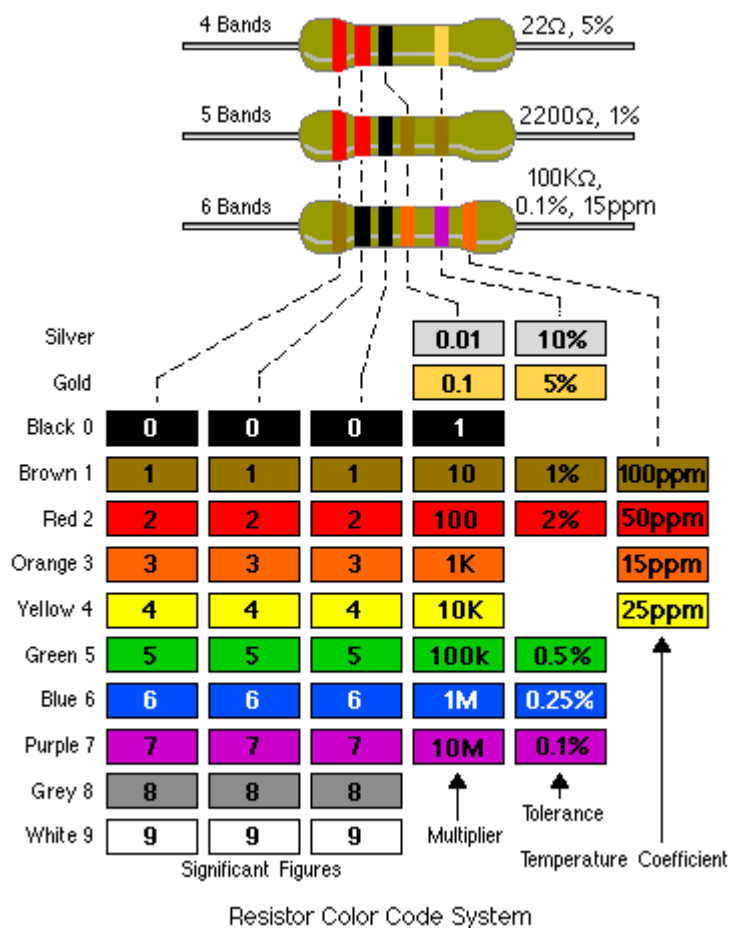
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All the resistor colours:

This is called the "normal" or "3 colour-band" (5%) range. If you want the 4 colour-band (1%) series, refer to

Talking Electronics website and click: **Resistors 1%** on the left index. Or you can use the table below.

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



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MAKE ANY RESISTOR VALUE:

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

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

Use 2 resistors in series or parallel as shown:

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

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

4R7 = 4.7 ohms

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MAKE ANY CAPACITOR VALUE:

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

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

Use 2 capacitors in series or parallel as shown:

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

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