Systems: Electronics

Resistors & Capacitors

Units for resistors and capacitors

size/component	**small**		**large**
resistance	ohm	kilohm	megaohm
capacitance	picoFarad	microfarad	farad
current	milliAmpere	Ampere	

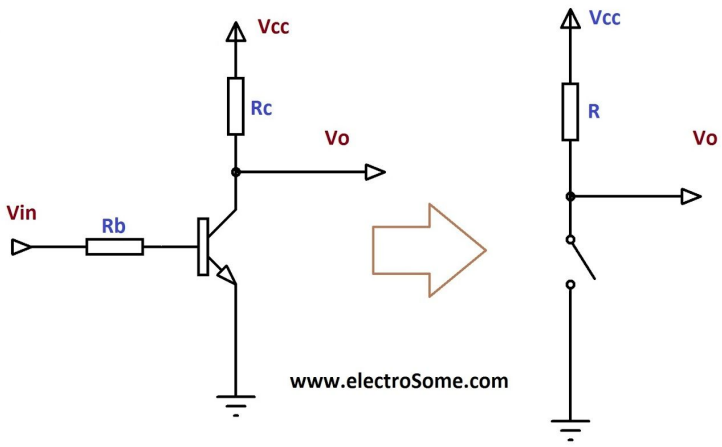
Ammeters are used to measure the current, voltmeters for voltage, and multimeter for resistance of something.

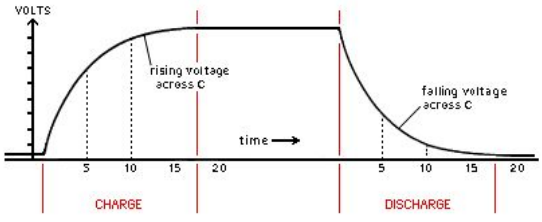
Diodes are used to direct the flow in current in one direction, and protect components from back EMF (electromotive force).

Transistors

A transistor is a semiconductor device that is used to amplify the electrical signal or act as a switch. It has three main parts, the base (going into component), collector (flat part) and emitter (arrow pointing outwards).

Transistor switch is when a transistor is attached to two resistors and connected to the rest of the circuit. The two resistors are necessary to avoid damaging the component. The emitter of the transistor needs to be connected to ground, or 0v. The base and the collector are both connected to resistors in series.





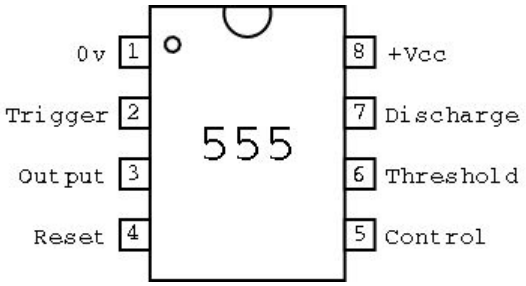
Capacitors

Capacitors are components which hold electrical charge, which is measured using farads. There are two main types of capacitors: electrolytic and ceramic. Electrolytic capacitors

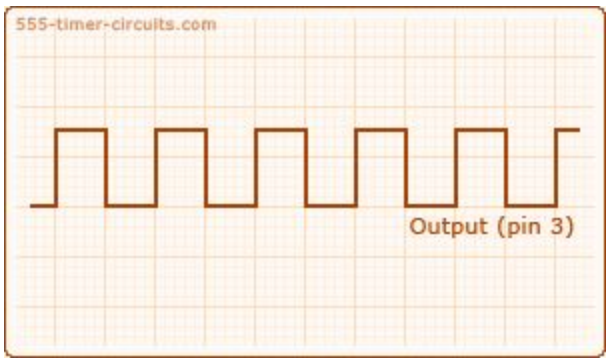
have polarity, and need to be connected the correct way, whereas ceramic capacitors do not need to (+ve, -ve). Another difference between the two types is that ceramic capacitors tend to hold less charge than electrolytic capacitors. The graph on the left shows how capacitors are charged and discharged over a specified length of time.

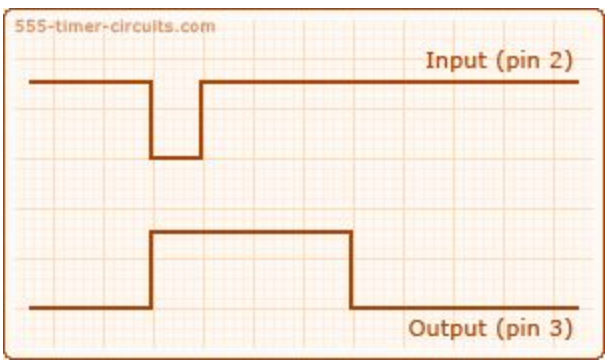
Delay

The 555 chip can be placed in a timing circuit, and is an IC which is mostly used for time delays. The 555 consists of over 40 different components, all miniaturized into one IC for simple use. It has 8 pins, which can be attached to either a monostable or astable circuit. Break down of pins:



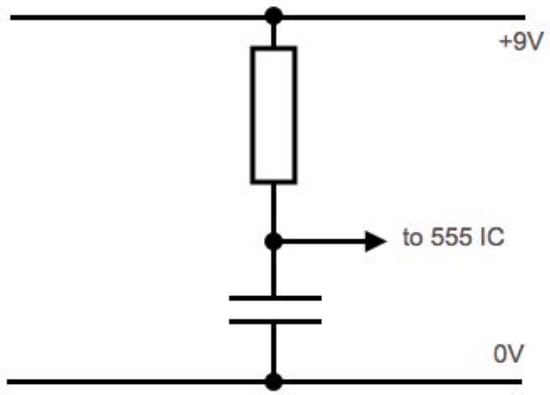
1) **0v** or ground - connects to the black wire of the power supply
2) **Trigger** - this is what causes the 555 to start working. The 555's pin 2 is an *active low trigger* meaning that there needs to be at least 1/3 of the vcc entering the pin in order to activate the chip.
3) Pin 3 is the pulsating **output**. When the 555 is triggered on pin 2, the output (pin 3) goes high. The output differs when it is on astable and monostable (bistable - schmidt's trigger) The diagram on the bottom shows the output for astable, and right for monostable.
4) **Reset** - when it is less than the *active low*, this pin makes the output low (0v), overriding the other inputs. Pin 4 restarts the 555's timing operation and is connected to the supply voltage.
5) Pin 5 is known as the **control** pin, and is in this case connected to to ground.
6) **Threshold** monitors the charging of the timing capacitor, and when is *active high (greater than 2/3 vcc)* makes the output low (0v). It stops the timing when active when it is at active high.
7) Pin 7 is **discharge** pin and is used to discharge the timing capacitor , and is connected to 0v (ground) when timer output (pin 3) is low. It is used to discharge the capacitor which works together with a resistor to control time delay (TD = 1.1 x R2 x C1).
8) **Vcc** - is connected to the positive supply voltage. The supply voltage can be anywhere from 4.5v to 15v, and most commonly 9v through 6 of the 1.5 volt batteries.



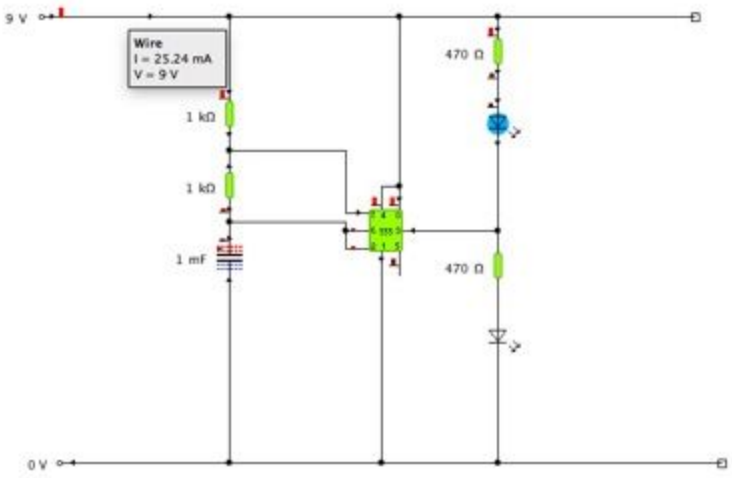


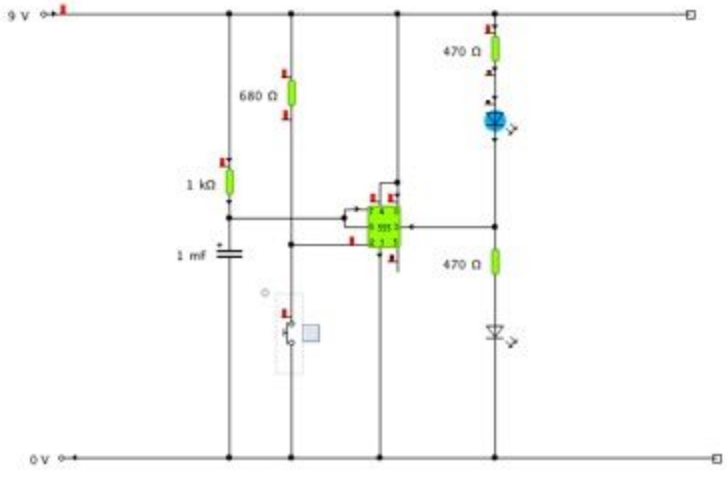
What is the difference between **Monostable** & **Astable**? An astable, pulsing or free running circuit produces pulses when it is turned on (multivibrator, the output goes off, on, off, on, etc). This is powered by the power supply, which means that no switch is required for the circuit to work. In a monostable circuit (or timer circuit), a time delay is produced when it is operated, and once the switch is activated, the pulse goes through the chip and the pulse lasts for a certain time delay until the pulse finishes, and the chip is deactivated. To restart the whole process, the input needs to be activated (e.g. a switch). **THE CHIP MEASURES THE TIME IT TAKES FOR THE CAPACITOR TO CHARGE.**

For example, a 555 chip is being used in a circuit that turns a green LED on for a specified time. The input would be the PTM switch, the process is the 555, and the output is the LED which would light up. In order to calculate the amount of time that the LED would be lit up for, we use the time delay formula which is: TD (seconds) = 1.1 x C1(farads) x R2 (ohms). Note that to find the time period, each of the values have to be in their original form, and **not** microfarads or kilohms. The two components that are set the value of the time period are the resistor and the capacitor, which need to be connected in series as shown on the picture on the right.



An example of a **astable** circuit vs. a **monostable** circuit.

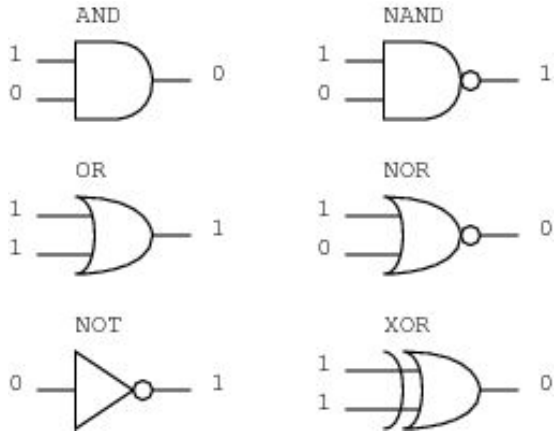




Logic Gates

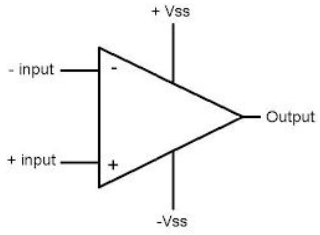
Examples of logic control systems: heating control, traffic lights, environmental control in a greenhouse, etc.

INPUTS		Truth Table Outputs					
A	B	AND	NAND	OR	NOR	EX-OR	EX-NOR
0	0	0	1	0	1	0	1
0	1	0	1	1	0	1	0
1	0	0	1	1	0	1	0
1	1	1	0	1	0	0	1



Op Amps

Operational amplifiers are used to compare voltages



CMOS

- The 4026 is old, and unstable when with static electricity, which is why the pins should never be allowed to be floating, or not connected to anything
- Any unnecessary pins must be connected to ground
- low power consumption, and supply voltages from 3v to 15v

Switches

(toggle, push button (PTM/PTB), micro, rotary and reed, membrane switch,tilt switch)

Membrane Switch

- Be able to draw the following diagram:

Opto-isolator

- Used as an alternative to relay
- It activated by sensing infrared
- Consists of an infrared emitting diode and a phototransistor to receive it