ROBOTICS FOR BEGINNER
Based On Digital & Analog Electronics

Steps to learn Robotics

1. In robot you need an electronic circuit, mechanical components such as wheels, motor and other toys stuff. In this book every requirement will be explained step by step

2. First of all in order to learn to make circuit, you should need to know about every electronic component, their specification, company make, their size, rating and all parameter should be at you tips.

You have to be able to recognize each and every electronic components and its detail. The company which makes an electronic component, they also provide its **datasheet** and **application note.** Every component has datasheet or manual. Datasheet are best source to get information about electronics components.

3. Now after getting information about each component, next step is how to use different components to make a circuit.

4. First of all use breadboards to make circuit, then after competing circuit on **breadboard, make** the same circuit on **general purpose PCB.**

5. Further tips to make robots are given step by step in following chapters

6. This is a complete application book giving application circuits of most of the electronic components that are available in the market near your place and tells about your common errors in connections of a circuit.

In this book, main aim is to make the students aware about applications of the basic electronics concepts without any involvement of microcontrollers. This book would be a first step towards robotics for the beginners.

PART- I: Electronic Components and Sensors knowledge

BREADBOARD: Breadboard is used to make circuits. But mostly after testing your circuits on breadboard you will be making PCB. Normally everyone says that if you connect on breadboard then wires may get loose and circuit will get disturbed due to shock. But no such problem occurred if you a good wiring. Then you can gain time for making PCB's.

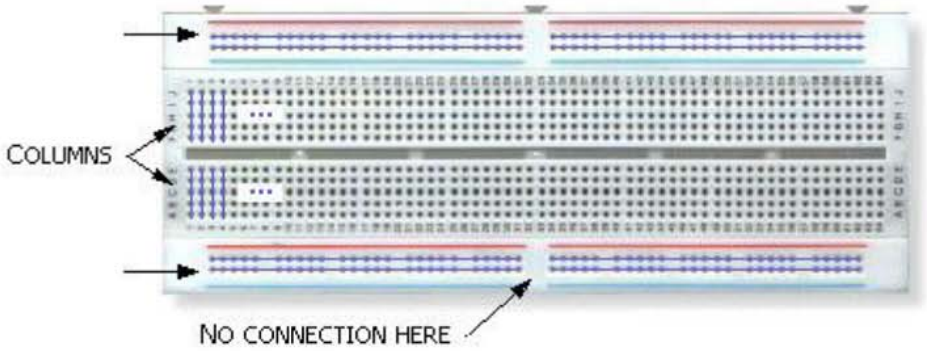
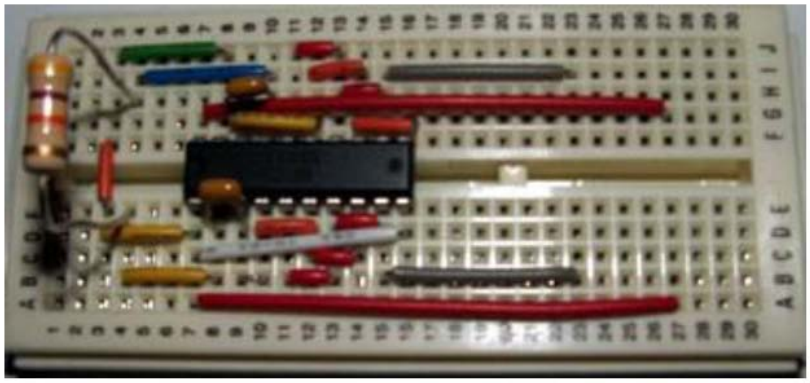
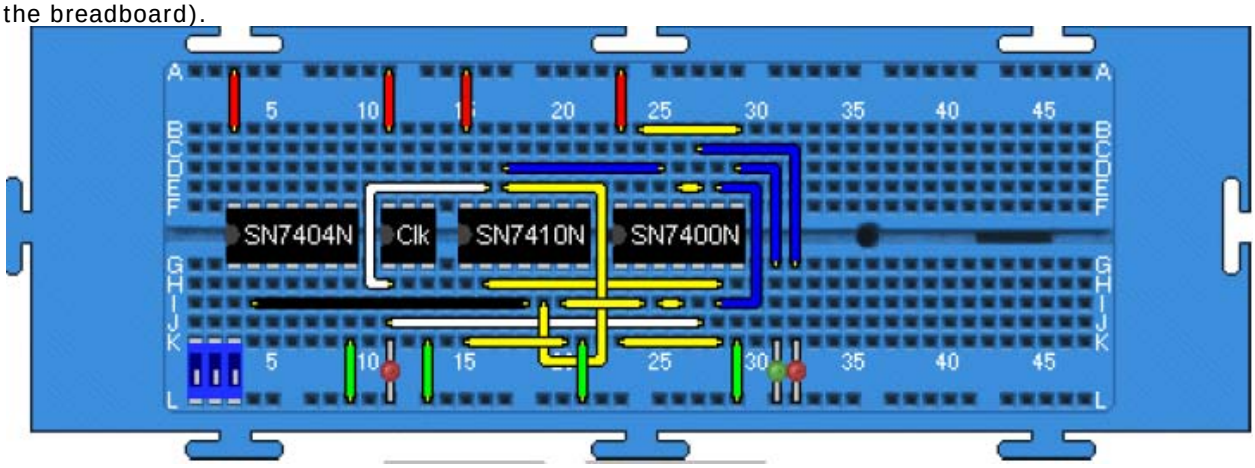


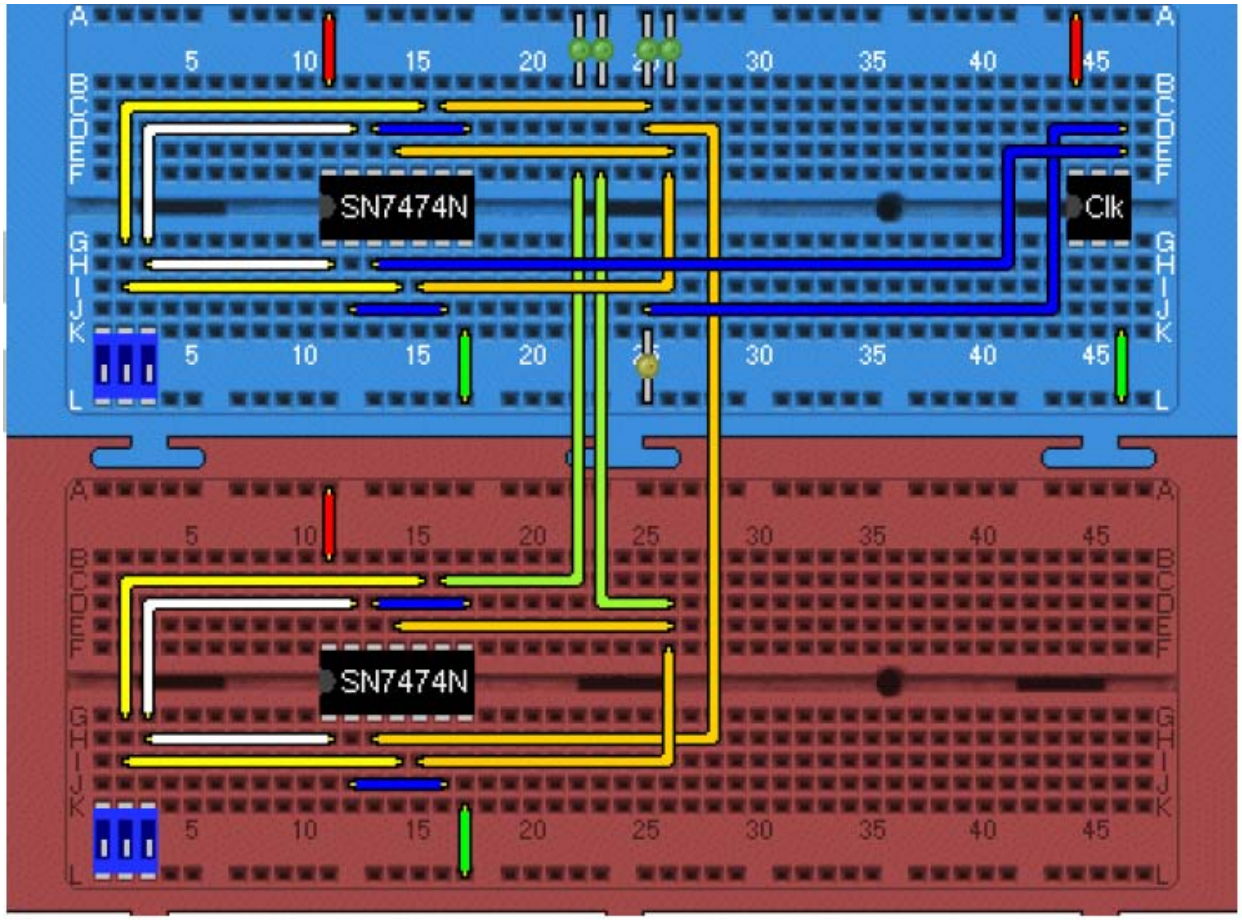
Figure 1: How the holes in a breadboard are connected electrically

Above diagram shows how breadboard connections should be made. So all you require is to do a good wiring. The breadboard is different mainly according to the size of their holes. The breadboard in Figure.1 has the smallest whole size. The main problem with small holes is that, it will be tough to insert IC's like 7805 power transistors so on. Even there is problem with size of wires also.
Following figures show good wiring practices you should follow so that your circuit won't be disturbed by any shocks.



In this you can see that the length of the wires used is of exact length between two points. If you do this type of wirings then no problems occur. But in this you can see that resistor is not properly inserted, for this you should cut the leads of the resistor so that its body is just touching (or touching the breadboard).





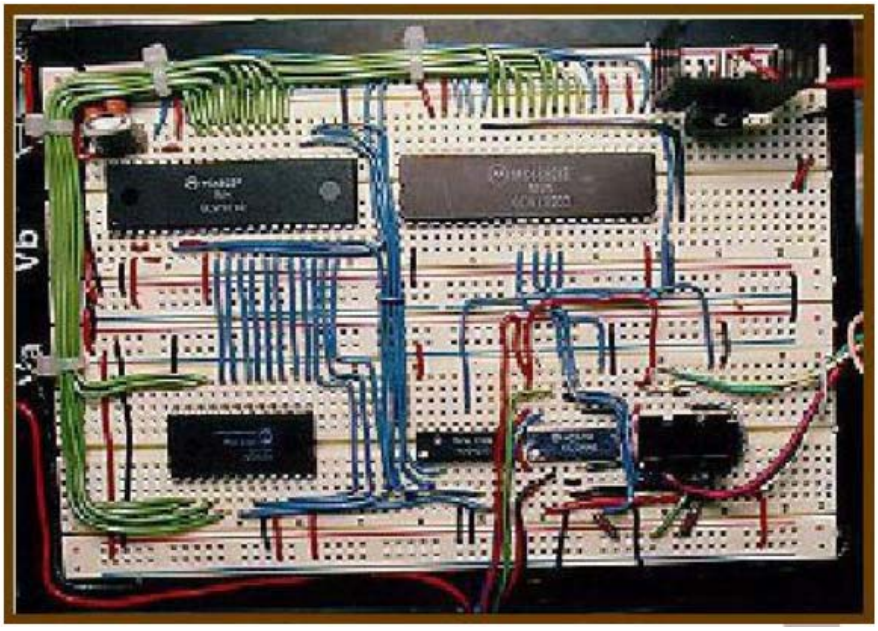


Fig: Good Connection

Above figures shows how to make good connections. In last one you can see how they made connections so that no problems will occur. Below you can see what connections you should not have to do.

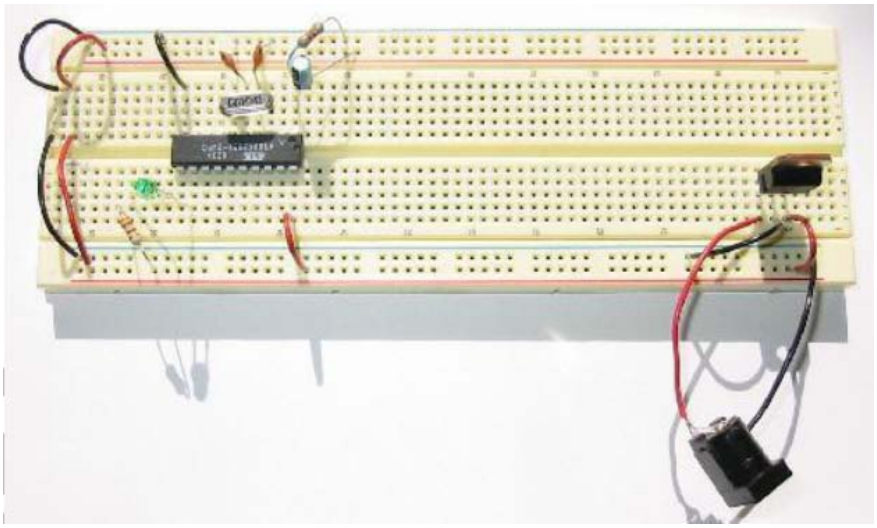


Fig: Poor Connection

After testing your circuit you have to make it on PCB boards. Mostly PCB I saw in industries is of three types of material

1. Paper phenolic (Low cost , mostly used)
2. Paper Expoxy
3. Epoxy glass (High Cost , high quality)

MULTIMETER

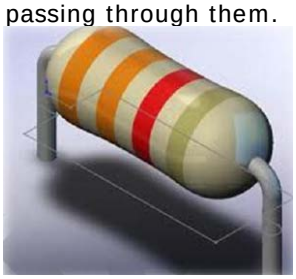
Multimeter is used to measure different parameters like voltage, current, resistance etc. In robotics you should use a multimeter which is capable of measuring voltage, résistance, continuity test, transistor (hfe). Cost of a multimeter depends on the number of quantities it can measure; even some multimeter's can test whether a diode is of Ge or Si. But we don't want that much costly multimeter.

Suppose if you want to measure output voltage of an adapter, see what is the maximum voltage of adapter (mostly around 15V). Then put the needle to 20V (a voltage greater than 15V). A display of **'1'** on multimeter means that it is not able measure the quantity in that position of the needle. Suppose if you want to measure a resistance and you put the needle to the 20Kohm, then if multimeter shows **'1'** then put the needle to 200Kohm, because the resistance is greater than 20Kohm. Same with all the measurements like voltage, current etc. **When you are buying a multimeter you must see that multimeter should be able to do continuity test (it is the most important one)**, voltage measurement and resistance measurement. These three are the important quantities you measure in robotics. If you want to study more about multimeter see the following links

http://en.wikipedia.org/wiki/Multimeter
http://www.doctronics.co.uk/meter.html

RESISTOR

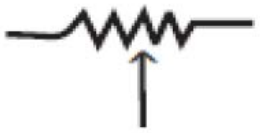
Resistors offers a resistance to the flow of current And act as voltage droppers or voltage dividers. They are "Passive Devices", that is they contain no source of power or amplification but only attenuates or reduce the voltage signal passing through them.



We mostly use resistance in this range even though more power rating high value resistors are available **(power up to 600 watt and resistor value up to 1 giga ohm).** So when you select a resistor its value and power rating should be the deciding parameter. Therefore for high current operations we use resistance of higher current ratings. The size of the resistor determines its power rating (i.e. as size/thickness increases power/current carrying capacity of resistance increases) **Types of resistors** Mainly they are of two types

a. Fixed resistors

b. Variable resistors



Potientiometer

Variable Resistance

Fixed Resistance

Basic Parameters of Resistance

1 .Value (measured in ohms)
2. Power rating (in watt)
3. Resistance Tolerance (e.g. ±1%,±2%,±5%,±10%,±15% etc.)
4. Dimensions L*B*H (used in bussed type resistors)
5. Maximum operating voltage (in volts)
6. Operating temperature (in ± degree centigrade)
7. Temperature coefficient (in ppm/°c)
8. Body diameter in mm (used in axial type resistors)
9. Lead length and diameter (used in axial type resistor)
10. Insulating resistance (≤ 1000MΩ)
11. Lead pitch (in mm)
12. Dielectric strength (in volts)

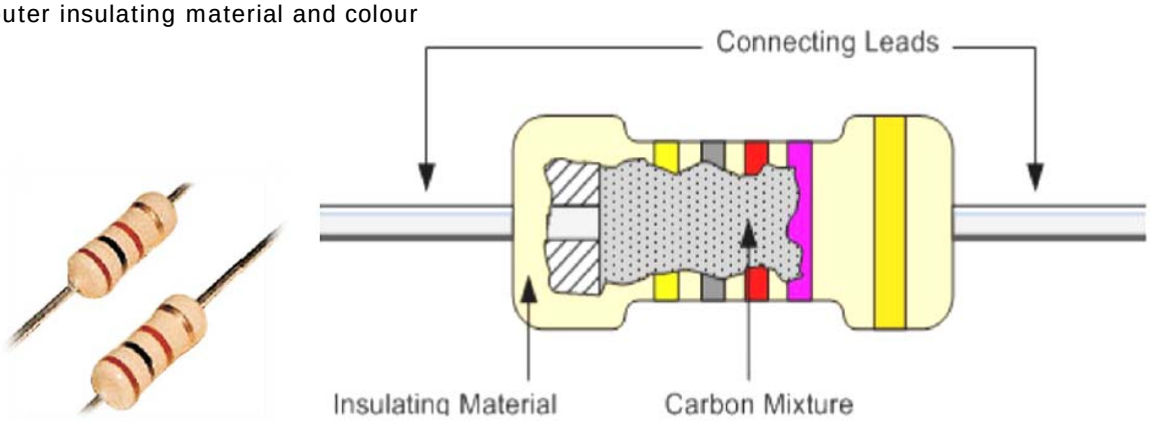
These are the main parameters of the resistor which that specify a particular type resistor.

Types of resistors according to their composition

1. Carbon resistor
2. Metal film resistor
3. Wire wound
4. Semiconductor resistance

1. Carbon Resistors

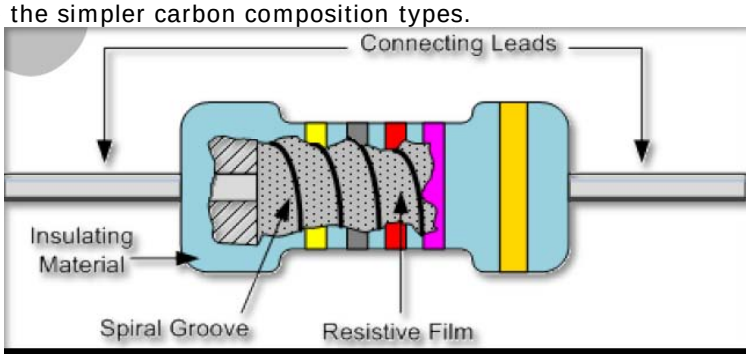
Resistors are the most common type of Composition Resistors as they are a cheap general purpose resistor. Their resistive element is manufactured from a mixture of finely ground carbon dust or graphite (similar to pencil lead) and a non-conducting ceramic (clay) powder to bind it all together. The ratio of carbon to ceramic determines the overall resistive value of the mixture and the higher this ratio is the lower the resistance. The mixture is then moulded into a cylindrical shape and metal wires or leads are attached to each end to provide the electrical connection before being coated with an outer insulating material and colour



Carbon Composite Resistors are low to medium power resistors with low inductance which makes them ideal for high frequency applications but they can also suffer from noise and stability when hot. Carbon composite resistors are prefixed with a "CR" notation (e.g. CR10kΩ) and are available in E6 (±20% tolerance (accuracy)), E12 (±10% tolerance) and E24 (±5% & ±2% tolerance) packages with power ratings from 0.125 or 1/4 Watt up to 2 Watts.

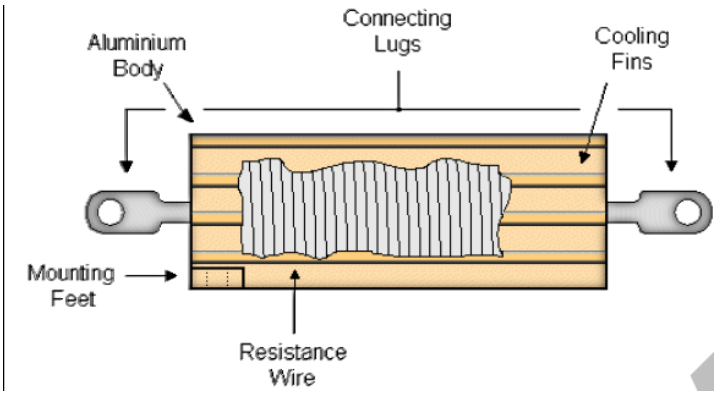
2. Metal Film Resistors

The generic term "**Film Resistor**" consist of *Metal Film*, *Carbon Film* and *Metal Oxide Film* resistor types, which are generally made by depositing pure metals, such as nickel, or an oxide film, such as tin-oxide, onto an insulating ceramic rod or substrate. The resistive value of the resistor is controlled by increasing the desired thickness of the film and then by laser cutting a spiral helix groove type pattern into this film. This method of manufacture allows for much closer tolerance resistors (1% or less) as compared to the simpler carbon composition types.



3. Wire wound Resistors

Wire wound resistor types are prefixed with a "WH" or "W" notation (eg WH10Ω) and are available in the WH Aluminum Cladded package (±1%, ±2%, ±5% & ±10% tolerance) or the W Vitreous Enameled package (±1%, ±2% & ±5% tolerance) with power ratings from 1W to 300W or more.



4. Semiconductor Resistors –
High frequency/precision surface mount thin film technology. It is the only resistor which is active remaining all is passive.

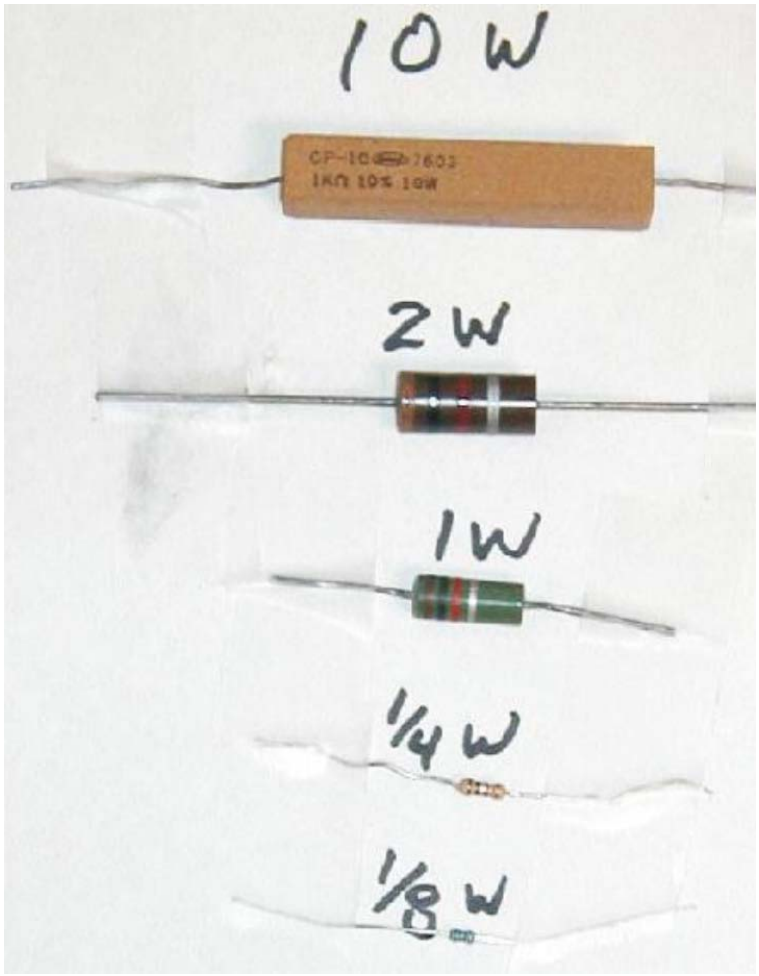
5. Varistors
Small size Varistors voltage: 82V Rated peak single pulse transient current: 800A Maximum clamping voltage at 5A: 145V.

Applications: Transistor, IC, thyristor, or triad semiconductor protection Surge protection in consumer electronics Surge protection in industrial electronics Electrostatic discharge and noise suppression Relay and electromagnetic value surge absorption Surge protection in communication, measuring, or controller electronics.

(a) (b) (c)

Fig: a) SIP/ DIL Resistance, b) Shunt Resistance c) Wire wound Resistance

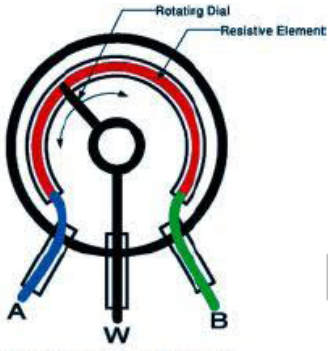
SIZE INCRESEAS POWER INCREASES



According to above diagram we can conclude that , size of resistance define its power rating Where higher current rating are required , large size resistance is used.

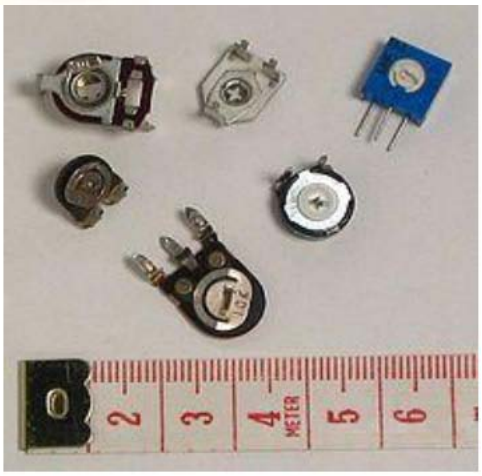
A **POTENTIOMETER** (colloquially known as a "**pot**") is a three-terminal resistor with a sliding contact that forms an adjustable divider. If only two terminals are used (one side and the wiper), it acts as a ***variable resistor*** or ***rheostat***. Potentiometers are commonly used to control electrical devices such as volume controls on audio equipment. Potentiometers operated by a mechanism can be used as position transducers, for example, in a joystick.

Potentiometers are rarely used to directly control significant power (more than a watt), since the power dissipated in the potentiometer would be comparable to the power in the controlled load (see infinite switch). Instead they are used to adjust the level of analog signals (e.g. volume controls on audio equipment), and as control inputs for electronic circuits. For example, a light dimmer uses a potentiometer to control the switching of a TRIAC and so indirectly control the brightness of lamps.



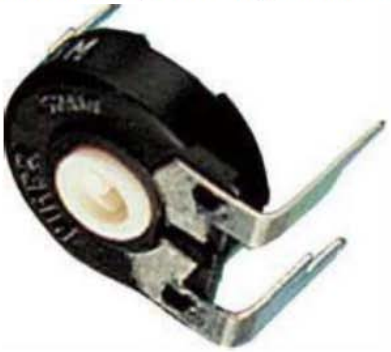
Connection Leads

Linear potentiometers ("faders")



PCB mount trimmer potentiometers, or "trimpots", intended for infer quent adjustment.

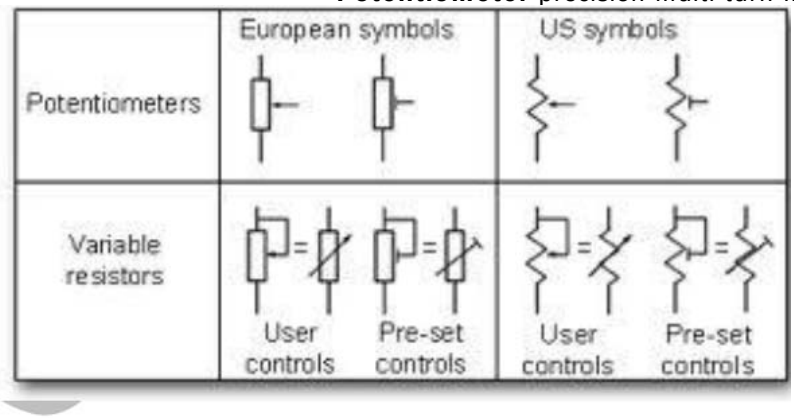
Ten Turn **Potentiometer**, Knob



Carbon **Potentiometer**

Square trimming **potentiometer**

Potentiometer precision multi turn metal shaft



Electronics Symbols

Potentiometer is mostly used as voltage divider.

CAPACITOR

A capacitor is used to store charge. Like resistors there is fixed as well as variable capacitor also. But we mostly use fixed capacitor in robotics; variable capacitors are mainly used in analog communication. There are capacitors with no polarity and polarity. Ceramic and Mica capacitors available are of no-polarity, but electrolytic capacitors are of polarity. There is a variation in their symbols also.

Mica capacitor Ceramic Capacitor Electrolytic Capacitor

In the above figure we can see that the different symbols for capacitors. Mica and ceramic capacitor don't have polarity while electrolytic have polarity, so one lead of electrolytic capacitor is bend (-ve lead). We can identify negative lead of electrolytic capacitor by checking the length of the lead, one with less length is -ve. On the body of electrolytic capacitor -ve symbol is shown. Be careful about

Electrolytic capacitor because inverting polarity can make **explosion**' (not firing) of capacitor (sometimes it can hurt your body).

Basic Parameters of Capacitor :

1. Capacitance
2. Tolerance
3. Operating Temperature
4. Dimensions
5. Leakage current
6. Its terminals
7. Factors for classification of capacitor are Its capacitance and voltage.

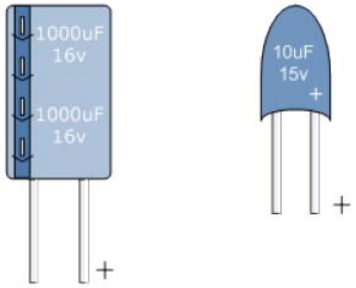
TYPES OF CAPACITORS:

1. **Electrolytic Capacitor**

Electrolytic Capacitors are generally used when very large capacitance values are required. Here instead of using a very thin metallic film layer for one of the electrodes, a semi-liquid electrolyte solution in the form of a jelly or paste is used which serves as the second electrode (usually the cathode). The dielectric is a very thin layer of oxide which is grown electro-chemically in production with the thickness of the film being less than ten microns. This insulating layer is so thin that it is possible to make capacitors with a large value of capacitance for a small physical size as the distance between the plates, d is very small.

Fig: Typical Electrolytic Capacitor

Electrolytic Capacitors are generally used in DC power supply circuits due to their large capacitances and small size to help reduce the ripple voltage or for coupling and decoupling applications. One main disadvantage of electrolytic capacitors is their relatively low voltage rating and due to the polarization of electrolytic capacitors, it follows then that they must not be used on AC supplies. **Electrolytic's generally come in two basic forms**; **Aluminum Electrolytic Capacitors and Tantalum Electrolytic Capacitors**. Tantalum capacitor takes lesser space as compared to electrolytic capacitor but cost more.



2. **Ceramic capacitor:**

Typical values of capacitance for an aluminum electrolytic capacitor range from 1uF up to 47,000uF and for a tantalum capacitor range from 47nF to 470uF. **Mica Capacitors** These are available in the values of typically less than 0.1uF capacitance. They are extremely shock resistant, include a high dV/dt rating, and maintain their capacitance over a very wide temperature range. Because of these desirable characteristics, mica capacitors can be used in high-power, high-current RF broadcast transmitters, defense electronics (jet aircraft, missiles, etc.), and also in power conversion circuits for low-capacitance snubber applications. These capacitors are found in radio/TV transmitters, cable TV amplifiers, avionics, and high-voltage inverter circuits. Specific characteristics that should be considered when choosing the appropriate **mica capacitor** include rated voltage (VDC), Peak RMS

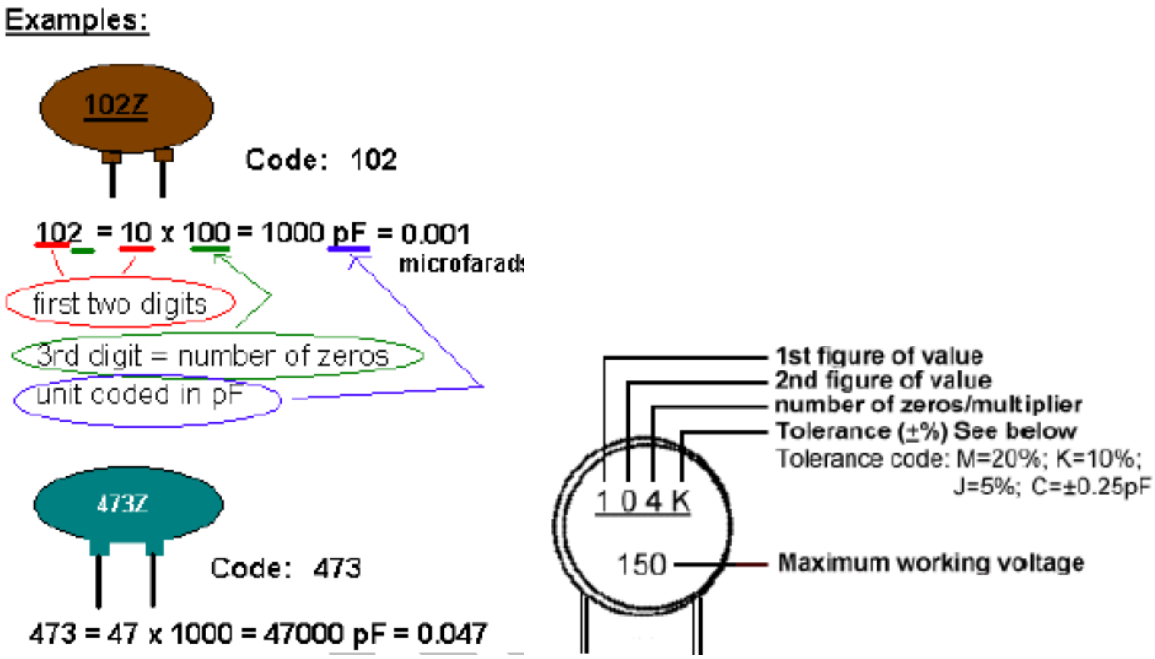
Voltage (Vrms), and Case/Package Type. **Note: - there is a formula to calculate the value of the ceramic capacitor which is shown in the following figure.**

(a) (b) (c) (d) (e)

Fig: a) Multilayer Ceramic Capacitor b) Ceramic Capacitor c) Disc Ceramic Capacitor d) RF ceramic Capacitor e) Super High voltage Ceramic Capacitor.

How to find values of capacitance???

Every capacitor has two factors - value of its capacitance and other the maximum voltage rating. For an electrolytic capacitor, this is not

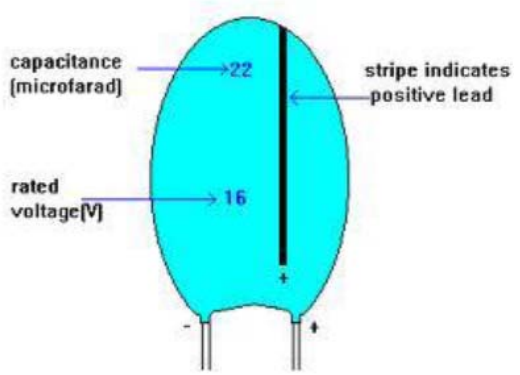


Important Things about Capacitor:

Capacitances vary from 22pF to about 15000uF. Values <.1uF are mainly mica and ceramic capacitors and C>=1uF are electrolytic capacitors. See the maximum voltage ratings of capacitor when you select electrolytic capacitors. Electrolytic capacitor 'explodes' when you invert polarity of capacitor and applying voltage about maximum rated voltage. When you see circuit, be careful about the symbols of capacitor used to choose which one you require (Electrolytic or ceramic).

3. **Tantalum capacitor:-**

These are also the like electrolytic capacitor but they are highly reliable. Its surface is mounted with tantalum. These type have low leakage and great capacitance.



Internal structure of Tantalum capacitor

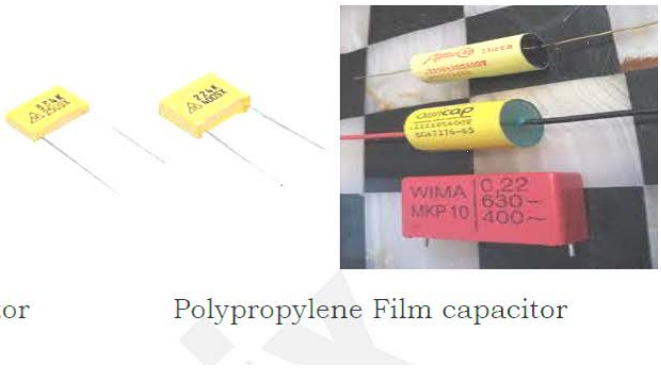
Trimmer Capacitor:

(a) (b) (c)

Fig: a) Ceramic Trimmer Capacitor b) Trimmer Capacitor c) Trimmer cap. or Variable cap.

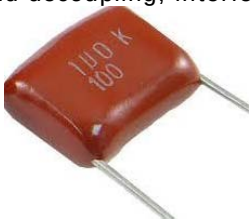
5. **Polypropylene:-** Ideal for use in power semiconductor circuits to suppress or attenuate undesired voltages peak.

Polypropylene radial capacitor
(High Voltage)



Polypropylene Film capacitor

6. **Polyester**:- These type of capacitor has high tolerance and these types of capacitors are used in blocking, bypassing, filtering, coupling and decoupling, interference suppression in low voltage circuit .

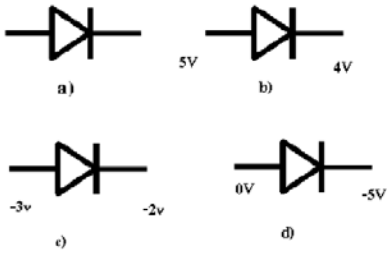


7. **Polystyrene:-** These capacitors has high stability and low loss characteristics.

8. **Electrical capacitor**:- Aluminum electrolytic motor start capacitors, housed in a mounded polycarbonate case. These types of the capacitor are suitable for small and medium size electric motors.

Diodes

Current flows from anode to cathode when the diode is forward biased. In a normal forward biased diode, energy is dissipated as heat in the junction, but in LED's energy dissipated as visible light. In robotics we use normal diodes as freewheeling diodes or to make power supply. LED's are of two types - IR led and normal LED. IR LED emits Infra Red radiations while normal LED emit visible light. So first talk about a normal diode. Mostly we us 1N4001 or 1N4007 as freewheeling diodes for motors or relays, sometimes in H-bridge also.



From the above figure try to find out which diodes are forward biased and which are reversed biased. You can see that a) is represents symbol of a diode b), d) are forward biased and c) is reverse biased(voltage at the P N junction should be greater than N junction by .7V).

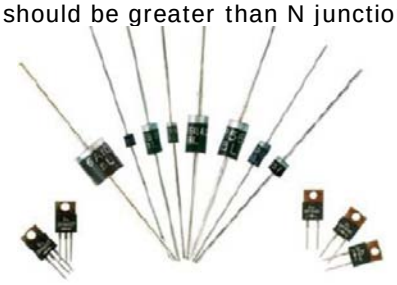
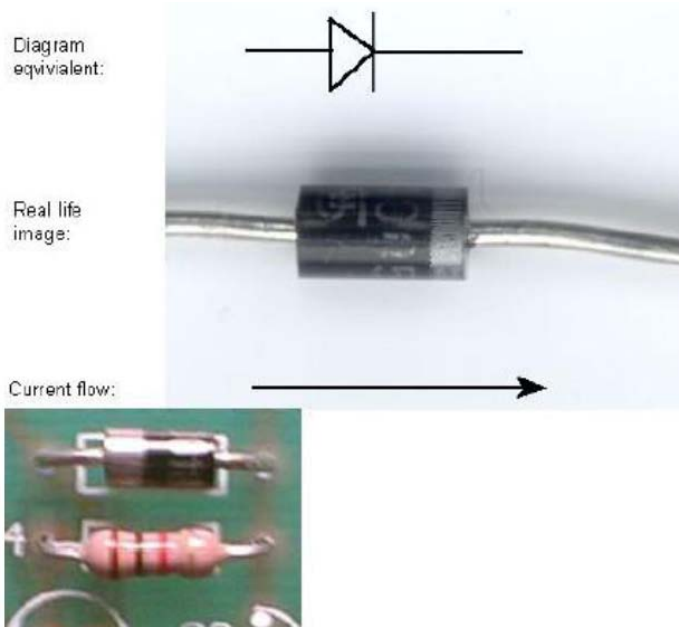
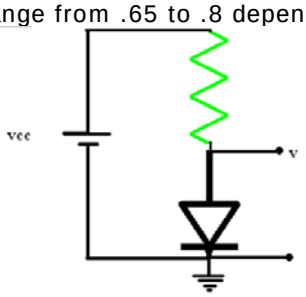


Figure shows normal diodes with different power ratings. I don't know about the transistor type diodes. High power rating diodes are used for high power motors. The following figure shows the normal diode available in the market. Diodes shown above are commonly known as **rectifying diodes**Figure shows normal diodes with different power ratings. I don't know about the transistor type diodes. High power rating diodes are used for high power motors. The following figure shows the normal diode available in the market. Diodes shown above are commonly known as **rectifying diodes.**



Above figure shows how to bend the leads of a diode and a resistor so that a properly inserted into breadboard or PCB. But remember not to bend too close to body. But there are different diodes LED, IRLED, Photo Diode, and Zener Diode. But in robotics we use LED, IR LED's, and Photo Diodes. Diode and Zener diodes are used, but rarely. Can u tell the voltage? Vcc ranges from 0-50 (it can go up to 200v also, for high power diodes). V range from .65 to .8 depending on series resistance (.7V).



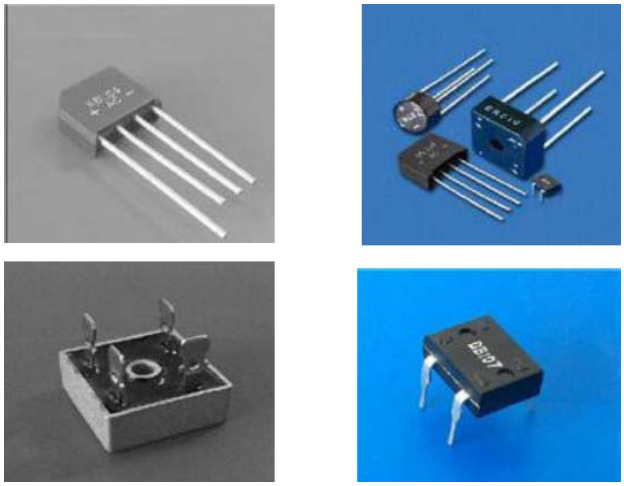
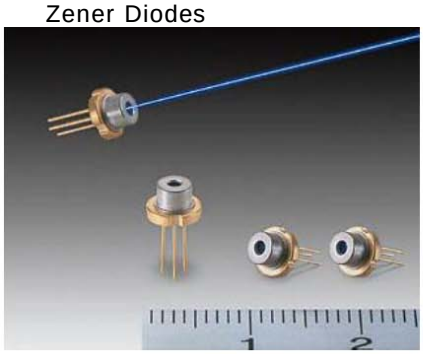


Fig: Full Bridge Rectifier Diode

Zener Diodes

High Power Diodes



Laser Diodes

DVD laser Diode

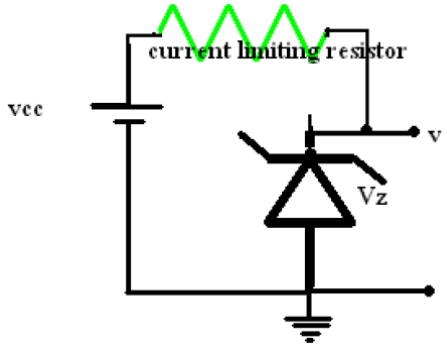
ZENER DIODE

A zener diode works in reverse biased region. In reverse biased it gives fixed output voltage. The following diagram shows a normal connection for the zener diode. The current limiting resisting should be chosen properly. Let's take an example for the use of zener diode, USB port gives Vcc=5V, but it takes input voltages around 3.3V. So we apply this circuit with zener diode, Vz=3.3V, (because most embedded systems work at 5V) to get voltage=3.3V. In forward bias it works as a normal diode.

See the link

http://www.allaboutcircuits.com/vol_3/chpt_3/9.html

http://www.phys.ualberta.ca



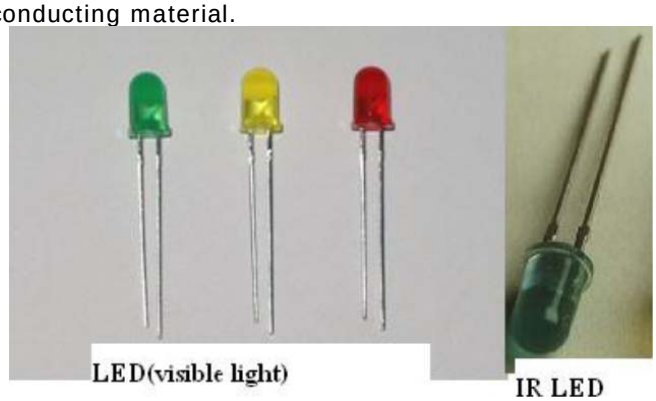
NOTE: If current limit resistor is not connected or it is not of proper value, then it causes heating of the zener diode. So remember about this before touching zener diode. If the input voltage is less than Vz then output voltage will be zero (ideally).

ZENER DIODE TABLE

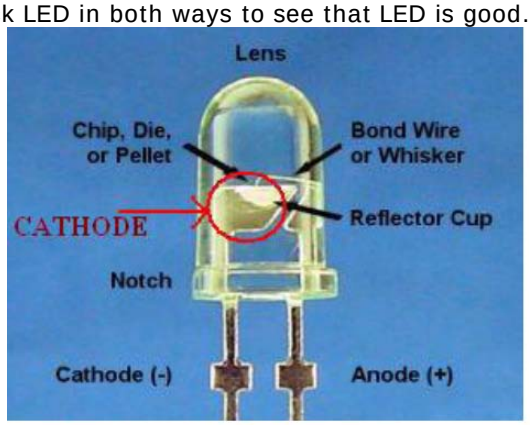
Volt	0.4 Watt		0.5 Watt		1 Watt		5 Watt	
2.4			1N5221	1N4617		UZ87=UZ88		UZ51=52=53
2.5			1N5222			UZ81=UZ82		UZ57=58=59
2.7			1N5223	1N4618				
2.8			1N5224					
3.0			1N5225	1N4619				
3.3	1N746		1N5226	1N4620	1N4728		1N5333	
3.6	1N747		1N5227	1N4621	1N4729		1N5334	
3.9	1N748		1N5228	1N4622	1N4730		1N5335	
4.3	1N749		1N5229	1N4623	1N4731		1N5336	
4.7	1N750		1N5230	1N4624	1N4732		1N5337	
5.1	1N751		1N5231	1N4625	1N4733		1N5338	
5.6	1N752		1N5232	1N4626	1N4734		1N5339	
6.0			1N5233	1N469			1N5340	
6.2	1N753		1N5234	1N4627	1N4735		1N5341	
6.8	1N754	1N957	1N5235	1N4628	1N4736	UZ8806	1N5342	UZ5806
7.5	1N755	1N958	1N5236	1N4629	1N4737	UZ8807	1N5343	UZ5807
8.2	1N756	1N959	1N5237	1N4630	1N4738	UZ8808	1N5344	UZ5808
8.7			1N5238	1N4695			1N5345	
9.1	1N757	1N960	1N5239	1N4631	1N4739	UZ8809	1N5346	UZ5809
10.0	1N758	1N961	1N5240	1N4632	1N4740	UZ8810	1N5347	UZ5810
11.0		1N962	1N5241	1N4633	1N4741		1N5348	
12.0	1N759	1N963	1N5242	1N4634	1N4742	UZ8812	1N5349	UZ5812
13.0	1N717	1N964	1N5243	1N4635	1N4743	UZ8813	1N5350	UZ5813
14.0			1N5244				1N5351	UZ5814
15.0	1N718	1N965	1N5245	1N4636	1N4744	UZ8815	1N5352	UZ5815
16.0	1N719	1N966	1N5246	1N4637	1N4745	UZ8816	1N5353	UZ5816
17.0			1N5247				1N5354	
18.0	1N720	1N967	1N5248	1N4638	1N4746	UZ8818	1N5355	UZ5818
19.0			1N5249				1N5356	
20.0	1N721	1N968	1N5250	1N4639	1N4747	UZ8820	1N5357	UZ5820
22.0	1N722	1N969	1N5251	1N4640	1N4748	UZ8822	1N5358	UZ5822
24.0	1N723	1N970	1N5252	1N4641	1N4749	UZ8824	1N5359	UZ5824
25.0			1N5253				1N5360	
27.0	1N724	1N971	1N5254	1N4642	1N4750	UZ8827	1N5361	UZ5827
28.0			1N5255				1N5362	
30.0	1N725	1N972	1N5256	1N4643	1N4751	UZ8830	1N5363	UZ5830
33.0	1N726	1N973	1N5257	1N4644	1N4752	UZ8833	1N5364	UZ5833
36.0	1N727	1N974	1N5258	1N4645	1N4753	UZ8836	1N5365	UZ5836
39.0	1N728	1N975	1N5259	1N4646	1N4754	UZ8840	1N5366	UZ5840
43.0	1N729	1N976	1N5260	1N4647	1N4755		1N5367	
47.0	1N730	1N977	1N5261	1N4648	1N4756	UZ8845	1N5368	
51.0	1N731	1N978	1N5262		1N4757	UZ8850	1N5369	UZ5850
56.0	1N732	1N979	1N5263		1N4758	UZ8856	1N5370	UZ5856
60.0			1N5264				1N5371	UZ5860
62.0	1N733	1N980	1N5265		1N4759	UZ8860	1N5372	
68.0	1N734	1N981	1N5266		1N4760	UZ8870	1N5373	
75.0	1N735	1N982	1N5267		1N4761	UZ8875	1N5374	UZ5875
82.0	1N736	1N983	1N5268		1N4762	UZ8880	1N5375	UZ5880
87.0			1N5269				1N5376	
91.0	1N737	1N984	1N5270		1N4763	UZ8890	1N5377	UZ5890
100.0	1N738	1N985	1N5271		1N4764	UZ8110	1N5378	UZ5310
110.0	1N739	1N986	1N5272			UZ8111	1N5379	UZ5311
120.0	1N740	1N987	1N5273			UZ8112	1N5380	UZ5312
130.0	1N741	1N988	1N5274			UZ8113	1N5381	UZ5313
140.0			1N5275			UZ8114	1N5382	UZ5314
150.0	1N742	1N989	1N5276			UZ8115	1N5383	UZ5315
160.0	1N743	1N990	1N5277			UZ8116	1N5384	UZ5316
170.0			1N5278			UZ8117	1N5385	UZ5317
180.0	1N744	1N991	1N5279			UZ8118	1N5386	UZ5318
190.0			1N5280			UZ8119	1N5387	UZ5319
200.0	1N745	1N992	1N5281			UZ8120	1N5388	UZ5320

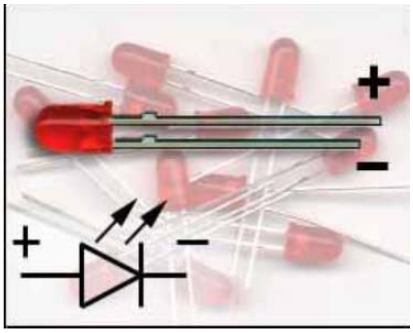
LIGHT EMITTING DIODE (LED)

Now let's see LED's. The main specification of LED are its current rating=20mA, typical cut in voltage=2V, life time=2lakh hours, approx voltage is around 4.5V. There is different color LED's depending on the semi conducting material.

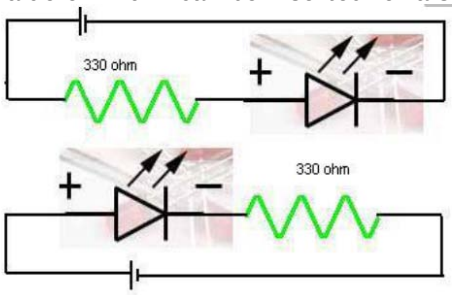


LED has two leads- cathode and anode. They are identified by the length of the lead. Cathode lead is of lesser length. But I some LED's with manufacturing defect have cathode lead longer. So in order to identify the cathode of the LED see the figure below. In that you can see that cathode is of broader filament. I got some white LED's of cathode of small filament. So this convention can be right or wrong. Check LED in both ways to see that LED is good.

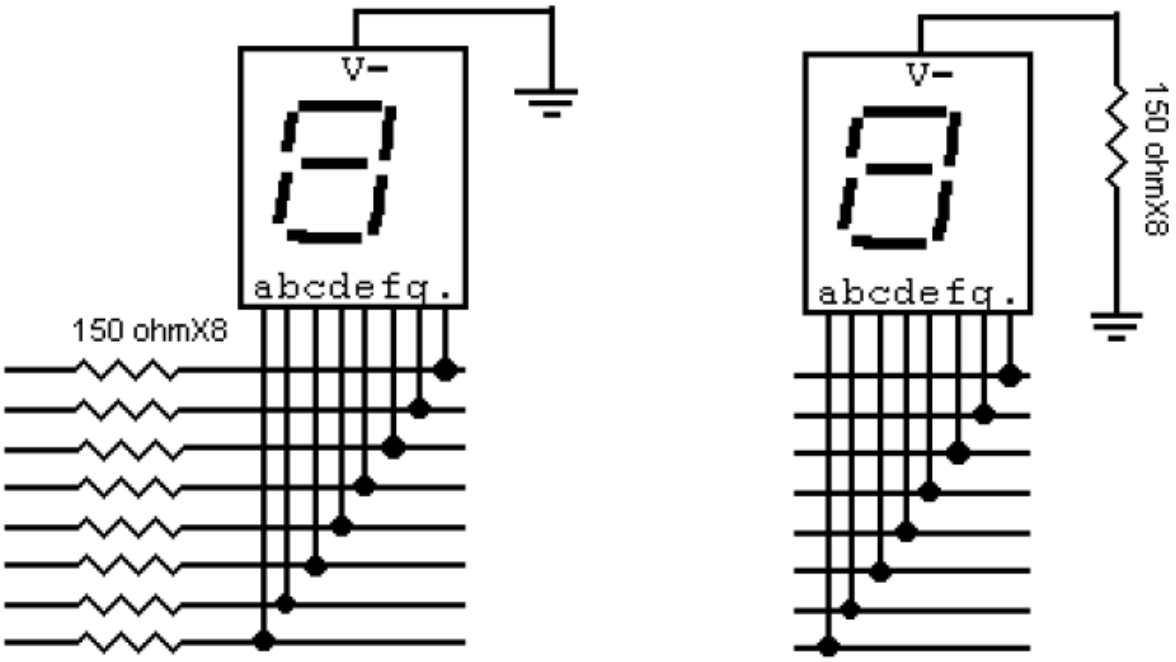




Don't connect LED to Vcc. Suppose if you connect the output of 7805 directly to an LED then the voltage output of 7805 reduces to 3.85V from 5.02 voltage output of 7805. So when you connect LED to the output of any IC connect a series resistor with it. The brightness of LED is controlled by the series resistance. If you want a good brightness use R=100,150Ω. If you want a medium Light, series resistance 330 Ω. The maximum value of 470 Ω can be inserted for a small light.



What is the difference when u connects resistor at anode side and resistor at cathode side. There is a difference in case of 7-segment displays.



See in the above diagram, you can see that resistance is connected at common cathode only. There is a difference between two. 7Segment display consist of 7 led's. Connecting a resistor in series with every LED and connecting a resistor in series with all LED's have a difference. In first case every LED has a series resistor, in this case the brightness of all LED's will be same, but in second case a series resistor with all LED's cause a different brightness with all, since all LED's are not identical. But in case of small 7segment LED's it won't create much problem, will have same brightness. But in case of big 7segments in railways etc. will have problem, causing some slightly different brightness. But in student case, second is good instead of 7 resistors. Suppose if you apply Ohm's law in the diode connected series resistor, then you can see voltage across LED is very low because the forward resistance of the diode is very low. But in case of diode we can't apply Ohm's law because diode is a non-linear device.

INFRA RED DIODES (IR LED'S / IR SENSORS)

The main difference between LED and IR LED is that IR LED emits Infrared Radiations, which we cannot see by our visible eye. The second difference is that IR LED takes a lot of current and damage fastly than LED's. I will explain more about 38KHz IR transmission and reception in Sensor's section. But we can use IRLED with photo diode as a sensor, which makes less prone to external light effects compared to LDR+LED combination. As you know IR radiations are heat emitting radiations, so be careful when you touch the IRLED's light emitting portion. I got 5-7cm clearance when I used IRLED+photo diode combination for edge detection. That is if the height is greater than 7 cm no reflection will come from ground, if it is less than 7cm then reflection will come from ground and photo diode detects it.

NOTE: IR LED becomes heated fast. Remember that IR LED always creates too much problems, most of the time it won't lit, that means the voltage across IR LED should be>2V for it to lit('lit' means produce IR radiations). *IR transmitter emit invisible light, detected by only mobile camera.i.e you can use mobile camera to check whether IR transmitter is working or not*
**** Fresnel lens is used to see the IR radiation***

ANALYSIS: Here I connected the output of 7805 directly to LED then voltage output of 7805 becomes 3.85V for LED and 1.5V for IR LED (previously without connecting any load it was 5.02V). If i connect a 330 ohm resistor series with IRLED and LED then voltage output becomes 4.95V

IR LED'S IN ROBOTICS

Most of the times, the sensors we use in robotics/ basic electronics for projects where you have to detect some sort of obstacle or colour etc. are IR Sensors (IR stands for Infra-Red). As the name suggests these detect infra red radiations coming from a body or a transmitter. IR sensor could be a containing a single receiver (in case where a body is a source of IR radiations) or it could be a pair of Transmitter and Receiver as shown in the picture below. Generally, the IR transmitters that come in market would be blue in color (in some cases, these could be transparent also) and the receivers are often transparent or black in colour. Picture below shows a pair of IR sensor.

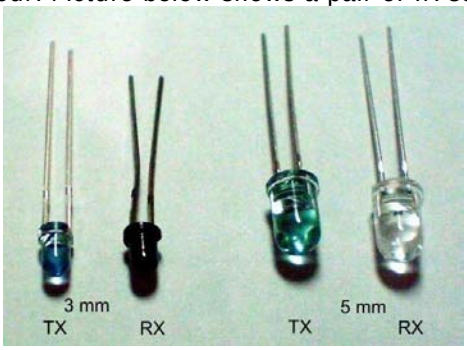


Fig: IR sensor Pair

In the above pictures, receiver could be easily detected, but as I have already told you those transmitters could be blue in color or transparent, so, the problem arises when both the transmitter and receiver are transparent/white in color. In this case, the transmitter could be detected by a simple circuit by connecting a 330Ω resistance in series with the transmitter and applying a power source of let's say: 5V to it. Then you could view the transmitter with any of your thermo graphic camera/lens, you could view a bright light (mostly blue in color) coming out of the transmitter that is not visible from naked eyes. So, this way you differentiate your IR Transmitter and Receiver.IR sensors fall in the category of photo-diodes. Although other similar sensors such as photo-cells (LDR's – Light Dependent Resistors) could not be misunderstood as IR sensors as these kind of sensors as their name suggests emit and receive normal light and they get triggered on normal room light as well where as IR sensors don't. A picture of photo-cell is shown below.

A point to be noticed is that LDR's don't have a positive or negative terminal whereas IR sensors do. However, we would study about LDR in detail in our next chapters.

Note: ***Resistance of the IR receiver reduces as IR radiations fall on it.***

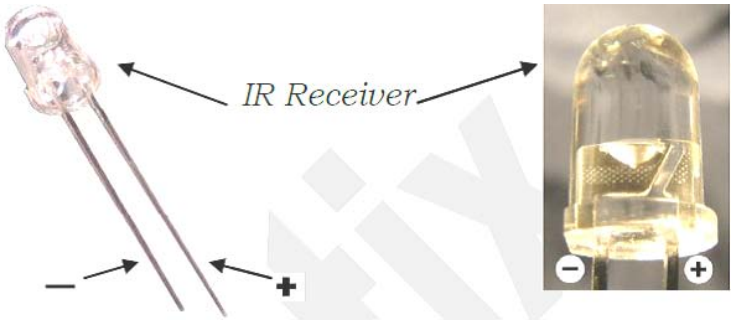
How to find polarity of an IR Tx. /Rx.?

The criteria to find the polarity of an ir sensor are simple as that of an LED. There are 2 methods:

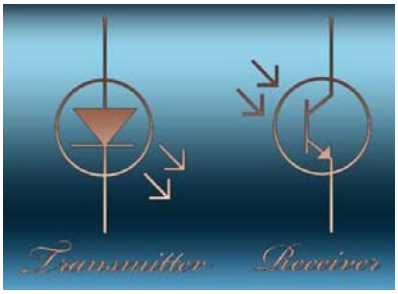
☐ Positive leg of the IR sensor is longer than the negative one.

☐ Negative terminal is thicker inside the plastic covering.

This would be clear from the image below.



Symbol for IR Receiver:



So, for transmitter, we consider an IR light source with outward arrows indicating that it emits IR radiations and inward arrows for IR receiver showing it as an IR light detector.

Material of IR Sensors/ IR LED's

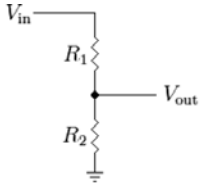
The material used to make a photodiode is critical to defining its properties, because only photons with sufficient energy to excite electrons across the material's band gap will produce significant photocurrents. Materials commonly used to produce photodiodes include:

Material	**Electromagnetic spectrum wavelength range (nm)**
Silicon	190 – 1100
Germanium	400 – 1700
Indium gallium arsenide	800 – 2600
Lead(II) sulfide	<1000 – 3500

Because of their greater band gap, silicon-based photodiodes generate less noise than germanium-based photodiodes, but germanium photodiodes must be used for wavelengths longer than approximately 1 μm. This is all the basic knowledge that you should have about IR sensors/ Photo-diodes.

Basic circuit of an IR Led

Let's see the basic circuit of IR Sensor. But in order to study that, you need to know about a simple potential divider circuit.



Considering the above ***potential divider circuit***, we assume that the impedances of the two components attached in series is resistive, or let's say we combine two or more resistance in series and apply Vcc to one end and ground terminal to the other.
Here, $Z_1=R_1$ and $Z_2=R_2$
Vcc=Vin
Also, Vout is calculated from the center of the 2 resistances.

Note: Always to find the output voltage of a sensor, take its value with reference to gnd terminal, not with Vcc for the sake of simplicity and easier calculations. Here,

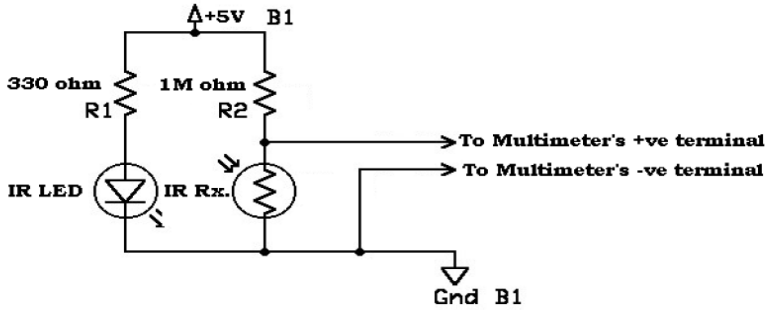
$$Vout = \frac{R2}{R1 + R2}$$

If $R_1=R_2$

$$Vout = \frac{Vin}{2}$$

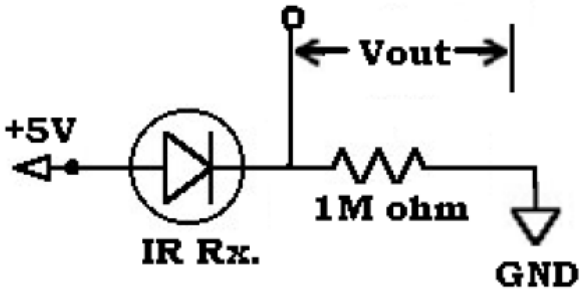
You could also design a voltage divider circuit by substituting the value of V_{out} and V_{in}, and find out R_1 and R_2. Considering case of IR Led's, it is the same as above but you have to only replace one of the resistors (R_1 or R_2) with IR Transmitter/ IR Receiver. This is so because, the parameter that changes in IR receiver with falling IR radiations is its resistance, hence, we could get a variable voltage out of the IR receiver in terms of varying IR light from IR transmitter.
Connections for IR Transmitter: Transmitter is connected as a simple LED as it also emits light, though it is invisible. It is connected in series with a 100Ω/330Ω resistance, as small as possible and given voltage supply across its ends. The resistance attached with this IR Led is kept small enough to increase its transmission power.
Connections for IR receiver IR receiver is connected in series with a 1MΩ resistance and connecting the supply across its ends. The output is taken from the center of the sensor and resistance with respect to ground.

The ***circuit*** is shown below.



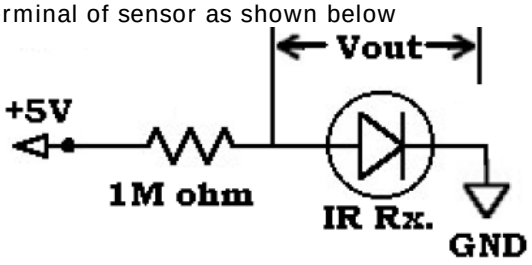
Further, there are 2 conditions for connecting the supply to the sensor.

CASE 1: When sensor is connected to Vcc and resistor to ground terminal, i.e. resistance is connected to the negative terminal of sensor as shown below.



Output: As we always check the output relative to ground terminal, also, as IR light falls on the receiver, its resistance decreases, so the output voltage is measured across 1MΩ resistance increases. You can check it on multimeter connecting the output of the circuit to positive/red lead of the multimeter and other terminal to the ground reference. So, conclusion here is that, as IR light falls on the receiver, the output voltage in above circuit increases from 0V to 5V.

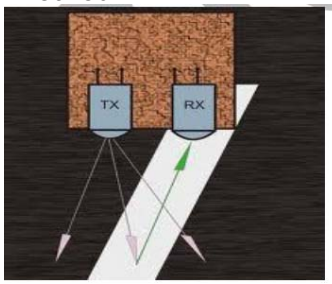
CASE 2: When sensor is connected to gnd. and resistor to the Vcc terminal, i.e. resistance is connected to the positive terminal of sensor as shown below



As we always check the output relative to ground terminal, also, as ir light falls on the receiver, its resistance decreases, so the output voltage is measured across receiver decreases. You can check it on multimeter connecting the output of the circuit to positive/red lead of the multimeter and other terminal to the ground reference. So, conclusion here is that, as IR light falls on the receiver, the output voltage in above circuit decreases from 5V to 0V.

Application Circuit The basic application of obstacle detection can be made by two different circuits according to the position of IR transmitter and receiver. These are: Retro-Reflective and Through-Beam methods. These are shown below:

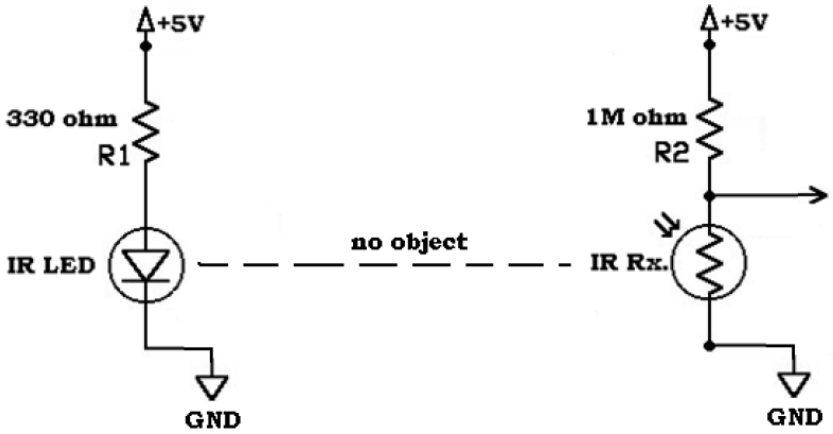
1. Retro-reflective method:



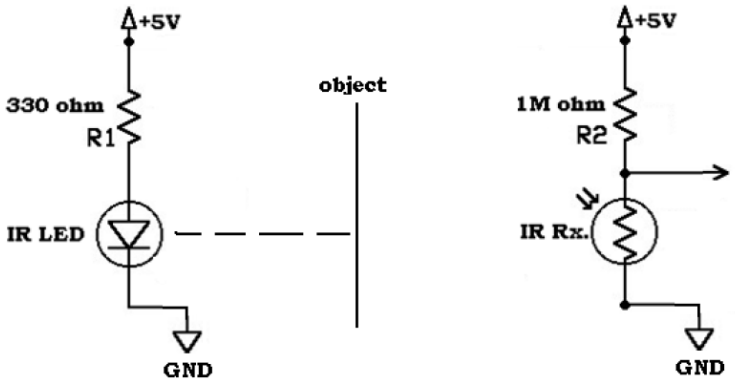
Above method helps in detecting the object by reflection from the surface. In this case, in normal condition, no IR light passes to the receiver, but as the object comes in front IR light is reflected from the object and passes to the receiver.

2. Through-beam method:

This method helps in detecting an object passing through the IR transmitter – receiver circuit. This operates on the basic principle of 'Line of Sight' between the transmitter and receiver.



When no object is there in between the IR Tx. – Rx. Pair, complete light goes to the receiver. But it gets blocked when an object comes in between.



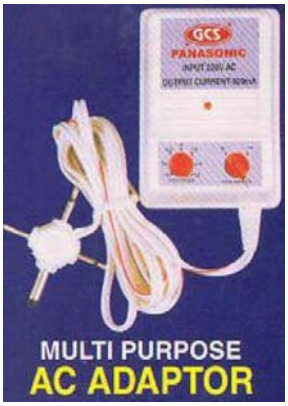
Output from IR Sensor: As the output comes in the form of varying voltage, so, this could be given to a comparator such as: LM358, LM741, LM324, etc. or to an Analog to Digital Converter or an IC NE555 in monostable mode or astable mode.

YOU CAN MAKE FOLLOWING ROBOTS USING IR SENSORS

- Obstacle detector
- Door Interrupter
- Autonomous Line follower Robot
- Autonomous Edge detector robot
- Autonomous Obstacle detector robot
- Autonomous Wall follower robot, etc.

POWER SUPPLY

We require DC supply for our circuits which should be obtained from 230V, 50Hz AC line. There is two way to get DC supply, one from DC battery and second from adapter or SMPS. Normally we use adapter for our circuits. When you go for troubleshooting power supply is another headache in robotics after sensor problems. The best way to avoid this problem is to use one SMPS instead of adapter. Normally adapters available for 12V, 500mA ratings. With that you can run DC motors. For beginners this 12V, 500mA adapter is enough.



The main thing you have to note when you buy one adapter is that
1) it should have variable shaft to get voltages from 3 to 12V.
2) It should be of a good company.
3) The light (LED) of adapter should be good.

Suppose if you short circuit +ve and -ve of adapter the LED will OFF, if some overload comes then the brightness of the LED decreases which will be helpful in troubleshooting. But better acquire an SMPS which will become shut down when short circuit occurs. If you have an SMPS then no problems with power supply occurs, better not to use the output of adapter of your Computer, buy one second hand SMPS even though it is of a 486 computer. But when you are making robots for competition in which robots run on battery, you should be careful because power supply problem also creates and your robots won't acquire the desired speed. If you are using SMPS and replace SMPS with battery in robots, you won't be getting better speeds because SMPS have good

current driving capability while battery won't have it. Even SMPS of Pentium1 systems have a power capability of about 40W.

NOTE: use separate power supply for the controlling Circuit (microcontrollers, power transistor, sensors etc..) and motor circuit because motor will always draw current and the controlling circuit won't get enough power for its working. You will mostly get a 9V battery for Rs.15. Buy three and use one 9V for the controlling circuit, other two 9v for motor driving. Use 78xx voltage regulators to get 5V, 12V, 24V etc..

SMPS

Following diagram shows Switched Mode Power Supply.

If you want tutorials on it try in Google, Wikipedia etc.. You will get +5V, -5V, +12V,-12V from SMPS. Different SMPS have different power ratings, depends on the processor and other peripherals. But old SMPS will be sufficient for us. There are four wires which should be short circuited properly to switch ON the SMPS. These wires go to the power button of the computer, remaining wires goes to the peripherals of the computer. The way in which you short circuit these four wires is written over the SMPS. So do it first to make the SMPS work. Now come to the wires to the peripherals, you can see that there are wires of different colors. Color voltage

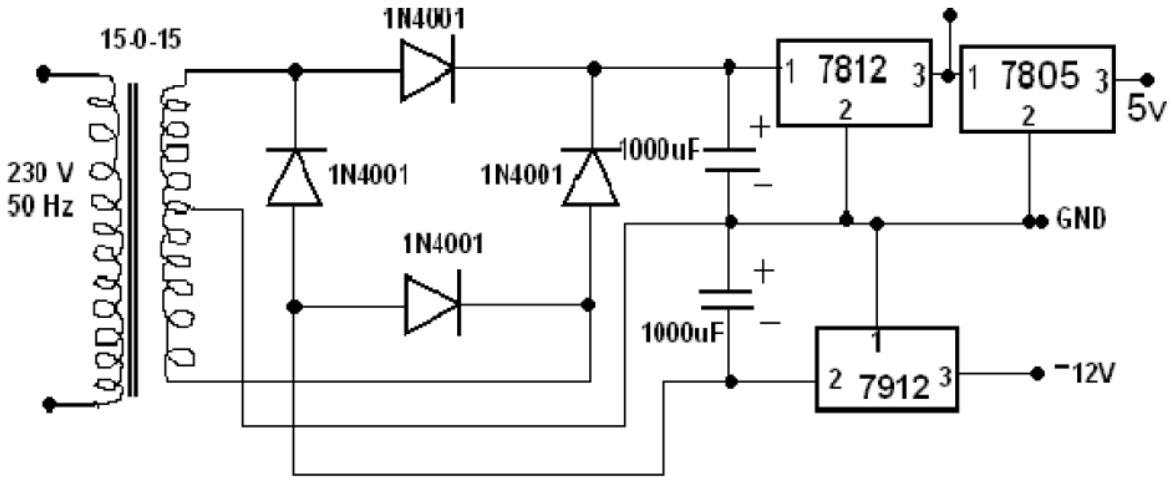
BLACK GND (0V) RED +5V Yellow +12V

Some SMPS have written the voltage corresponding to the colors over it. You measure it using a multicentre and identify the color for the corresponding voltage. The fan of the SMPS should run for the working of the SMPS. In SMPS the main problem you will face is that fan will not run.

This is because of

1) The wires you have short circuited may not be proper or they are not short circuited tightly. Shake that short circuited wire sometimes that will run the fan. 2) Short circuit in your circuit. Suppose if you connected +5V and Ground (say for example).

POWER SUPPLY CKT



Above circuit shows how to produce +/-12V, 5V from 230V AC line. It basically consists of a bridge rectifier with a capacitor filter and a voltage regulator. If you invert polarity of the capacitors then sometimes it will burst because all the capacitor here are electrolytic capacitors. If you invert the polarity of the diodes then this circuit won't work. See the pins of voltage regulators. Here you can see

that -12V is with respect to ground, remember that we measure all quantities with respect to ground. Suppose if you want -12V, don't say that you connect 0V to +ve and 12V to -ve lead because we say -12V with respect to ground and ground (0V) is a common terminal.

The main troubleshooting in circuit is to
1) Check that your power supply, whether it will be able to provide the sufficient power to the circuit, controlling as well as motor driving circuit.
2) Check the polarity of the power supply.
3) See the light of the adapter,
4) If it is OFF then you check whether your switch (power switch) is ON
5) If it is still OFF even though the power is ON then you check for the short circuits in the circuit.
6) If the light is DIM then you can infer that the adapter is not able to drive the circuit. When I connected a 3V DC motor from a toy car directly to adapter the light of the adapter becomes DIM. When I connected the output of adapter to input of 7805 and the output of 7805 directly to IR LED then the light of the LED DIM. Suppose if you connect the output of the adapter to 7805 and short the second and third pins of 7805(Vcc and gnd) then the light of the adapter will goes OFF.

VOLTAG REGULATORS

Voltage regulators produce fixed DC output voltage from variable DC (a small amount of AC on it). Normally we get fixed output by connecting the voltage regulator at the output of the filtered DC (see in above diagram). It can also used in circuits to get a low DC voltage from a high DC voltage (for example we use 7805 to get 5V from 12V).
There are two types of voltage regulators
1. Fixed voltage regulators (78xx, 79xx)
2. Variable voltage regulators (LM317)

In fixed voltage regulators there is Another classification
1. +ve voltage regulators
2. -ve voltage regulators

POSITIVE VOLTAGE REGULATORS

This includes 78xx voltage regulators. The most commonly used ones are 7805 and 7812. **7805 gives fixed 5V DC voltage if input voltage is in (7.5V, 20V)**. You may sometimes have questions like, what happens if input voltage is <7.5 V or some 3V, the answer is that regulation won't be proper. Suppose if input is 6V then output may be 5V or 4.8V, but there are some parameters for the voltage regulators like maximum output current capability, line regulation etc... , that parameters won't be proper. When I applied 3.55V input, i got around 3.5V. Remember that electronics components should be used in the proper voltage and current ratings as specified in datasheet. You can work without following it, but you won't be able to get some parameters of the component. Get datasheet from Google by searching '7805 datasheet' or from www.alldatasheet.com.

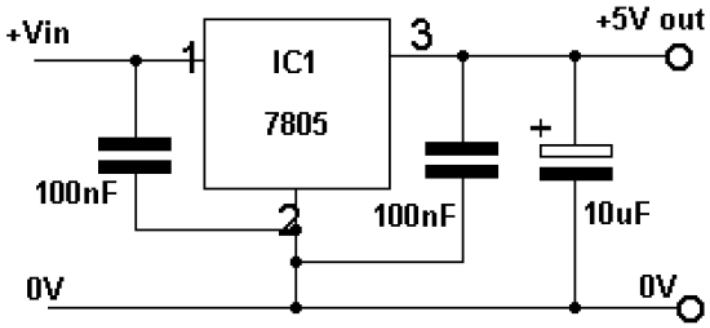


Fig: Circuit (How to get Filter +5 volt from any battery)

Next task is to identify the leads of the 7805. So first u have to keep the lead downward and the writing to your side, see the figure below. You can see the heat sink above the voltage regulator. **(1-input,2-gnd,3-output)** This is the same way of lead identification for all 3 terminal IC's (for e.g. Power transistor). The above diagram shows how to use 7805 voltage regulator. In this you can see that coupling capacitors are used for good regulation. But there is no need for it in normal case. But if you are using 7805 in analog circuit you should use capacitor, otherwise the noise in the output voltage will be high. The mainly available 78xx IC's are **7805, 7809,7812,7815,7824**

Note: In robotics you will need mostly +ve Voltage regulator, so not so need to go to –ve voltage regulator, just read it.

NEGATIVE VOLTAGE REGULATORS

Mostly available -ve voltage regulators are of 79xx family. You will use -ve voltage if you use IC741. For IC741 +12v and -12v will be enough, even though in most circuits we use +15v and -15v. You can get more information about 7905 from the following link.

http://www.national.com/ds/LM/LM7905.pdf

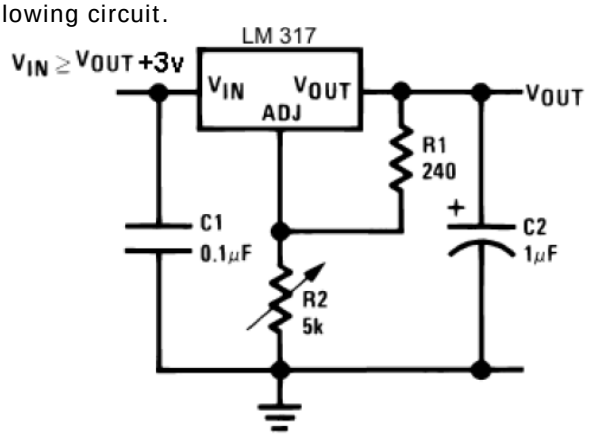
http://cache.national.com/ds/LM/LM7905.pdf

7805 gives fixed -5V DC voltage if input voltage is in (-7V,-20V) The mainly available 79xx IC's are 7905,7912 1.5A output current, short circuit protection, ripple rejection are the other features of 79xx and 78xx IC's.

VARIABLE VOLTAGE REGULATORS

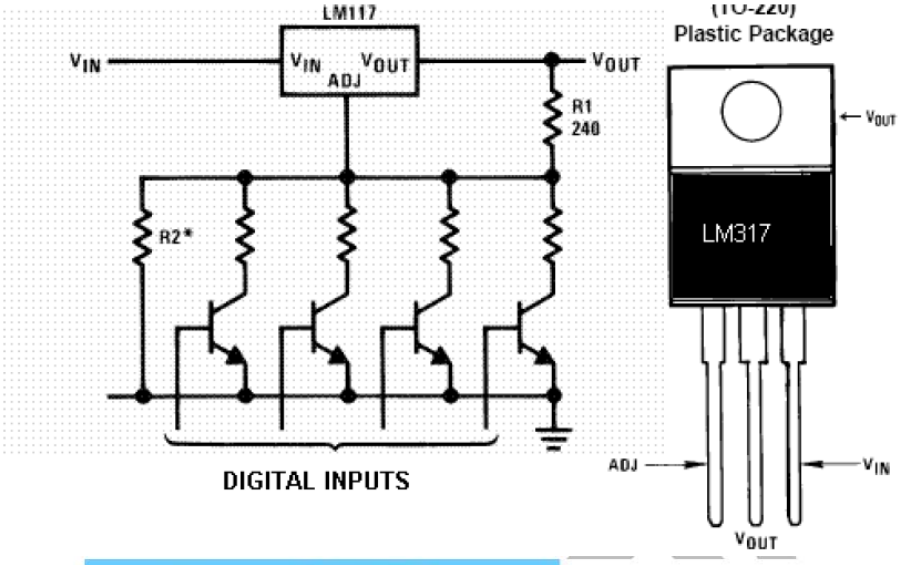
Most commonly variable voltage regulator is LM317 although other variable voltage regulators are available. The advantage of variable voltage regulator is that you can get a variable voltage supply by just varying the resistance only. http://focus.ti.com/docs/prod/folders/print/lm317.html http://www.national.com/pf/LM/LM317.html

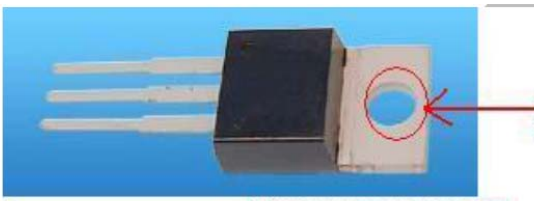
LM317 can be used to drive motor because it can handle output current up to 1.5A. In some low power devices like image sensor or USB we require 3.3V, in that circuit we use LM317.In a line follower we introduce some speed variations for motor for different bendings, you can do it by either using PWM or using the following circuit.



NOTE: Remember about the input voltage limitations. Remember about the heat sink of the voltage regulators before touching the voltage regulator IC because it will be in the heated state normally.

Your hand will get burned (not big burn, some small) if we touch the heat sink of the voltage regulator. So first touch the heat sink gently and confirm it is not heated, and then only remove the IC from the breadboard. If you are driving high power circuits and motors from the output of the voltage regulator screw an external heat sink to the voltage regulator. Size of the heat sink depends on the output power driving.





Note: To know about detail of any IC just go through its **data sheet** or **Application Note** of IC.

CONNECTORS

D-Sub connector
(E.G DB-9, DB-25)

T-Connector
For high Power Supply

DC plug

AUDIO CONNECTOR

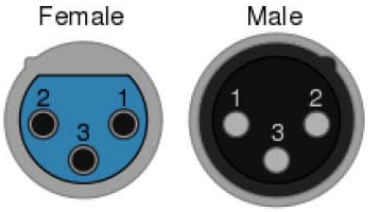
RF CABLE CONNECTOR

Types of electrical connectors

- ☐ Terminal blocks
- ☐ Posts
- ☐ Crimp-on Connectors
- ☐ Insulation displacement connectors
- ☐ Plug and socket connectors
- ☐ Component and device connectors
- ☐ Blade connector
- ☐ Ring and Spade Terminals

Commonly used connectors

- ☐ 8P8C connector
- ☐ D-subminiature connectors
- ☐ USB connectors
- ☐ Power connectors
- ☐ Radio frequency connectors
- ☐ DC Connectors



XLR connector
Showing the notch for alignment.

Some blade connectors

An ideal electrical connector would have a low contact resistance and high insulation value. It would be resistant to vibration, water, oil, and pressure.

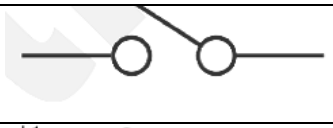
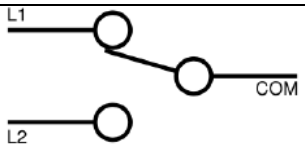
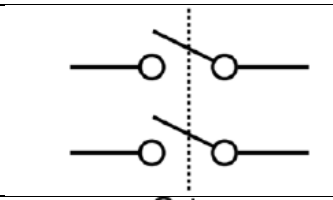
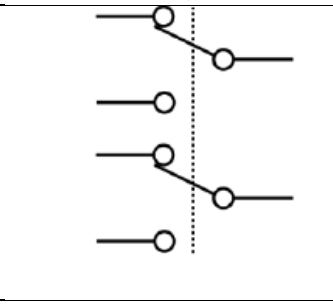
SWITCHES

Switch is an electrical component that can break an electrical circuit, interrupting the current or diverting it from one conductor to another manually Switch is an important and most basic components used in robotics In robotics switches are used to make remote control for Robots. We

usually use these switches to control the direction of motors. Switch can also be used as Sensor i.e. Touch sensor, limit switch etc.

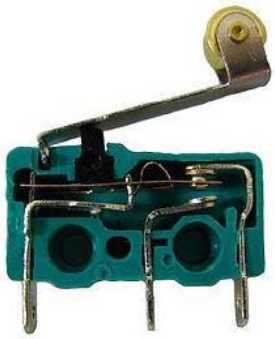
Relay is also a kind of switch that actuate by electrical signal

Contact terminology

SPST	Single pole, single throw A simple on-off switch: The two terminals are either connected together or disconnected from each other. An example is a light switch.	
SPDT SPCO SPTT	Single pole, double throw A simple changeover switch: C (COM, Common) is connected to L1 or to L2. Similar to *SPDT*. Some suppliers use *SPCO/SPTT* for switches with a stable off position in the centre and *SPDT* for those without.	
DPST	Double pole, single throw Equivalent to two *SPST* switches controlled by a single mechanism	
DPDT DPCO	Double pole, double throw Equivalent to two *SPDT* switches controlled by a single mechanism. Double pole changeover *or* Double pole, centre off Equivalent to *DPDT*. Some suppliers use *DPCO* for switches with a stable off position in the centre and *DPDT* for those without.	

Note: In order to control the motor using switch always use high current rating switch.

MICRO SWITCH is an electric switch that is actuated by very little physical force. By extending its arm it can be used to act like a touch sensor for making obstacle detector robot, edge detector robot etc.



Micro switches are capable of switching very high voltage and higher current devices.

A TOGGLE switch is a class of electrical switches that are manually actuated by a mechanical lever, handle, or rocking mechanism.

In robotics i used toggle switch to make manual robots or for making wired remote control for robots explained below in fig

Always use DPDT (6 terminal , center off) switches for making remote control for robot

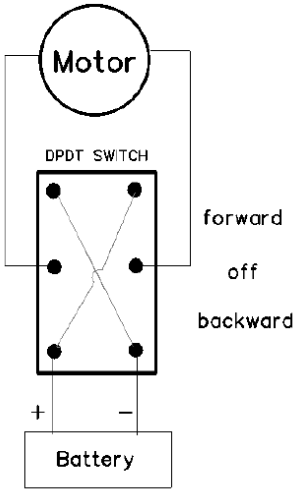


Fig: Connection for controlling motor direction using DPDT switch

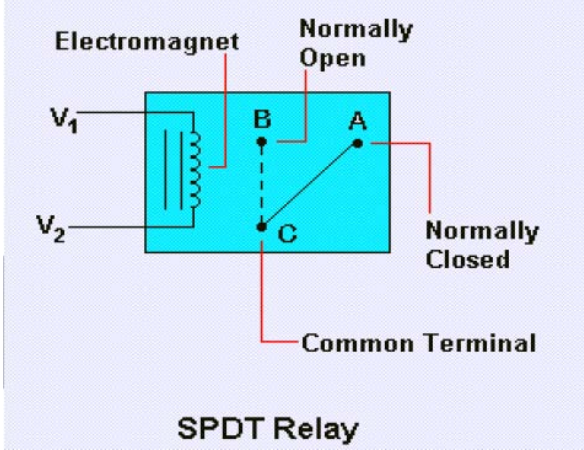
DPDT as Reversing switch

A DPDT switch has six connections, but since polarity reversal is a very common usage of DPDT switches, some variations of the DPDT switch are internally wired specifically for polarity reversal. These crossover switches only have four terminals rather than six. Two of the terminals are inputs and two are outputs. When connected to a battery or other DC source, the 4-way switch selects from either normal or reversed polarity. Such switches can also be used as intermediate switches in a multiway switching system for control of lamps by more than two switches.
Application of DPDT switches is mainly in direction control of motors , and actuators.

RELAY

You have seen controlling home equipments such as light, fans and
Equipments that run on 230V using parallel port of computer or a microcontroller or any other digital IC's. This is possible through relays. Relay is an electromagnetic device which works on magnetic field. The only difference between a switch and a relay is that switch operates when given a manual input whereas relay on the other hand triggers when given an input electrical signal on its 2 input terminals. Relay is also called an electromagnetic switch.

If you apply proper low voltage on one side the metal will get contacted. Following figure shows an SPDT Relay and its terminals.

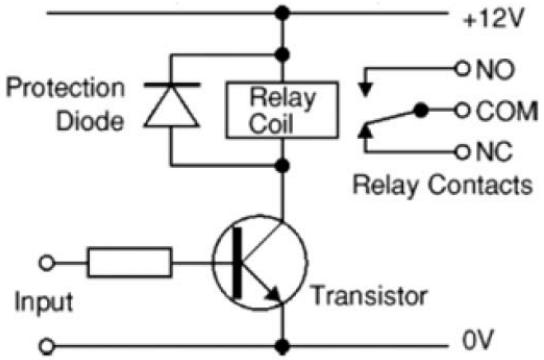


The voltage is applied on its input terminals V1 and V2 that internally acts as two ends of an inductor coil. 'C' is the common terminal and is permanently connected to a contact that is magnetic in nature. When there is no input applied to the input terminals, contact is established between terminals 'C' and 'A' as shown in the figure above. 'A' is normally closed terminal. But when a suitable amount of voltage signal is applied to its input, contact breaks up from 'A' and gets attached with 'B' that is normally open terminal.

Note that either of the input terminals of relay could be taken as a positive or negative terminal as an inductor coil has no polarity.

Relays also come in different packages such as SPDT, SPST, SPCO, DPST, DPDT, DPCO with same symbols and connections as shown in the table of —types of switches‖ in the previous chapter.

A simple circuit showing the triggering of relay through a low voltage via transistor is shown below.



Note that it is not necessary to use a transistor to drive a relay, it is used only to detect minute signals and passes ground to the terminal of relay when triggered by input signal. It is used in the configuration of —Transistor as a Switch . We could also apply direct input to the terminals of relay if it is sufficiently large enough to drive a relay. Other components that could be used to drive a relay are amplifier circuits such as Op-amps as amplifiers (LM741) or current amplifier ULN2003, etc. We would discuss transistors and amplifier IC's in next coming chapters. The relays mostly available are of 12V,196 ohm relays, if you use D880 transistor for driving it then remember the resistance at the base of the transistor should be around 1Kohm. You can hear a sound when the relay got activated.

Checking a relay circuit:

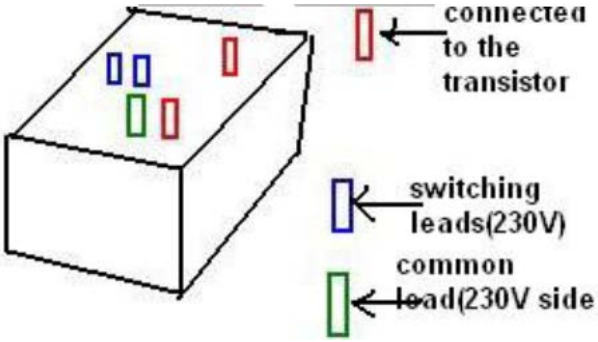
1. First check the relay is good and test whether your relay work with the Vcc you use. So first you connect Vcc and gnd between two ends of the relay. If it is activated you can hear sound. If not see the voltage rating of the relay and increase voltage. This is the most problem occurring with relays. For a 6V, 100ohm relay it required 6.86V to make it work. If Vcc=5v then u can hear a small sound that means that magnetization is not enough.

2. See the connections properly because on the other side of the relay you might be using 230V, so be careful when you touching the relay.

3. See the voltage of the other circuits and sensors when you connect relay (whether they are getting proper voltages).

4. Remember to put the protection diode

5. Touch the heat sink of the transistor to see if the transistor is getting heated or any faults.
6. See the value of the resistor connected in the base of the transistor.



Here it is a small relay representation (a diagram of relay i have). The other side of the relay can be 230V or even 5V (no restriction), but we normally get 230V relay, means voltage<=230 (on the 230V side). You can use this in the last stage of a line follower(assume that line follower has more than 2 LDR's), when last sensor go out of the line, you can use relay mechanism to provide Vcc to the other lead of the motor so that motor start to rotate backward.

APPLICATIONS OF RELAY

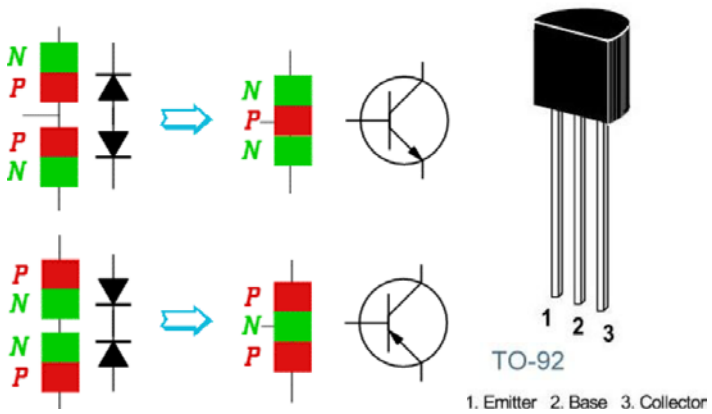
Application of relays is basically to switch a high voltage or AC voltage device from low voltage. The simplest example of relay in day-to-day life is indicators in your cars. When you press the indicator switch to turn on the lights you can hear the triggering sound of the relay. In robotics, most of the application of relay is in the remote controls for driving the robots or we could say driving a motor through relay that operates on high voltage with small voltage given by switch/ sensor as an input. We would study its detail in the chapter of Motors and Remote in next sections. **NOTE**: The switching speed (around 100ms)of relay limits its application in high power circuits(so SCR and Triac came).

You will get better tutorials here:

http://www.1728.com/project3.htm
http://www.the12volt.com/relays/relays.asp
http://electronics.howstuffworks.com/relay.htm
http://www.kpsec.freeuk.com/components/relay.htm

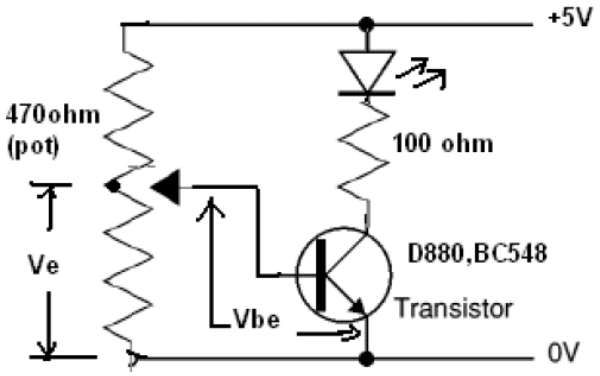
TRANSISTOR

Transistors are semiconductor devices that act as either electrically controlled switches or amplifier controls. The beauty of transistors is the way they can control electric current flow in a manner similar to the way a faucet controls the flow of water. With a faucet, the flow of water is controlled by a control knob. With a transistor, a small voltage and/or current applied to a control lead acts to control a larger electric flow through its other two leads. Bipolar junction transistors are formed from two p-n junctions, in either n-p-n or p-n-p configuration.

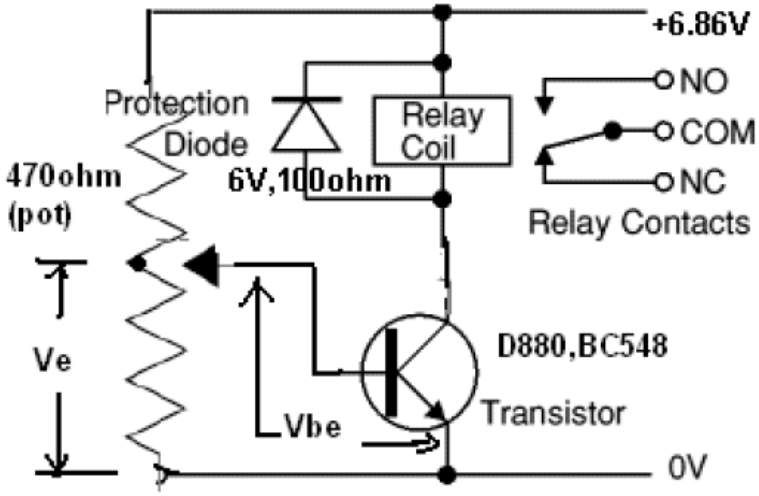


The middle, or *base*, region between the junctions is typically very narrow. The other regions, and their associated terminals, are known as the *emitter* and the *collector*. A small current injected through the junction between the base and the emitter changes the properties of the base-collector

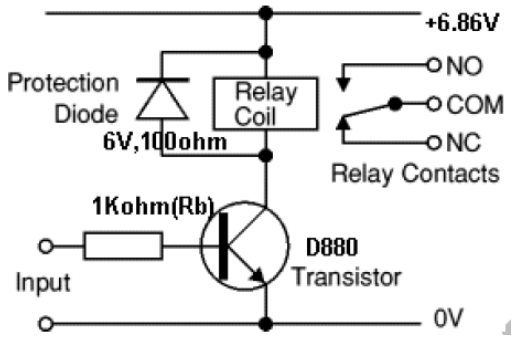
junction so that it can conduct current even though it is reverse biased. This creates a much larger current between the collector and emitter, controlled by the base-emitter current.
When we talk of transistor in robotics, we talk about the cut off and saturation region only, while in your course you study transistor in active region.
So here I am talking about transistor as a switch. When we say transistor as a switch, we talk of cut off or not because the typical cut off voltage is around .5V and the saturation voltage (Vbe) is around .8V. There are regions between them. Let's start with transistor to glow an LED.



Connect this ckt and see. Connect multimeter at the base of the transistor and see the voltage. In this circuit we can see that Ve=Vbe. For the transistor to be switched ON Ve=.5V. Vary the potentiometer to make Vbe=.5V, you can see that LED starts glowing(but it is less brightness). Vary the potentiometer to make Vbe to around .8V , you can see that the LED brightness increases. This is because when Vbe=.5V it starts with cut off and when Vbe=.7V in active and Vbe=.8V it become saturation region. Transistor is a current controlled device. In active region Ic=hfe Ib and in saturation region Ic>hfeIb. That is why the brightness of the LED changes.



This circuit is used to turn on or turn off relays. Suppose if you use an LDR and a series resistor to turn ON and OFF light in your room, if the intensity of the light become LOW.
Now let's discuss about the circuit to turn ON/OFF relays using a microcontroller or a computer.



Here you can see that we are using a 6V, 100ohm relay. The circuits given in this book are all tested. The output voltage of the adapter when we put it into 6V is 6.86V. A 6V relay will switch properly only when Vcc>6V. If you use the output of 7805 then you can hear only a small sound or sometimes no sound meaning that relay is not getting enough magnetization. So remember it. See the relays troubleshooting section. Now come to the series resistor in the base of the transistor. It can vary from 100Ω to 10KΩ.But 1KΩ is good. If we use a 100 Ω resistor in series then the relay won't be switched properly. If you use 10KΩ then also relay will not be switched. If Rb<100Ω then you can see that the adapter light dims(Ic=Ib). You can verify it by connecting and removing the base voltage to Vcc. If it is not switching then your circuit is not working. You can see that Ic=Ib and Ic=hfeIb are the limits.
Here we can see we are using a protection diode, sometimes called freewheeling diode. The purpose of the protection diode is to protect the transistor from the burning of transistor because relay is a coil, i.e an inductor, the property of the inductor is to oppose its cause . So when you switch off the circuit the discharging of the inductor occurs in opposite direction (remember the properties of inductors), so if you use a protection diode, then it will discharge through relay+diode circuit, otherwise transistor got damaged. But if you use power transistor, this problems won't occur.

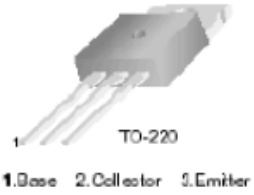
WHY POWER TRANSISTOR???

Mostly we use power transistors in robotics because it is to drive high power circuits like motors, relays. Let's compare normal transistor BC548 and power transistor D880 (datasheet).

BC548(NPN Epitaxial Silicon Transistor)

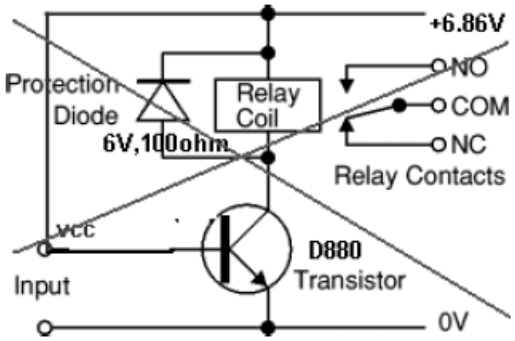
hfe-110
Maximum Collector to Base Voltage(VCBO) =30V
Maximum Collector to Emitter Voltage(VCEO) =30V
Maximum Base to Emitter Voltage(VEBO) =5V
Maximum Collector Current(Ic) =100mA
Maximum Power Dissipation =500mW
Case: TO-92 Plastic Package
Weight: approx. 0.18 g

KSD880(Low Frequency Power Amplifier)



hfe-60-300
Maximum Collector to Base Voltage(VCBO) =60V
Maximum Collector to Emitter Voltage(VCEO) =60V
Maximum Base to Emitter Voltage(VEBO) =7V
Maximum Collector Current(Ic) =3A
Maximum Power Dissipation =30W
Maximum Base Current =.3A

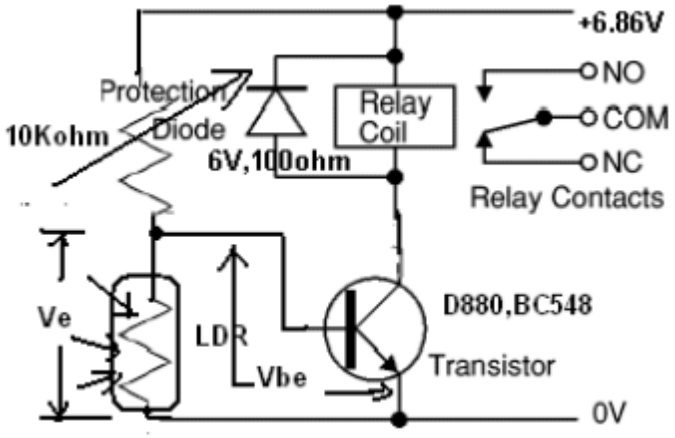
You see that hfe is low in power transistor. In the above transistor circuits we have seen that we normally connect motor or relay in between collector and base. You see the max. Ic of the transistors, D880 = 3A and BC548=.1A Normal DC motor have current rating of 250 mA. So if I connect this motor to the collector of BC548 then it will not able to drive the motor because max. Ic of BC548 is 100mA. But a D880 can drive this motor. This is the main reason we use power transistor. Second is the probability of damage because of the heat sink of the power transistor. If some short circuit occurs the heat sink will get heated, it won't get damaged. See the maximum voltage ratings of the power transistor. So if you are using some other transistor, see it's datasheet first to see that it will be able to be used in that circuit. The main thing you have to note is max. Ic and hfe (VCEO,VCBO see this also to choose Vcc).



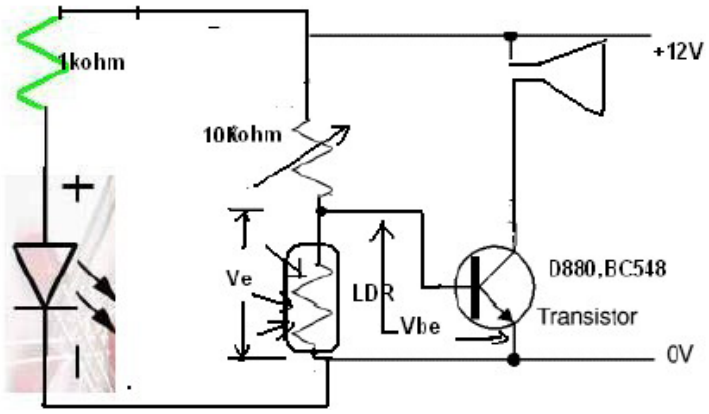
See this circuit. In this we connected Vcc directly to the base without a resistor. If you connect like this adapter light will go off and circuit won't work properly. Remember that transistor is a current controlled device

NOTE:

- When using transistor first see the ratings of the transistor from its datasheet.
- See the ratings of the device connected in the collector of transistor and match it with maximum Ic of the transistor.
- Remember that transistor is a current controlled device. So connect an appropriate resistor in the base.
- When you check whether the circuit with transistor will work in saturation region measure Vbe first and see if it is in saturation region. It will be explained in H-bridge part.



This is a circuit which is used to switch on an equipment when the Intensity of light is less. An LDR is a device whose resistance decreases as light increases. So adjust 10Kohm resistance so that, equipment will turn off when the light intensity is above desired level (this level is set by you). This circuit can be used for automatic switching of streetlights.

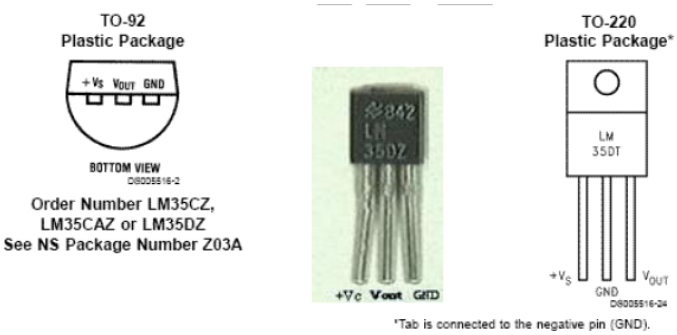


Here is another circuit which can be called as a basic burglar alarm. So when a thief passes a way it cuts the light and resistance of LDR increases to make the buzzer to beep. Here i put 10Kohm resistor because the value of resistance of the LDR is around 10Kohm. First test the value of LDR resistance and put the resistance so that when light is there the transistor is cut off and when dark the voltage drop increases and transistor become saturated and the buzzer beeps Normal buzzer beeps when voltage >7V mostly. See the relay troubleshooting. Mostly relays are of 6V and 12V. Be careful about that. The resistance in series with LED should be proper so that LED will not be burned.

SENSORS

A sensor is basically an input device as a switch, but the difference is that it works with any physical quantity such as temperature, light, air pressure, humidity, etc. rather than manual input. I would be discussing some of the sensors used in many day to day life projects starting with temperature sensor.

Temperature sensor: Commonly available temperature sensors are LM35, DS1621, thermistor. Thermistor gives resistance proportional to the temperature. But accuracy is not good in thermistor. DS1621 gives digital output in I2C format, so you require a microcontroller to interface to see the temperature. Thermistor require accurate resistance in series to get good reading with accuracy The resistance of thermistors are 100ohm,1Kohm(the one i have heard). But thermistor creates some headaches although it is cheap. LM35 have 3 terminal Vcc, ground, Vout. So it is easy and gives analog output.



LM35: The most commonly available LM35 is LM35DZ measures temperature from 0 to 100 degree. Normally sensors become inaccurate with age. But LM35 will not have this problem. We get LM35 in TO-92 package, just like small transistors like BC547. The main problem you will be creating is interchanging leads. Vs ranges from 4V to 30V. Output is 10mV* degree in Celsius. That is if the temperature is 29 degree then Vout=.29V. Let's try for a circuit which will glow an LED if the output voltage is greater than some voltage. Use comparator with a reference voltage at one end and LM35

output at other end, so that comparator become high when the temperature is above reference. More Links:
http://www.facstaff.bucknell.edu/mastascu/elessonshtml/Sensor s/TempLM35.html
http://www.cjseymour.plus.com/elec/tempsens/tempsens.htm
http://www.national.com/pf/LM/LM35.html

LIGHT SENSORS

Light sensors are used to measure the intensity of light. Mostly available sensors are Cadmium Sulphide LDR sensor, IR senor like photodiode, photo transistor, TSOP1738. For beginners LDR is easy to handle. So as a beginner better start with LED+LDR combination or IR LED + photodiode. LDR is economical than other sensors and easy to handle.

LIGHT DEPENDENT RESISTOR (LDR): LDR is basically a resistor whose resistance varies with intensity of light. More intensity less its resistance (i.e, in black it offers high resistance and in white it offers less resistance). This is the basic sensor which beginners should start with. Figure below show some of the pictures of LDR

LDR's with greater surface area,

LDR which are commonly used

Greater surface area, better the sensing will be. The sensing material is made of Cadmium Sulphide.
Resistance: 400ohm to 400Kohm
Normal resistance variation: 1Kohm to 10Kohm (in the robots which I used for line following for identifying black and white strips)
Sensitivity: about 3msec(Sensitivity is defined as the time taken for output to change when input changes, i got this reading by verifying with ADC interfaced with parallel port, sensitivity of LDR's is in milliseconds. This is the best sensitivity obtained to me).
Voltage ratings: I used it on 3V, 5V and 12V
Practical application in Line follower Robots: LED's are used with LDR which will act as a source of light for LDR because we are placing the LDR below the robot where light is not present. If we want to identify Black and White strips we add a light source with LDR and the white strip reflects light while black won't reflect light. Detailed description of this topic is given the the chapter of line follower robot.

Above figure shows how LED is placed with LDR. Here LDR is covered because we want light reflections from ground only, not from sides of LED. Also cover the LED so that the light will move pointed, so that reflection will directly go to LDR. When you attach LED and LDR to the body of the robot, use tape to paste the sensors. Remember if you robot body is of aluminum, and then some short circuit or current flow can occurs through the body. So apply tape perfectly so that no short

circuit problems occur. Remember that LDR is a resistor and have no polarity while all other sensors have. PROBLEMS: LDR is mainly used with visible light. So the problem of external light will affect the LDR. The affect of visible light is more in LDR then comes Photo diode, then TSOP1738.
http://www.technologystudent.com/elec1/ldr1.htm
http://www.kpsec.freeuk.com/components/other.htm
http://www.mstracey.btinternet.co.uk/technical/Theory/theoryse nsors.htm
http://www.tpub.com/neets/book7/26g.htm

PHOTO DIODE

Photo diode works in reverse biased region. A photo diode leads can be identified by seeing the length of the leads. Short lead is the cathode connected to greater voltage. The current flowing through the photo diode changes with intensity of the light. You can use it for edge detection. I tried to do edge detection of a table, i got range about 7cm. IR LED is used for producing light. When you are using IR LED be sure that it is working properly by measuring the voltage across the IR LED, should be greater than 2V. When connecting IRLED the voltage of the circuit drops, so be careful that voltage to other circuits won't fall below the level.

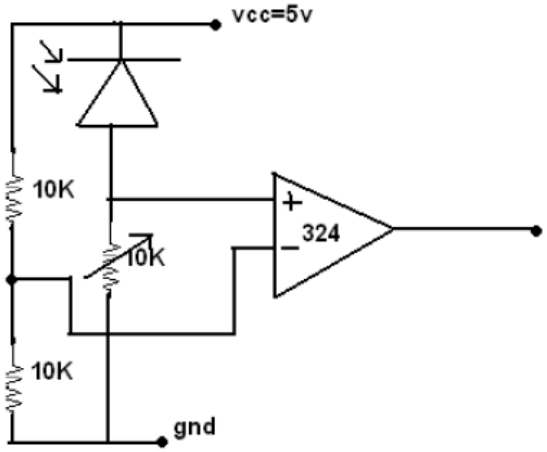
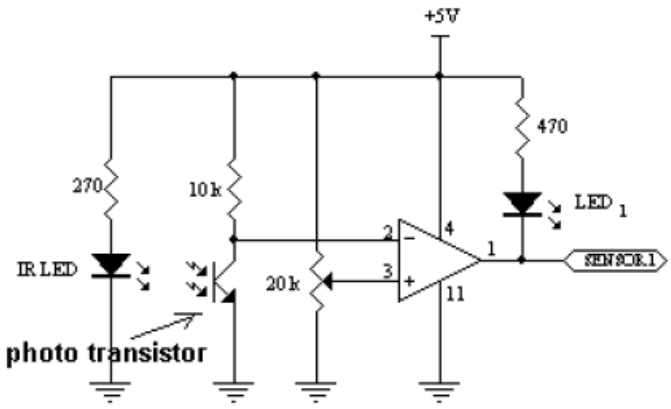


Photo diode and IR led looks same. The only difference is in its color IR LED is some dark in color. If you still can't identify. See this post
http://nod.phpwebhosting.com/~robotics/modules.php?name=Forums& file=viewtopic&t=435 **Here is some link for photo diode:**
http://www.radioelectronics com/info/data/semicond/photo_diode/photo_diode.php
http://en.wikipedia.org/wiki/Photodiode
http://www.lasermate.com/PR.htm
http://electron9.phys.utk.edu/optics421/modules/m4/photodiode.htm **Note**: Further details about LDR and Photodiode are covered in the chapter of IR LED before.

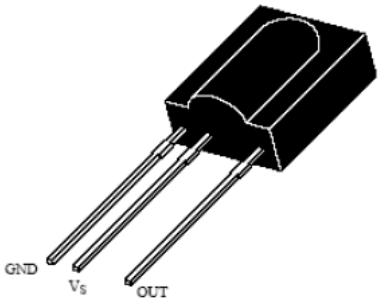
PHOTO TRANSISTOR

Photo transistor is one in which base is like the receiver of light. When light falls there will be a short circuit between collector and emitter. This can be used in optical communications. You can use either IR or laser (cheap one available). But in case of transmission we require line of sight propagation. Here is a circuit for detection of IR using photo transistor.
http://www.kmitl.ac.th/~kswichit/LFrobot/LFrobot.htm



Here when light is not there then the resistance of transistor will be high, so the V-(pin2)>V+(pin3) making output of comparator LOW. That is when no reflection from ground or any obstacle on the IR. When light is there then the resistance will be very less and V+>V-. So output of comparator is HIGH. Suppose if you are using it for line detection, then there is reflection of IR from the white surface, but IR radiations are absorbed by black surface, so no or less reflection from the surface in black strip. Remember to check the voltage across IR to see whether IR LED is working or not and it should be greater than 2V. When black strip comes, output of comparator become 0V and the LED glows (visible light LED).

TSOP1738

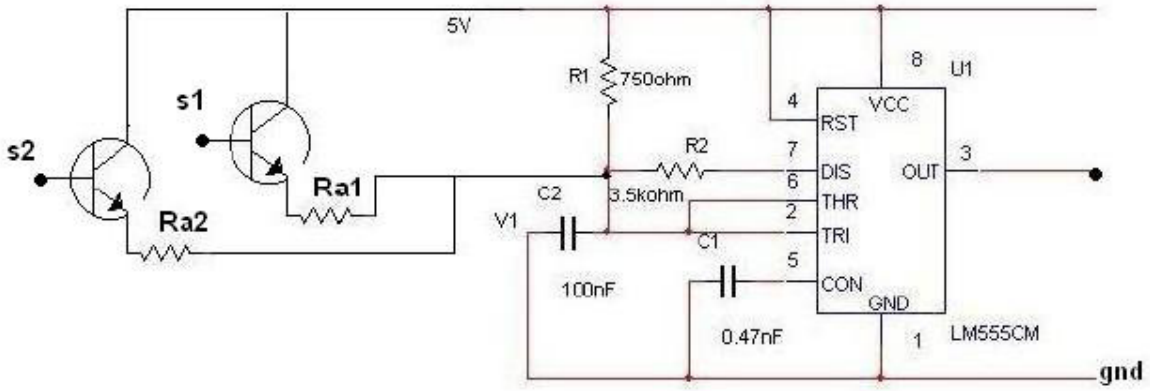


Supply Voltage (Pin 2) VS –0.3...6.0 V
Supply Current (Pin 2) IS 5 mA O
utput Voltage (Pin 3) VO –0.3...6.0 V
Output Current (Pin 3) IO 5 mA
Continuous data transmission possible (up to 2400 bps)
Suitable burst length: 10 cycles/burst

DISTANCE MEASUREMENTS

For a small distance measurement we can use a photo diode or photo transistor, but only distance up to 5-7cm. You just connect the output to ADC or any comparator to measurement. Suppose if we use one LM324 for distance measurement, you can measure 1cm, 2cm, 3cm,4cm. You just connect a 330 ohm in series with IR LED. At the other end use a photo diode in reverse region.
http://www.multyremotes.com/IRSw.htm
http://www.roboticsindia.net/modules.php?name=Forums&file=viewtopic&t=410
http://www.students.uwosh.edu/~piehld88/laser.htm
http://www.wanyrobotics.com/distance.html
If you want a good distance then you should use 38Khz modulated IR with TSOP1738 detector. Use IC555 to generate 38Khz square wave. Better tutorials available in roboticsindia, see
http://www.roboticsindia.net/modules.php?name=News&file=article&sid=32&mode=&order=0&thold=0
http://www.roboticsindia.net/modules.php?name=News&file=article&sid=35&mode=&order=0&thold=0 You can get range about 1 Meter. If you want to measure various distances then you should vary Ra of the IC555. Suppose if you want to measure distance from a fixed point, then you have to vary

the frequency of IC555. You can do it fixing Rb>Ra and vary Ra so that frequency will vary slightly from some 36Khz to 40Khz and find corresponding reading. You can do it by using the following technique.



Suppose if you want to measure distance from a fixed point. This is done by varying the frequency. When S1=1 then Raeq=R1//Ra1= R1Ra1/ (Ra1+R1). So this will produce a different frequency some between 36 to 40 KHz. When S2=1 Raeq=R1//Ra2. And when S1=S2=1 then Raeq=R1//Ra1//Ra2. By varying S1, S2 you can measure the distance from it. But this mostly requires the need of some circuitry. Better go for a microcontroller. Adjust Ra1, Ra2 so that desired frequencies are obtained. About the range of IR sensor
http://www.triindia.co.in/forums/viewtopic.php?t=12
http://www.triindia.co.in/forums/viewtopic.php?t=4
http://users.triera.net/zupanbra/senzor.html

COLOR SENSING:

I haven't heard of availability of color sensors. But we can make it from scratch. Suppose if you want to sense the color of ball. First thing you have to bring robot near the ball. The distance of the ball from the robot should be fixed. Second thing the effects of external light. First make the robot a fixed distance from the ball. This is made by using a IR LED+photo diode combination. Bring robot close so that you will get a good response. For sensing color you use LED+LDR combination. But the problem with external light will be higher in this case. So you should provide some mechanical mechanism to hide external light. Photo diode or modulated 38Khz+TSOP is used for distance measurement. But photo diode is enough to get distance about 5cm or near. Use comparator output to the output of photo diode for distance measurement. Use LDR to sense the color. But the accuracy is a real problem. RANGE FINDING:
http://www.roboticsindia.net/modules.php?name=Forums&file=viewtopic&t=148 SONAR:
http://www.leang.com/robotics/info/articles/minison/minison.html

ANGLE MEASUREMENT

Suppose if your robot is going over an inclined plane and we want to measure the inclination of the plane then we should go for angle measurement. This is done simply using the principle of a pendulum. If you goes up an inclined plane a pendulum kept perpendicular to the gravity will change its angle with normal. Attach a somewhat heavy ball to the shaft of the variable resistor (potentiometer). When robot goes up the plane, the inclination of the pendulum changes and the shaft of the variable resistor will vary. You connect the output of the variable resistor to ADC to get reading. Instead of pendulum and variable resistor keep a source of light perpendicular to the ground and keep some LDR's in the robot so that the light source moves and the reading of a LDR's will change. Keep some 5 LDR's for good accuracy. The robot will go up and down an inclined plane. So greater the number of LDR's greater will be accuracy. Suppose if you use one LDR and connecting LDR output to ADC and measuring angle is not good because it won't be able to detect whether robot is going up or down in an inclined plane (the readings will remain same for both side. Suppose if we take +20 degree then the LDR reading will be same for -20degree). So it is better to use some LDR's or potentiometer shaft attached with a heavy ball and output of potentiometer to ADC.

MOTORS

As a beginner we mostly use DC motors, stepper motor and servo motor will come later. As everybody know DC motor has two leads. If we apply +ve to one lead and ground to another motor will rotate in one direction, if we reverse the connection the motor will rotate in opposite direction. If we keep both leads open or both leads ground it will not rotate (but some inertia will be there). If we apply +ve voltage to both leads then braking will occurs. You can test this, first without applying any voltage you rotate the shaft of the motor, then apply ground on both lead and try to rotate the shaft. Both will almost remain same, but if we apply both lead +ve voltage (+12V) and try to rotate the shaft, you can feel the difference between the previous one. You have to apply more force to rotate the same rotation in previous connection. So we take this condition as braking, because if we want to stop the motor suddenly then this is the better way which is easily possible. There are methods to brake motor fastly, like shorting two leads, applying negative polarity exists, but we won't use this in robotics. We apply (1,1) condition to break the motor fastly(see H-bridge section for more about it). The main things about a DC motor are Voltage rating, current rating, Torque, Speed. Remember Torque is inversely proportional to speed. So we had to get a good speed motor to get good torque because we can operate the good speed motor in slow speed to get good torque. So maximum speed of the motor should be as high as possible. Normally available DC motors (without gears) have **12V, 250mA, 2400rpm** (may change) ratings. But it is better to have a geared motor, because you should make gears to get a good torque to drive robot. Normally we get Speed/9 reduction gears to reduce speed and get a good torque. Put three gears to reduce speed to 2400/27(calculation is taken avoiding gear loss). So we get a speed of 80 rpm. I used DC geared motor of 12V, 250mA, 60-80rpm, 2kgcms Torque costs Rs.380 and another one of 12V,250mA,60-80rpm,1Kgcms Torque costs Rs.135 . So as a beginner it is better to have a geared motor than a normal motor because you have to make gears. O.P.K Reddy used 12V, 250mA, 60-80rpm, 2kgcms motor to make a rope climbing robot. So better get a pair of good geared motor.

DC MOTOR

DC geared motor taken from Toy clamp

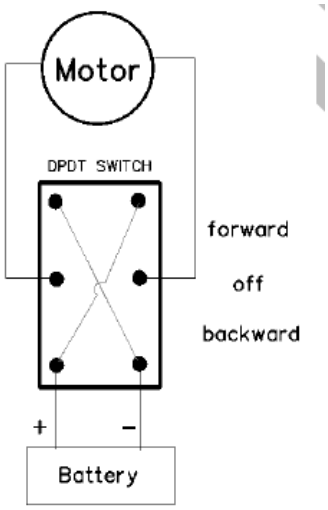
DC Geared Motor with Motor

DC motor has two wires. Since in robotics we need low rpm 110-500, so we prefer to used geared motor.

Motor driver IC is: L293d, L298, ULN2003, ULN2803, Relays

Controlling DC motor: First basic step to control dc motor is to control its direction using DPDT Switch in such a way that polarity of motor gets changed when we change the position of switch

Note: we need at least 6 terminal switch (DPDT) to forward, reverse and stop the motor as shown in picture below.



DPDT Switches

Connection Diagram for motor direction control

STEPPER MOTOR

A **stepper motor** (or **step motor**) is a brushless, synchronous electric motor that can divide a full rotation into a large number of steps. Stepper motor need special circuit to run known as drives Stepper motor have 5 (unipolar motor) to 6 wires (Bipolar motor). IC 4017, 74147, ULN2003, L293d, 555 can be used to make stepper motor drives Microcontroller are also used to make programmable drives But for beginner stepper motor is not mandatory. You should need classes to learn about stepper motor. Stepper motors will move only through a fixed angle. One step is the least count of a stepper motor. Stepper motors are used where accuracy is needed. Stepper moves only a fixed angle. Stepping angles available are 3.5, .75, 1.5, 1.8 degrees etc... There are two types of stepper motors 1. Bipolar stepper motor 2. Unipolar stepper motor The disadvantage of a stepper motor is that it is having a less torque, even though the movement is accurate ***Note****: speed of stepper motor depend upon the frequency of signal applied not on the voltage .voltage/current parameter just control the torque.*

SERVO MOTOR

The servo motor is actually an assembly of four things: a normal DC motor, a gear reduction unit, a position-sensing device (usually a potentiometer—a volume control knob), and a control circuit.

The shaft typically does *not* rotate freely round and round like a DC motor, but rather can only turn 200 degrees or so back and forth. The servo has a 3 wire connection: power, ground, and control. The power source must be constantly applied; the servo has its own drive electronics that draw current from the power lead to drive the motor. The control signal is pulse width modulated (PWM), but here the **duration** of the positive-going pulse determines the **position** of the servo shaft. For instance, a 1.520 millisecond pulse is the center position for a Futaba S148 servo. A longer pulse makes the servo turn to a clockwise-from-center position, and a shorter pulse makes the servo turn to a counter-clockwise-from-center position. The servo control pulse is repeated every 20 milliseconds. In essence, every 20 milliseconds you are telling the servo, “go here.”

APPLICATION OF SERVO

1. RC Engine car
2. RC Planes/Heli for controlling aileron, rudder ,elevator
3. Robotics
4. Wireless controlling of engines, speed control, automation, telemetry

8cc Nitro Engine Car

6cc Engine Plane

PART- II: SOME DIGITAL IC'S IN ROBOTICS

Some of the IC's that I would be covering in this book are listed below.
LM741, LM358, LM324 : OP-AMPS
NE555 : TIMER
L293D , L298: MOTOR DRIVER
ULN2003 : DARLINGTON TRANSISTOR ARRAY
HT9170 : DTMF DECODER
HT12D / HT12E FOR WIRELESS APPLICATION
RF MODULES 434MHZ
74194 STEPPER MOTOR DRIVER

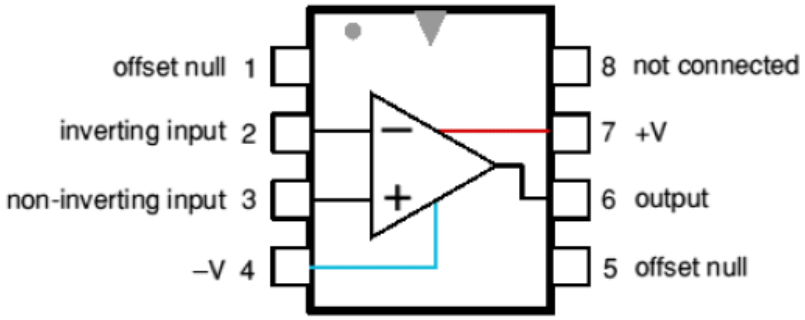
Before start working on IC very first time read following instruction carefully:
1. Always select best manufacture of IC. Because in market a IC for e.g. 555 is made by approx 10 companies including Chinese, which has poor performance , low life time , low output current etc
2. ST Microelectronics (1st preference) or Fairchild (2nd preference) is company I preferred to use
3. Always keep operating voltage minimum (mostly 5 volt) and current minimum (mostly 200 to 250 milli ampere)
4. Check IC by touching, after you switch on the power supply.

If IC is getting heated means IC is inserted wrong or some connection is short. Then check and redo connection
5. Always start working on breadboard kit
6. Before purchasing IC read is Datasheet from internet www.alldatasheets.com

OP-AMPS (741, LM324, LM358) As the name implies it is an operational amplifier. It performs mathematical operations like addition, subtraction, log, antilog etc. The main reason for OPAMPS used over transistors is that transistor can only amplify AC while OPAMPS can amplify AC and DC. You can get good amplifier gain in OPAMPS. The most commonly used OPAMPS are 741 and 324. IC741 is used in close loop configuration and LM324 and LM358 in open loop configuration. i.e. LM324 mainly used as comparator while 741 for amplification, addition etc.

IC741 We mostly use IC 741 as amplifier,adder,subtractor, adder cum subtractor. I am not giving more explanation because you can easily get circuit in internet or normal class texts. See the circuits of amplifier,adder,subtractor. I will give more examples in Sun Tracker and Light Following Robot. http://www.uoguelph.ca/~antoon/gadgets/741/741.html.

741 in 8-pin DIL (Dual In Line) pack

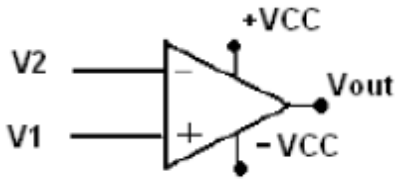


Power supply voltage +/-3V to +/-18V
Maximum differential input voltage 30V
Maximum voltage to either input 15V
Maximum power dissipation 500mW
Open-loop voltage gain 100,000
Input Resistance 2Mohm
CMRR 90dB
Slew Rate .5V/uS

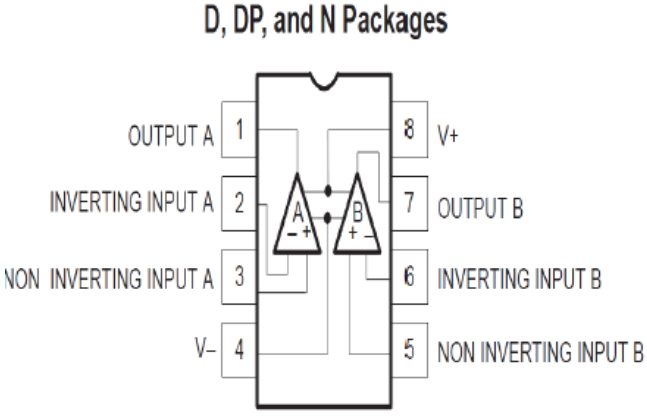
The 741 has two inputs and one output. The difference between these two inputs is amplified and that is what appears at the output. For this reason, the 741 is sometimes called the DIFFERENCE AMPLIFIER or COMPARATOR. Normally we use -Vcc = -12V and +vcc= +12V which is preferred over +/-15V because it is easy to generate for us. See the power supply section for the ckt to generate +/-12v from 230V AC.

COMPARATOR (LM358 and LM324)

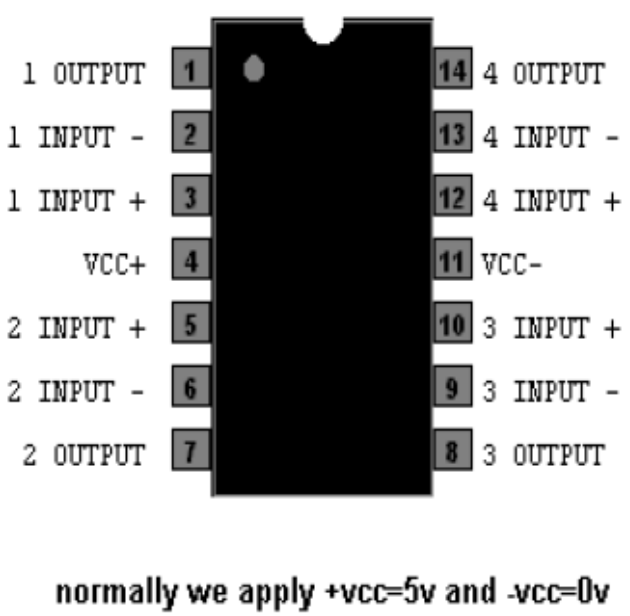
Comparator is a digital IC. The difference between the analog IC and digital IC is that in digital IC the output has only two states, while in analog IC it has more than two states. IC7404, it has two states LOGIC HIGH and LOGIC LOW, IC555 is also digital IC. IC741 is an analog IC because it has output voltage vary from -12v to 12V. Comparator has only two states +vcc or –vcc but LM324 we normally apply Vcc=5V and -vcc=0. So output will have only 5V and 0V. But LM324 output LOGIC HIGH will be aroundVcc-1.5V and LOGIC LOW around .2V. So if you use Vcc=5V then LOGIC HIGH=3.5V and LOGIC LOW=0V. But LOGIC HIGH for a digital circuit is a voltage greater than 2.4V and LOGIC LOW is less than .8V.

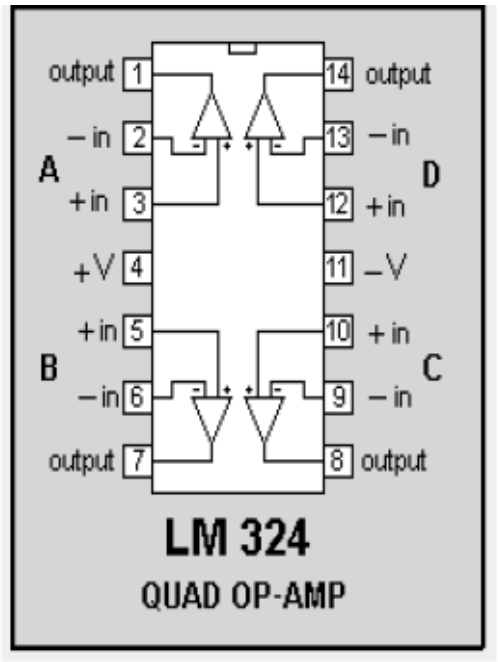


Above figure shows the general circuit diagram of a general comparator. If V1>V2 then Vout=+Vcc and if V1<V2 then Vout=-Vcc. Suppose if V1=V2, then output will be +vcc or –vcc theoretically. But practically no such condition exist, because an operational amplifier has a gain of 10^6, so there is no condition exist. The difference between LM358 and LM324 is that LM358 has 2 inbuilt comparators and LM324 has 4 comparators in build.
Below given pin diagram of both will clear you their working.



LM358 Pin configuration

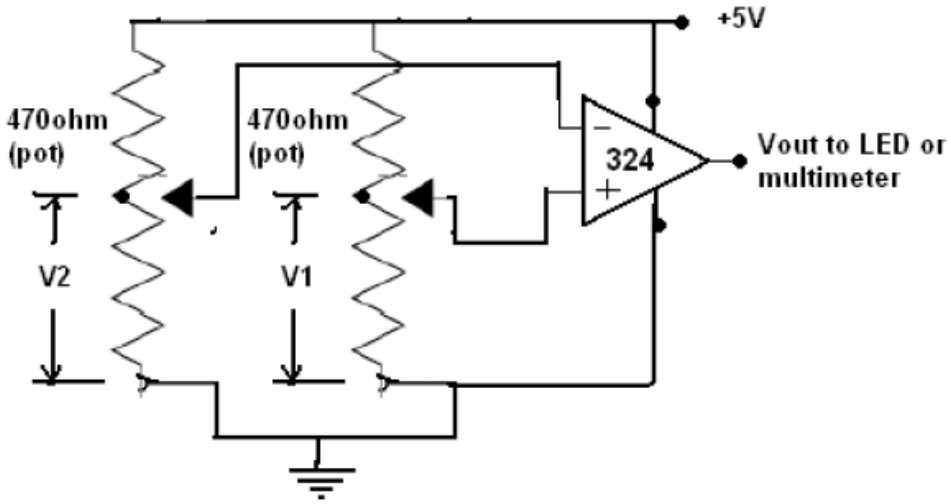




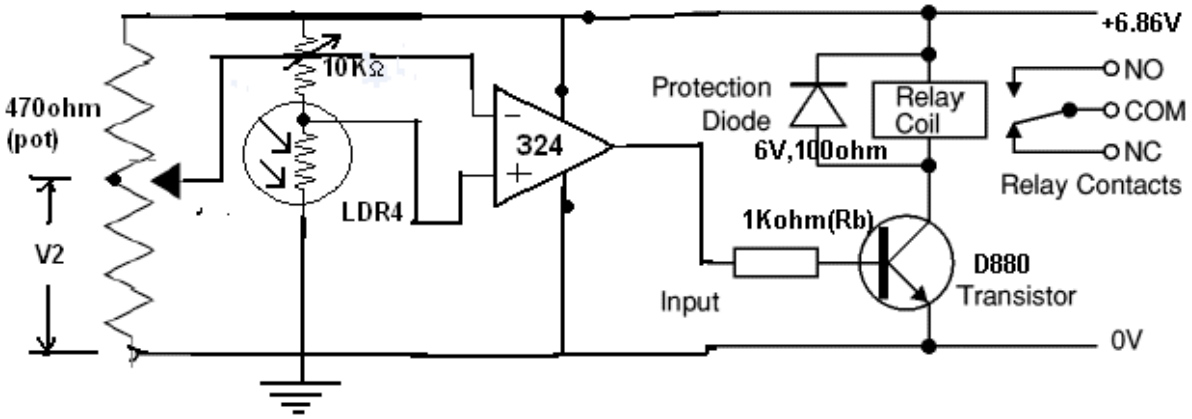
LM324 Pin configuration

Supply voltage – 3 v to 32v
Output voltage swing – 0 to V+ -1.5V

LET'S START:



Here you can use 1Kpot or 10Kpot instead of 470ohm potentiometer. Connect this circuit and start testing comparator LM324. 1. Insert IC properly into the breadboard. 2. Apply Vcc=+5v and -Vcc=0V 3. This circuit is used to test 324 the four operational amplifiers before using in the circuit. 4. Vary V1 and V2 to see the Vout. 5. Use multimeter or LED to see Vout and test the conditions of a Comparator.



This circuit is used to turn ON light or any equipment if the light intensity is below a level. This level is set by 470ohm pot (i.e, V2 is the reference). You can make the same circuit using power transistor, but difference between two.
When Vcc=5V and I apply v+=10v and v-=4.5 then output is 3.84 when Vcc=12V same input o/p 11.45 so be careful of Vcc of Lm324.

TIPS: 1. When u connect Vcc of Lm324 to gnd, then it will easily get heated. 2. The input cannot be greater than Vcc 3. You should remember that when using multiple voltages, Vcc should be greater than maximum voltage. Otherwise you will get wrong results.

Why Comparator is preferred over Power Transistor?
In robotics we require only two levels, active HIGH or active LOW that exist in comparator, but in power transistor there is regions between cut off and saturation, so that output varies with the input voltage at the base. Second thing is that power transistor is a current controlled device. But we always require voltage comparison, so we prefer comparator. But comparator outputs cannot be connected directly to the relay or motors. I will explain in H-bridge section.

Why LM324 is preferred over IC741?

1.If you use IC741 as comparator with Vcc=5V and -Vee=0 then for HIGH=4.5V and LOW=1.52, so in both condition transistor will be saturated, so in order to use IC741 as a comparator better apply -15,+15.

2. When LM324 is used with Vcc=5V then HIGH=3.6V(but this is the logic high for digital circuit) and LOW=0. So this will be better, you won't be able to get HIGH=5V.

3. In 741 when Vcc=5V, Vee=1.33V then HIGH=4.0 and LOW=0V. This is the reading which i got.

4. The best way of checking IC741 and IC324 is by using comparator configuration. But remember in checking case the input voltage to the comparator should be less than the supply voltages used. The output voltage will be some Vcc-2V and -Vee+2V at max.

5. You can used Vcc/ Vee to +/-9V at min for good response.

IR SENSOR CIRCUIT USING OPAMP:
You have already studied this IR Sensor topic in previous chapters, now; there is one problem in that circuit. This problem is that you cannot drive a high current device directly from a sensor, i.e. if you want to drive a relay, buzzer, or even an LED from that sensor, which is not possible due to low current and voltage problems. In this case you use a comparator IC such as LM358 or LM324 or LM741, etc. This works as if any small voltage is used as input, the output generated is upto Vcc voltage applied to the IC and you could easily drive a relay or buzzer through this circuit. See the circuit below showing the interfacing of IR sensor circuit with LM358:

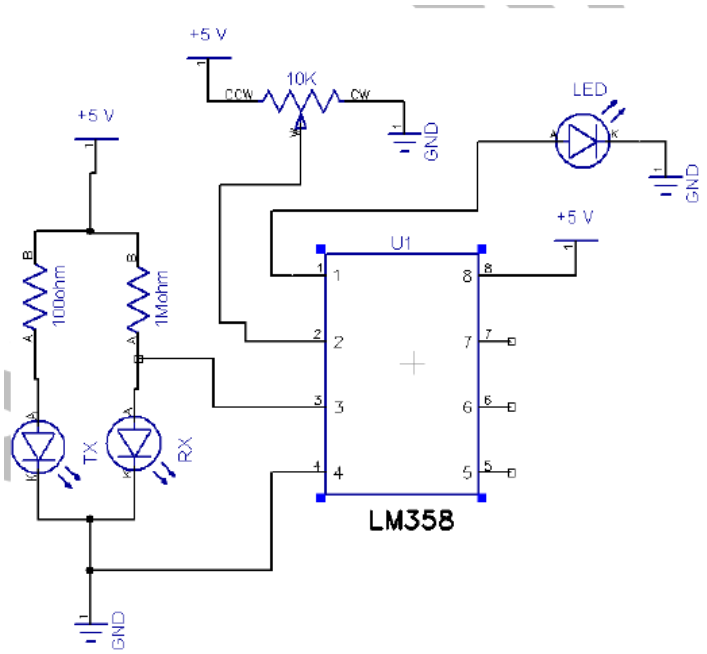


Fig: IR SENSOR MODULE CIRCUIT

Note: You can also use LDR in place of RX and WHITE LED in place of TX. Same circuit can be used to construct LDR module of **light follower Robot.**

555 TIMER IC The 555 IC has most of the applications and most widely used IC in the electronics projects. It is basically called a timer IC used for time delay generation, clock pulses generator for counters, sensors, ultrasonic TSOP sensors, etc. and also as a comparator. The only difference between Op-Amp as a comparator and 555 as a comparator is that in Op-amp, once the input is triggered output remains high or low constantly, but in case of 555 IC, once the input pin is triggered, the output remains high for a certain period of time as decided by the R-C ckt explained later on. We would be now studying 2 modes of 555 timers, i.e. Monostable mode and Astable mode and a ckt for triggering 555 with IR sensors. Let's start with the pin description of IC 555:

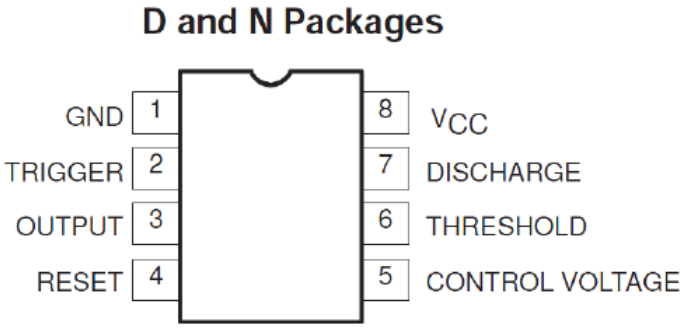


Fig: Pin Diagram of 555 Timer

Also, this 555 IC could operate on varied ranges of voltage from 4.5V to 16V for NE555/SA555/SE555C and from 4.5V to 18V for SE555. The 555 monolithic timing circuits is a highly stable controller capable of producing accurate time delays, or oscillation. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor. For a stable operation as an oscillator, the free running frequency and the duty cycle are both accurately controlled with two external resistors and one capacitor. The ckt may be triggered and reset on falling waveforms, and the output structure can source or sink up to 200 mA.

FEATURES:

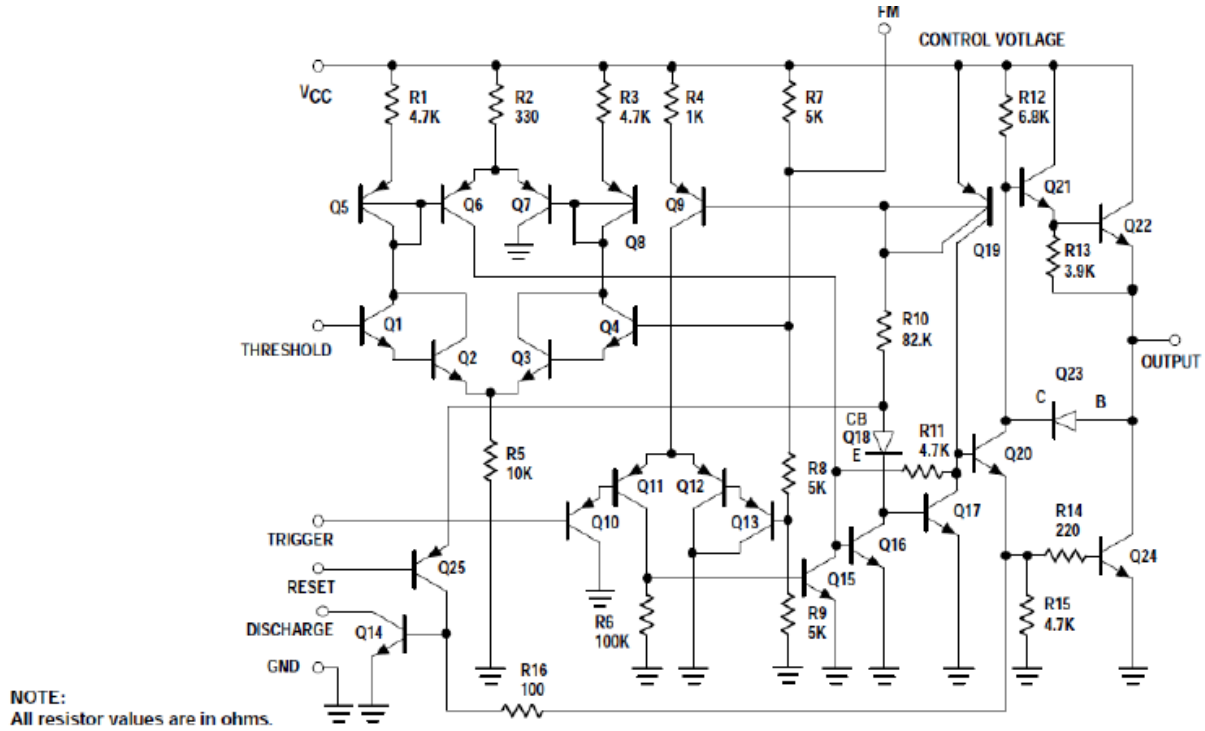
- Turn-off time less than 2 ms
- Max. Operating frequency greater than 500 kHz

- Timing from microseconds to hours
- Operates in both astable and monostable modes
- High output current
- Adjustable duty cycle
- TTL compatible
- Temperature stability of 0.005% per °C

APPLICATIONS:

Precision timing
Pulse generation
Sequential timing
Time delay generation
Pulse width modulation

INTERNAL ARCHIETECTURE OF 555 IC



Trigger Requirements

Due to the nature of the trigger circuitry, the timer will trigger on the negative-going edge of the input pulse. For the device to time-out properly, it is necessary that the trigger voltage level be returned to some voltage greater than one third of the supply before the timeout period. This can be achieved by making either the trigger pulse sufficiently short or by AC coupling into the trigger. By AC coupling the trigger (see Figure 3), a short negative-going pulse is achieved when the trigger signal goes to ground. AC coupling is most frequently used in conjunction with a switch or a signal that goes to ground which initiates the timing cycle. Should the trigger be held low, without AC coupling, for a longer duration than the timing cycle the output will remain in a high state for the duration of the low trigger signal, without regard to the threshold comparator state. This is due to the predominance of Q15 on the base of Q16, controlling the state of the bistable flip-flop. When the trigger signal then returns to a high level, the output will fall immediately. Thus, the output signal will follow the trigger signal in this case.

Control Voltage
One additional point of significance, the control voltage, is brought out on the timer. As mentioned earlier, both the trigger comparator, Q10-Q13, and the threshold comparator, Q1-Q4, are referenced to an internal resistor divider network, R7, R8, R9. This network establishes the nominal two thirds of supply voltage (VCC) trip point for the threshold comparator and one third of VCC for the trigger comparator. The two thirds point at the junction of R7, R8 and the base of Q4 is brought out. By imposing a voltage at this point, the comparator reference levels may be shifted either higher or lower than the nominal levels of one third and two thirds of the supply voltage. Varying the voltage at this point will vary the timing. This feature of the timer opens a multitude of application possibilities such as using the timer as a voltage-controlled oscillator, pulse-width modulator, etc. For applications where the control voltage function is not used, it is strongly recommended that a bypass capacitor (0.01mF) be placed across the control voltage pin and ground. This will increase the noise immunity of the timer to high frequency trash which may monitor the threshold levels causing timing error.

Modes of Operation The timer lends itself to three basic operating modes: 1. Monostable (one-shot) 2. Astable (oscillatory) 3. Time delay By utilizing one or any combination of basic operating modes and suitable variations, it is possible to utilize the timer in a myriad of applications. The applications are limited only to the imagination of the designer.

MONOSTABLE MODE One of the simplest and most widely used operating modes of the timer is the monostable (one-shot). This configuration requires only two external components for operation. The sequence of events starts when a voltage below one third VCC is sensed by the trigger comparator. The trigger is normally applied in the form of a short negative-going pulse. On the negative-going edge of the pulse, the device triggers, the output goes high and the discharge transistor turns off. Note that prior to the input pulse, the discharge transistor is on, shorting the timing capacitor to ground. At this point the timing capacitor, C, starts charging through the timing resistor, R. The voltage on the capacitor increases exponentially with a time constant T=RC. Ignoring capacitor leakage, the capacitor will reach the two thirds VCC level in 1.1 time constants or **T = 1.1 RC** Where T is in seconds, R is in ohms, and C is in Farads. This voltage level trips the threshold comparator, which in turn drives the output low and turns on the discharge transistor. The transistor discharges the capacitor, C, rapidly. The timer has completed its cycle and will now await another trigger pulse.

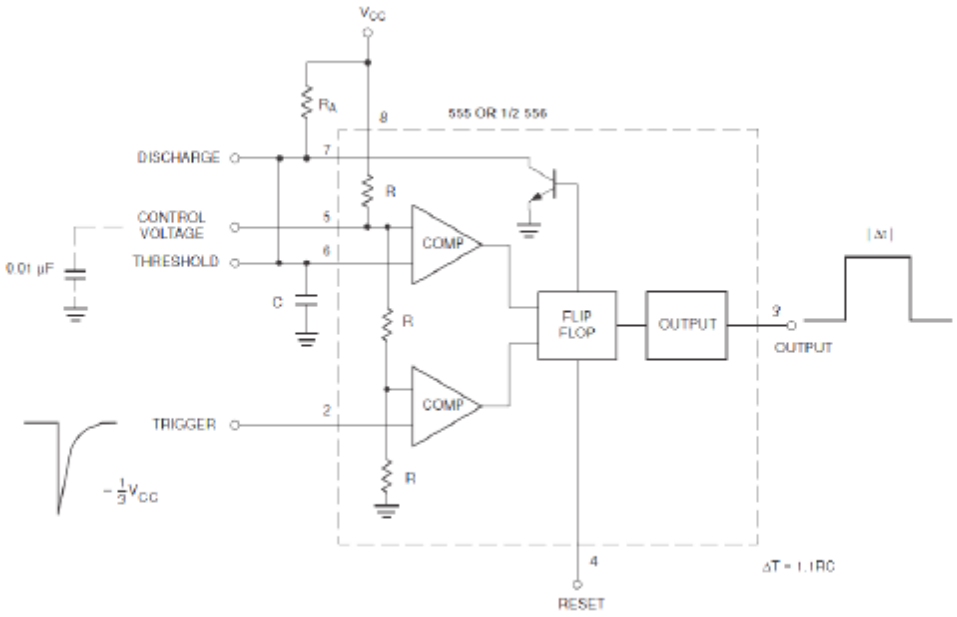


Fig: Monostable Operation

ASTABLE MODE

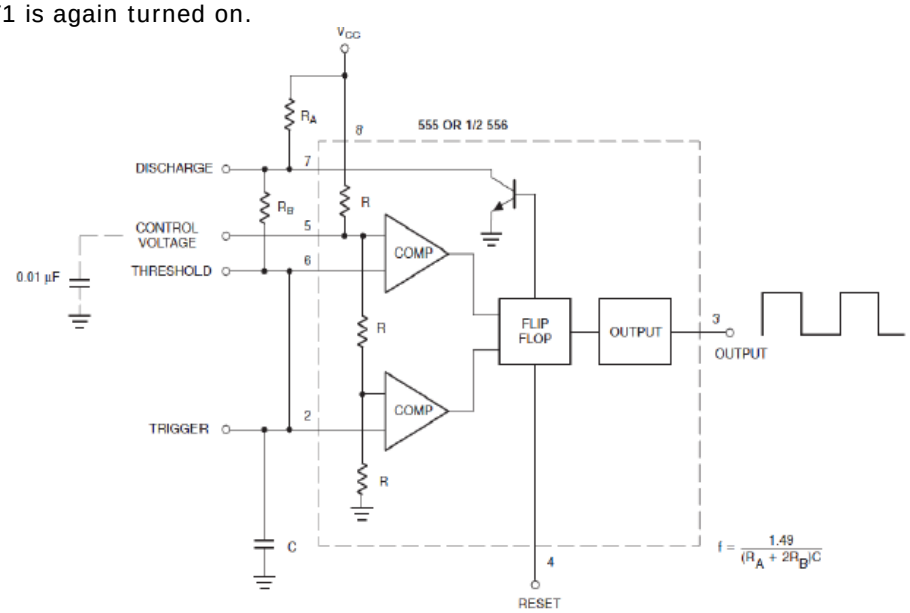
In the astable (free-run) mode, only one additional component, RB, is necessary. The trigger is now tied to the threshold pin. At power-up, the capacitor is discharged, holding the trigger low. This triggers the timer, which establishes the capacitor charge path through RA and RB. When the capacitor reaches the threshold level of 2/3 VCC, the output drops low and the discharge transistor turns on. The timing capacitor now discharges through RB. When the capacitor voltage drops to 1/3 VCC, the trigger comparator trips, automatically retriggering the timer, creating an oscillator whose frequency is given by:

$$f = \frac{1.49}{(R_A + 2R_B)\,C}$$

Selecting the ratios of RA and RB varies the duty cycle accordingly. Lo and behold, we have a problem. If a duty cycle of less than fifty percent is required, then what? Even if RA=0, the charge time cannot be made smaller than the discharge time because the charge path is RA+RB while the discharge path is RB alone. In this case it becomes necessary to insert a diode in parallel with RB, cathode toward the timing capacitor. Another diode is desirable, but not mandatory (this one in series with RB), cathode away from the timing capacitor. Now the charge path becomes RA, through the parallel diode into C. Discharge is through the series diode and RB to the discharge transistor. This scheme will afford a duty cycle range from less than 5% to greater than 95%. It should be noted that for reliable operation a minimum value of 3kW for RB is recommended to assure that oscillation begins.

Time Delay

In this third basic operating mode, we aim to accomplish something a little different from monostable operation. In the monostable mode, when a trigger was applied, immediately changed to the high state, timed out, and returned to its pre-trigger low state. In the time delay mode, we require the output not to change state upon triggering, but at some precalculated time after trigger is received. The threshold and trigger are tied together, monitoring the capacitor voltage. The discharge function is not used. The operation sequence begins as transistor (T1) is turned on, keeping the capacitor grounded. The trigger sees a low state and forces the timer output high. When the transistor is turned off, the capacitor commences its charge cycle. When the capacitor reaches the threshold level, only then does the output change from its normally high state to the low state. The output will remain low until T1 is again turned on.



Astable Operation

Triggering 555 with IR sensors:
The following ckt is used for triggering the 555 ckt with IR sensors and moving a motor forward and reverse.

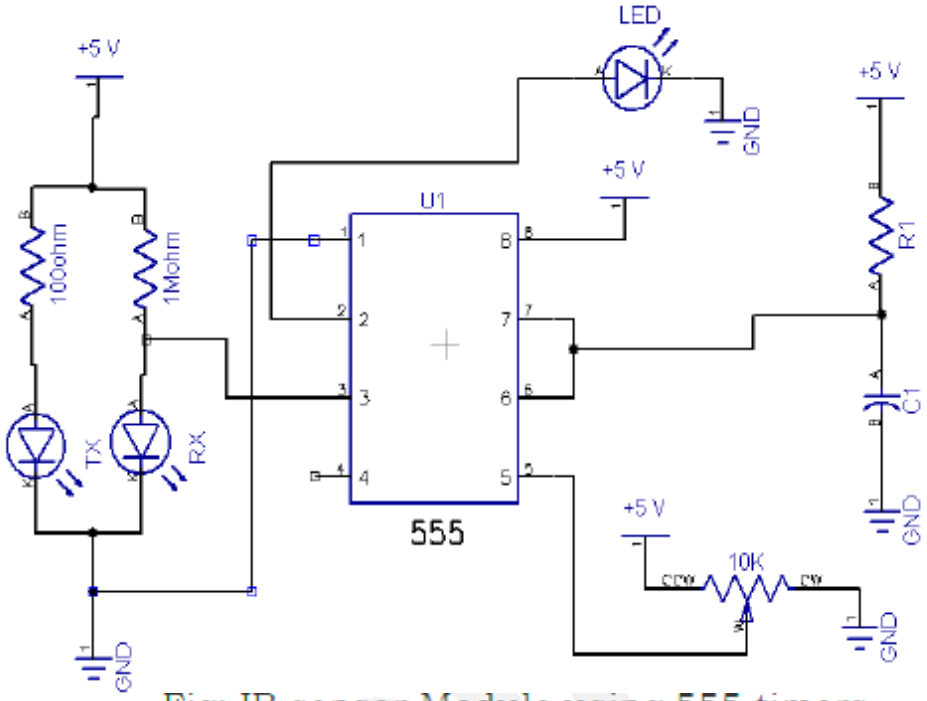
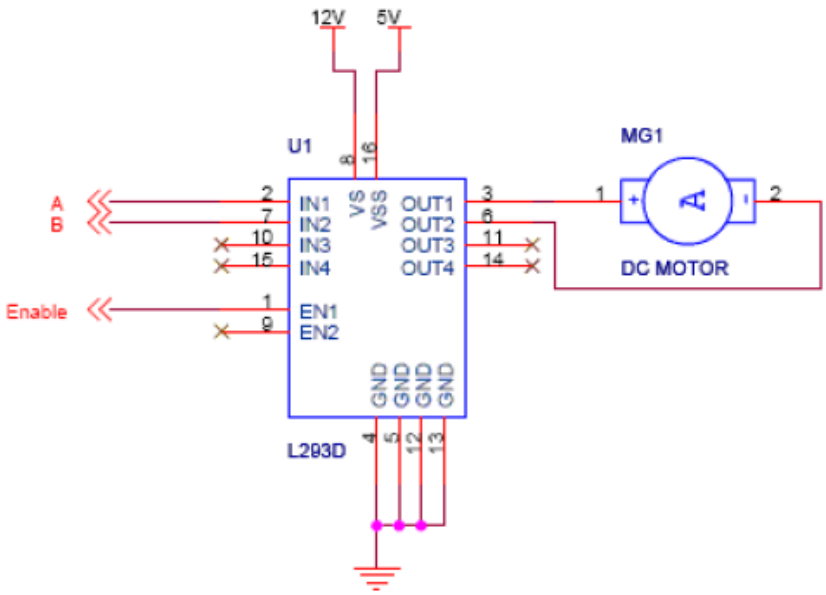


Fig: IR sensor Module using 555 timers

Troubleshooting Tips:
1. 555 IC can be trigger by touching on 2 pin (trigger)
2. 555 trigger if voltage at pin 2 is below 2/3 of Vcc.
3. Trigger voltage is half of voltage applied at 5 pin (control voltage)
4. Control voltage (pin 5) used to set trigger voltage of 555 timers.
5. Lower the trigger voltage , more sensitive is sensor
6. Higher the triggering voltage, lower is sensitivity of sensor module.
7. Sensing Range of sensor is controlled by control voltage.
8. 555 timer is industry most widely and lower cost IC.
9. Best manufacture of 555 is ST, avoid use of other company IC.
10. While making circuits always keep voltage upto 5 volt and current not more than 250mA.
11. For more application of 555. Read its Application Note.

L293D / MOTOR DRIVER /H-BRIDGE

L293D is a dual H-Bridge motor driver, so with one IC we can interface two DC motors which can be controlled in both clockwise and counter clockwise direction and if you have motor with fix direction of motion then you can make use of all the four I/Os to connect up to four DC motors. L293D has output current of 600mA and peak output current of 1.2A per channel. Moreover for protection of circuit from back EMF output diodes are included within the IC. The output supply (VCC2) has a wide range from 4.5V to 36V, which has made L293D a best choice for DC motor driver. A simple schematic for interfacing a DC motor using L293D is shown below



Truth Table

A	B	Description
0	0	Motor stops or Breaks
0	1	Motor Runs Anti-Cloclwise
1	0	Motor Runs Clockwise
1	1	Motor Stops or Breaks

For above truth table, the Enable has to be Set (1). Motor Power is mentioned 12V, but you can connect power according to your motors.

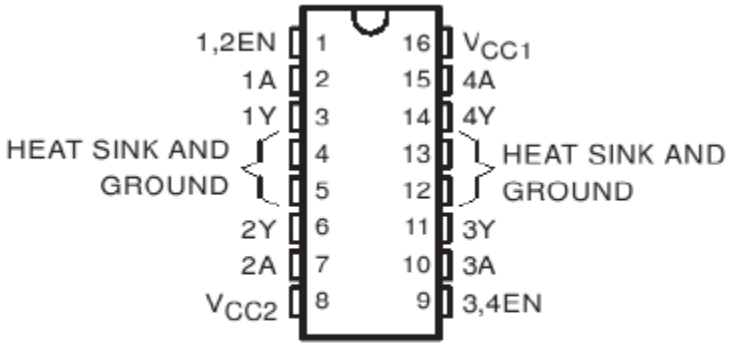
Note: STMicroelectronics IC cost is 90 INR (Always use ST)

Fairchild is about 50 INR (Poor performance, Low current)

As you can see in the circuit, three pins are needed for interfacing a DC motor (A, B, Enable). If you want the o/p to be enabled completely then you can connect Enable to VCC and only 2 pins needed from controller to make the motor work. As per the truth mentioned in the image above it's fairly simple to program the microcontroller. It's also clear from the truth table of BJT circuit and L293D the programming will be same for both of them, just keeping in mind the allowed combinations of A and B. We will discuss about programming in C as well as assembly for running motor with the help of a microcontroller. As seen from above, L293d is an 16 pin IC(integrated Circuit) shown below along with its pin configuration:

Fig: L293D (ST Microelectronics)

L293D PIN CONFIGURATION AND input- output logic function table:



FUNCTION TABLE
(each driver)

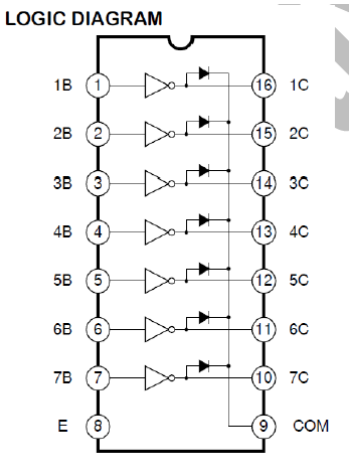
INPUTS†		OUTPUT
A	EN	Y
H	H	H
L	H	L
X	L	Z

H = high-level, L = low-level
X = irrelevant
Z = high-impedance (off)
† In the thermal shutdown mode, the output is in a high-impedance state regardless of the input levels.

ULN2003

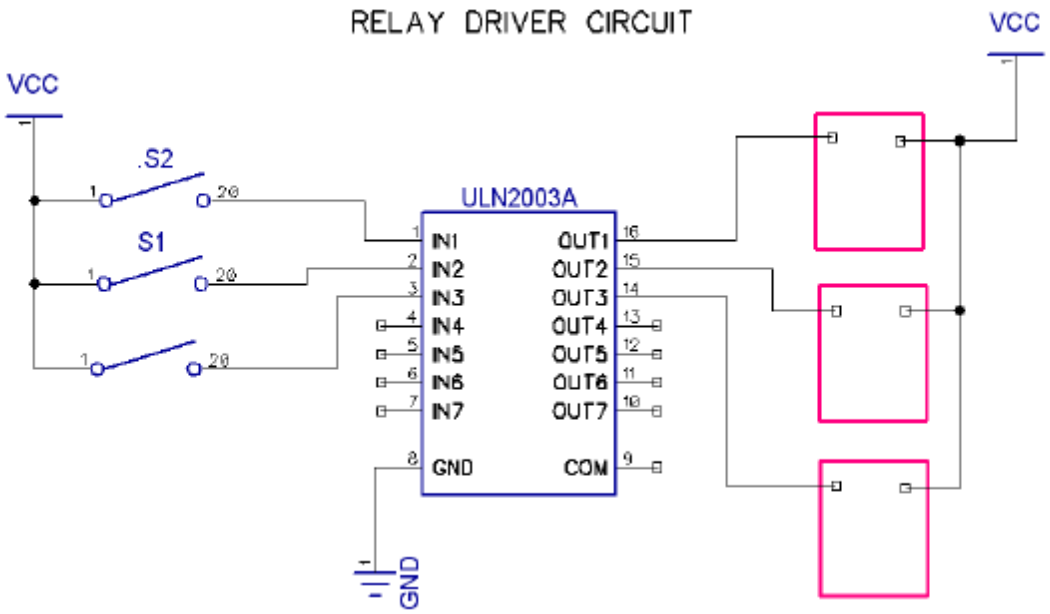
The ULN2003 is a monolithic high voltage and high current Darlington transistor arrays. It consists of seven NPN darlington pairs that features high-voltage outputs with common-cathode clamp diode for switching inductive loads. The collector-current rating of a single darlington pair is 500mA. The darlington pairs may be parrlleled for higher current capability. Applications include relay drivers, hammer drivers, lampdrivers, display drivers(LED gas discharge),line drivers, and logic buffers. The ULN2003 has a 2.7kW series base resistor for each darlington pair for operation directly with TTL or 5V CMOS devices.

LOGIC DIAGRAM



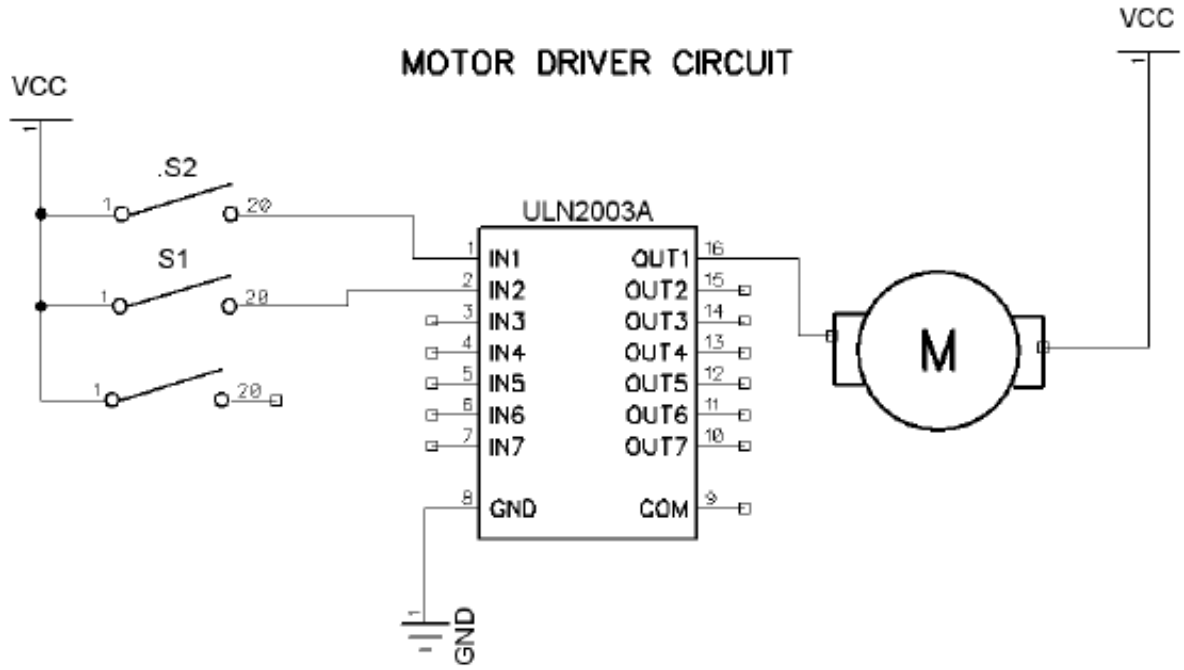
It accept 5 volt signal as input and can drive 7 motor in ON-OFF , 7 relay and high power lamps In robotics it is mostly used to control the relays ,and relays are used to control high power Motors for e.g. robowar application

Driving 4 relays using ULN2003 and controlling AC socket



In these circuit input can be given from any Digital ic / Microcontroller / Switches / Computer Parallel port etc . Do practice on this circuit before using ULN2003 with other IC. The Circuit shown above is used to drive relays

Driving Motor using ULN2003



9170/8870/DTMF DECODER

DTMF IC is kind of decoder that take analog tone/DTMF tone as input and produce 4 bit digital output. In mobile phone each button produce different frequency tone and this IC produce different output for different frequency.

If '1' is pressed output is 0001
If '2' is pressed output is 0010
If '3' is pressed output is 0011
If '4' is pressed output is 0100
If '5' is pressed output is 0101
If '6' is pressed output is 0110
If '7' is pressed output is 0111
If '8' is pressed output is 1000
If '9' is pressed output is 1001
If '0' is pressed output is 1010
If ' *' is pressed output is 1011
If '0' is pressed output is 1100

Dual-tone multi-frequency signaling (DTMF) is used for telecommunication signaling over analog telephone lines in the voice-frequency band between telephone handsets and other communications devices and the switching center. The version of DTMF that is used in push-button telephones for tone dialing is known as *Touch-Tone*, was first used by AT&T in commerce as a registered trademark, and is standardized by ITU-T Recommendation Q.23. It is also known in the UK as *MF4*.

Other multi-frequency systems are used for internal signaling within the telephone network.

The Touch-Tone system, using the telephone keypad, gradually replaced the use of rotary dial starting in 1962, and since then DTMF or Touch-Tone became the industry standard for both cell phones and landline service.

MULTIFREQUENCY SIGNALING

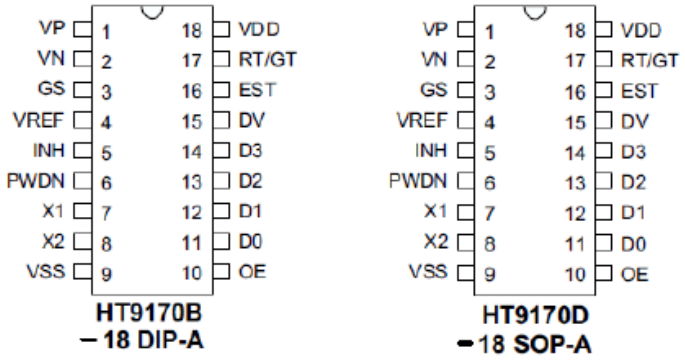
Prior to the development of DTMF, automated telephone systems employed pulse dialing (*Dial Pulse* or DP in the U.S.) or loop disconnect (LD) signaling to dial numbers. It functions by rapidly disconnecting and re-connecting the calling party's telephone line, similar to flicking a light switch on and off. The repeated interruptions of the line, as the dial spins, sounds like a series of clicks. The exchange equipment interprets these dial pulses to determine the dialed number. Loop disconnect range was restricted by telegraphic distortion and other technical problems, and placing calls over longer distances required either operator assistance (operators used an earlier kind of multi-frequency dial) or the provision of subscriber trunk dialing equipment.

Multi-frequency signaling (see also MF) is a group of signaling methods, that use a mixture of two pure tone (pure sine wave) sounds. Various MF signaling protocols were devised by the Bell System and CCITT. The earliest of these were for in-band signaling between switching centers, where long-distance telephone operators used a 16-digit keypad to input the next portion of the destination telephone number in order to contact the next downstream long-distance telephone operator. This semi-automated signaling and switching proved successful in both speed and cost effectiveness. Based on this prior success with using MF by specialists to establish long-distance telephone calls, *Dual-tone multi-frequency*(DTMF) signaling was developed for the consumer to signal their own telephone-call's destination telephone number instead of talking to a telephone operator.

The HT9170B/D Are Dual Tone Multi Frequency (DTMF) Receivers Integrated With Digital Decoder And Band Split Filter Functions As Well As Power-Down Mode And Inhibit Mode Operations. Such Devices Use Digital Counting Techniques To Detect And Decode All The 16 DTMF Tone Pairs Into A 4-Bit Code Output.

Highly Accurate Switched Capacitor Filters Are Implemented To Divide Tone Signals Into Low And High Group Signals. A Built-In Dial Tone Rejection Circuit Is Provided To Eliminate The Need For Pre-Filtering.

Pin Assignment



HT9170B
– 18 DIP-A

HT9170D
– 18 SOP-A

Pin Description

Pin Name	I/O	Internal Connection	Description
VP	I	Operational Amplifier	Operational amplifier non-inverting input
VN	I		Operational amplifier inverting input
GS	O		Operational amplifier output terminal
VREEF	O	VREF	Reference voltage output, normally $V_{DD}/2$
X1	I	oscillator	The system oscillator consists of an inverter, a bias resistor and the necessary load capacitor on chip. A standard 3.579545MHz crystal connected to X1 and X2 terminals implements the oscillator function.
X2	O		
PWDN	I	CMOS IN Pull-low	Active high. This enables the device to go into power down mode and inhibits the oscillator. This pin input is internally pulled down.
INH	I	CMOS IN Pull-low	Logic high. This inhibits the detection of tones representing characters A, B, C and D. This pin input is internally pulled down.
VSS	—	—	Negative power supply, ground
OE	I	CMOS IN Pull-high	D0~D3 output enable, high active
D0~D3	O	CMOS OUT Tristate	Receiving data output terminals OE="H": Output enable OE="L": High impedance
DV	O	CMOS OUT	Data valid output When the chip receives a valid tone (DTMF) signal, the DV goes high; otherwise it remains low.
EST	O	CMOS OUT	Early steering output (see Functional Description)
RT/GT	I/O	CMOS IN/OUT	Tone acquisition time and release time can be set through connection with external resistor and capacitor.
VDD	—	—	Positive power supply, 2.5V~5.5V for normal operation

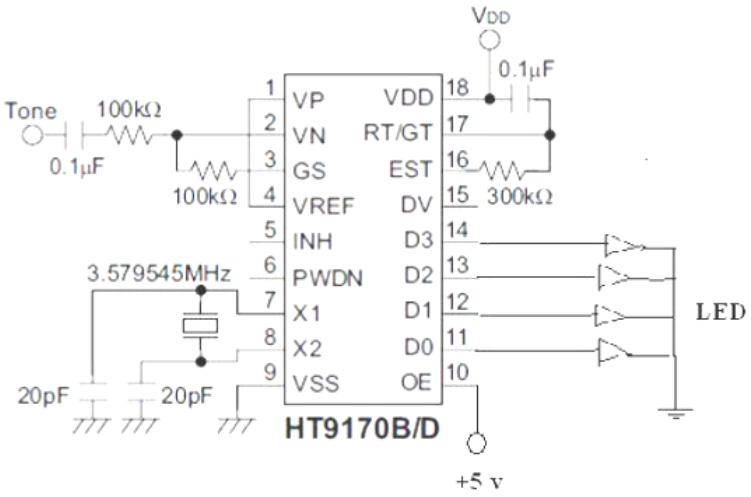


Fig: Interfacing Mobile with DTMF IC

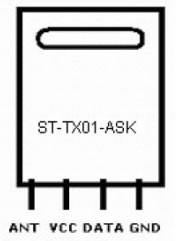
Troubleshooting Tips:

1. Above given circuit is tested and working.
2. Every speaker has two wire, connect one wire to ground and other to tone input
3. Keep keypad tone of mobile high
4. Every volume option of mobile set to maximum level

HT12D/HT12E/ WIRELESS APPLICATION

In this topic we will learn how to make thing control wirelessly by creating their own RF modules and circuit. We can control any appliances, robotics application, data transmission and many more RF application HT12E is decoder IC used for encoding in transmission Purposes HT12D is encoder IC used for decoding in Reception Purposes These two IC have almost same pin description In any RF Application we need Two Components Endcoder and Modulation ckt as shown below

RF transmitter The ST-TX01-ASK is an ASK Hybrid transmitter module. ST-TX01-ASK is designed by the Saw Resonator, with an effective low cost, small size, and simple-to-use for designing.
Frequency Range:315 / 433.92 MHZ.
Supply Voltage: 3~12V.
Output Power: 4~16dBm
Circuit Shape: Saw



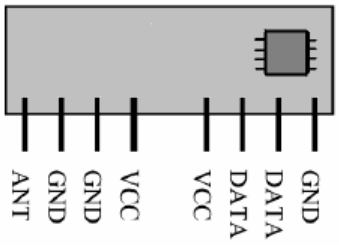
RF receiver

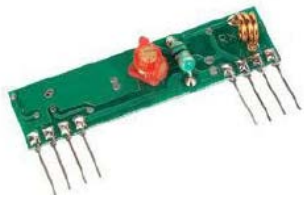
The ST-RX02-ASK is an ASK Hybrid receiver module. An effective low cost solution for using at 315/433.92 MHZ.

ST-RX02-ASK receiver

The circuit shape of ST-RX02-ASK is L/C.
Receiver Frequency: 315 / 433.92 MHZ
Typical sensitivity: -105dBm
Supply Current: 3.5mA

IF Frequency: 1MHz

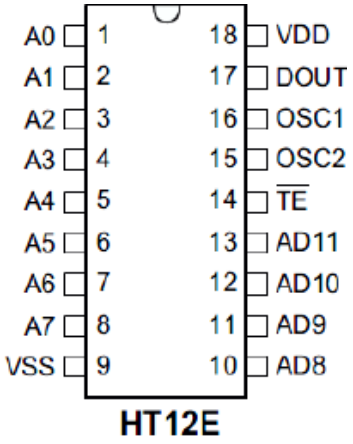




Remark: 1. Antenna length about :23cm for 315MHz 17cm for 434MHz **Encoder**

HT12E General Description

The 212 encoders are a series of CMOS LSIs for remote control system applications. They are capable of encoding information which consists of N address bits and 12N data bits. Each address/data input can be set to one of the two logic states. The programmed addresses/data are transmitted together with the header bits via an RF or an infrared transmission medium upon receipt of a trigger signal. The capability to select a TE trigger on the HT12E or a DATA trigger on the HT12A further enhances the application flexibility of the 212 series of encoders. The HT12A additionally provides a 38kHz carrier for infrared systems.



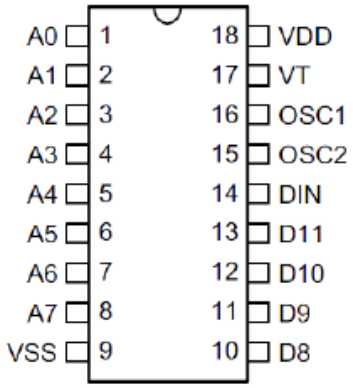
Pin Diagram of HT12E (Encoder)

Pin Description

Pin Name	I/O	Internal Connection	Description
A0~A7	I	CMOS IN Pull-high (HT12A)	Input pins for address A0~A7 setting These pins can be externally set to VSS or left open
		NMOS TRANSMISSION GATE PROTECTION DIODE (HT12E)	
AD8~AD11	I	NMOS TRANSMISSION GATE PROTECTION DIODE (HT12E)	Input pins for address/data AD8~AD11 setting These pins can be externally set to VSS or left open
D8~D11	I	CMOS IN Pull-high	Input pins for data D8~D11 setting and transmission enable, active low These pins should be externally set to VSS or left open (see Note)
DOUT	O	CMOS OUT	Encoder data serial transmission output
L/MB	I	CMOS IN Pull-high	Latch/Momentary transmission format selection pin: Latch: Floating or VDD Momentary: VSS

Encoder HT12D General Description The 212 decoders are a series of CMOS LSIs for remote control system applications. They are paired with Holtek_s 212 series of encoders (refer to the encoder/decoder cross reference table). For proper operation, a pair of encoder/decoder with the same number of addresses and data format should be chosen. The decoders receive serial addresses and data from a programmed 212 series of encoders that are transmitted by a carrier using an RF or an IR transmission medium. They compare the serial input data three times continuously with their local addresses. If no error or unmatched codes are found, the input data codes are decoded and then transferred to the output pins. The VT pin also goes high to indicate a valid transmission. The 212 series of decoders are capable of decoding informations that consist of N bits of address and 12_N bits of data. Of this series, the HT12D is arranged to provide 8 address bits and 4 data bits, and HT12F is used to decode 12 bits of address information.

8-Address
4-Data



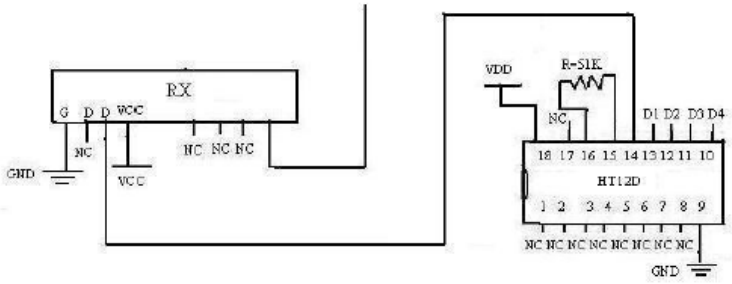
HT12D
Pin diagram

Pin Description

Pin Name	I/O	Internal Connection	Description
A0~A11 (HT12F)	I	NMOS Transmission Gate	Input pins for address A0~A11 setting These pins can be externally set to VSS or left open.
A0~A7 (HT12D)			Input pins for address A0~A7 setting These pins can be externally set to VSS or left open.
D8~D11 (HT12D)	O	CMOS OUT	Output data pins, power-on state is low.
DIN	I	CMOS IN	Serial data input pin
VT	O	CMOS OUT	Valid transmission, active high
OSC1	I	Oscillator	Oscillator input pin
OSC2	O	Oscillator	Oscillator output pin
VSS	—	—	Negative power supply, ground
VDD	—	—	Positive power supply

Receiver

BASIC CIRCUIT FOR RECIEVER



VDD=VCC=5V

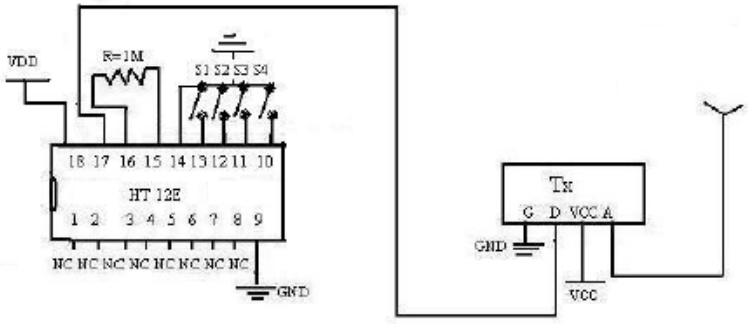
NC — Not Connected

RX — Receiver Module

D1...D4 — Output Data

Transmitter

BASIC CIRCUIT FOR TRANSMITTER



VDD=VCC=5V

NC — Not Connected

Tx — Transmitter Module

S1...S8 — Switches

Trouble-shooting HT12D and HT12E: Connect 4 led's at the output/ data pins of ht12d and transmit pulses manually from ht12e data pins and check the output received on the Led's at the receiver side.

74194 /PIPO/STEPPER MOTOR DRIVER

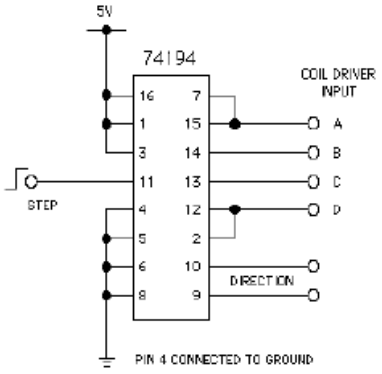
INTRODUCTION: UNIPOLAR stepper motor driver is a digital IC based circuit that uses a parallel input parallel output shift register to work as stepper motor logic generator.. The drivers are designed for simple requirement applications and are made with parts that are available from a variety of sources. Both of the stepper drivers are use a 74194 - Bidirectional Universal Shift Register from the 74LS or 74HC - TTL families of logic devices to produce the stepping function. A diagram at the bottom of this page shows the difference between the 74194 - UNIPOLAR and BIPOLAR step pattern generators. The UNIPOLAR driver uses a ULN2003 - eight segments, Darlington IC as its output device. These stepper drivers have only basic control functions: Forward, Reverse and Stop adjustment. The calculated Step rate adjustment range of the drivers is 0.72 (1.39 sec) to 145 steps per second. (Lower and higher step rates are also possible.) The only step angle for these drivers is

the design step angle of the motor itself. 'Half-stepping' is not possible with either of the driver circuits.

COMPARISON OF THE 74194 – UNIPOLAR AND BIPOLAR STEP GENERATOR CONFIGURATIONS

 http://home.cogeco.ca/~rpaisley4/CircuitIndex.html Stepper 10 Pattern Comparison 03 December, 2008

UNIPOLAR GENERATOR



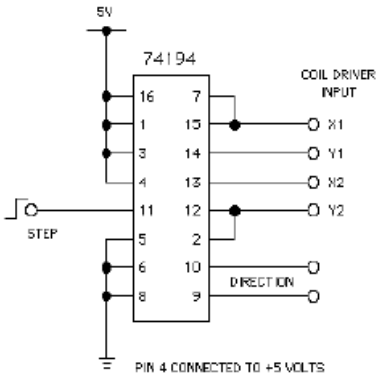
OUTPUT FROM THE 74194

PIN	STEP 1	2	3	4
15	H	L	L	L
14	L	H	L	L
13	L	L	H	L
12	L	L	L	H

ULN2803 MOTOR DRIVER

IN	STEP 1	2	3	4	OUT
1,2	L	H	H	H	18,17
3,4	H	L	H	H	16,15
5,6	H	H	L	H	14,13
7,8	H	H	H	L	12,11

BIPOLAR GENERATOR



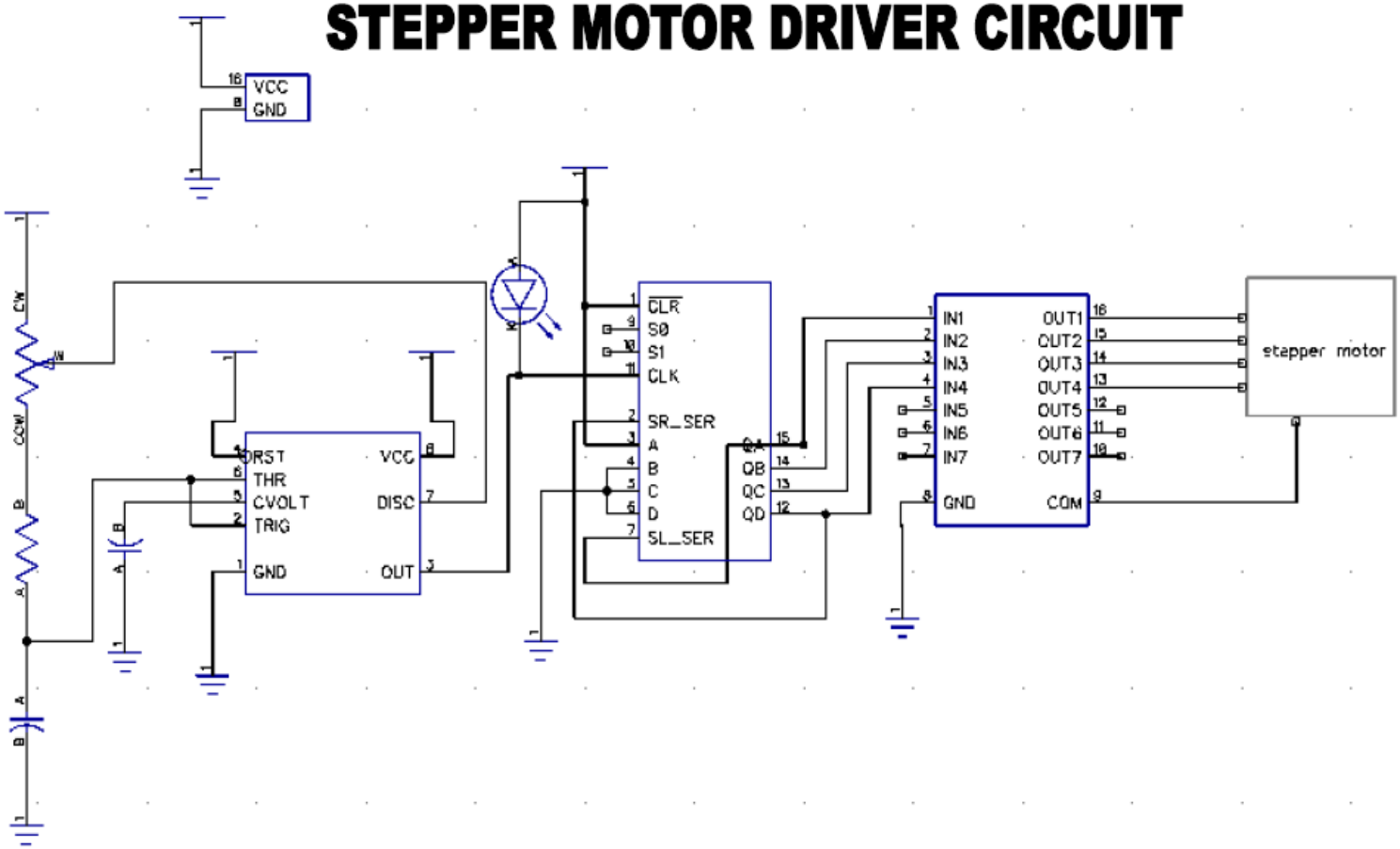
OUTPUT FROM THE 74194

PIN	STEP 1	2	3	4
15	H	L	L	H
14	H	H	L	L
13	L	H	H	L
12	L	L	H	H

L293D MOTOR DRIVER

IN	STEP 1	2	3	4	OUT
10	H	L	L	H	11
15	L	H	H	L	14
2	H	H	L	L	3
7	L	L	H	H	6

STEPPER MOTOR DRIVER CIRCUIT



PART – III SOME ROBOTICS APPLICATIONS OF BASIC ELECTRONICS

Line Follower Robot

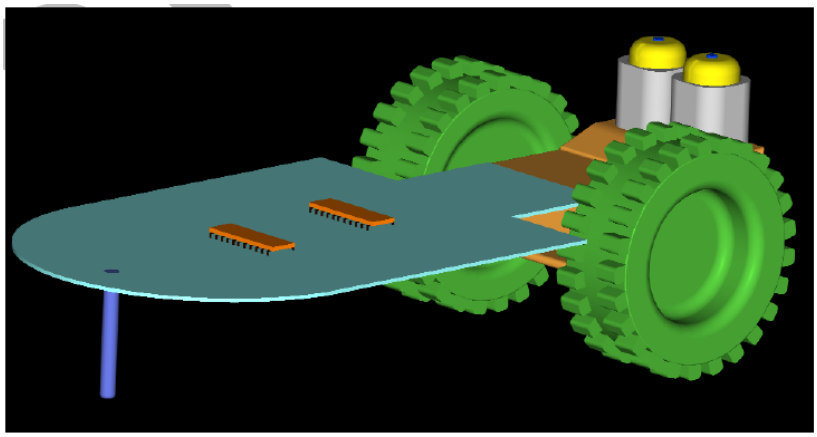
Problem Statement: A robot that moves on a Line that is basically over a black line on a white surface.

Principle: It is based on the property of colors (black white) i.e. white colour selectively reflects light and black colour absorbs light. There are two parts of this line follower robot:-

1. Electronic part
2. Mechanical part

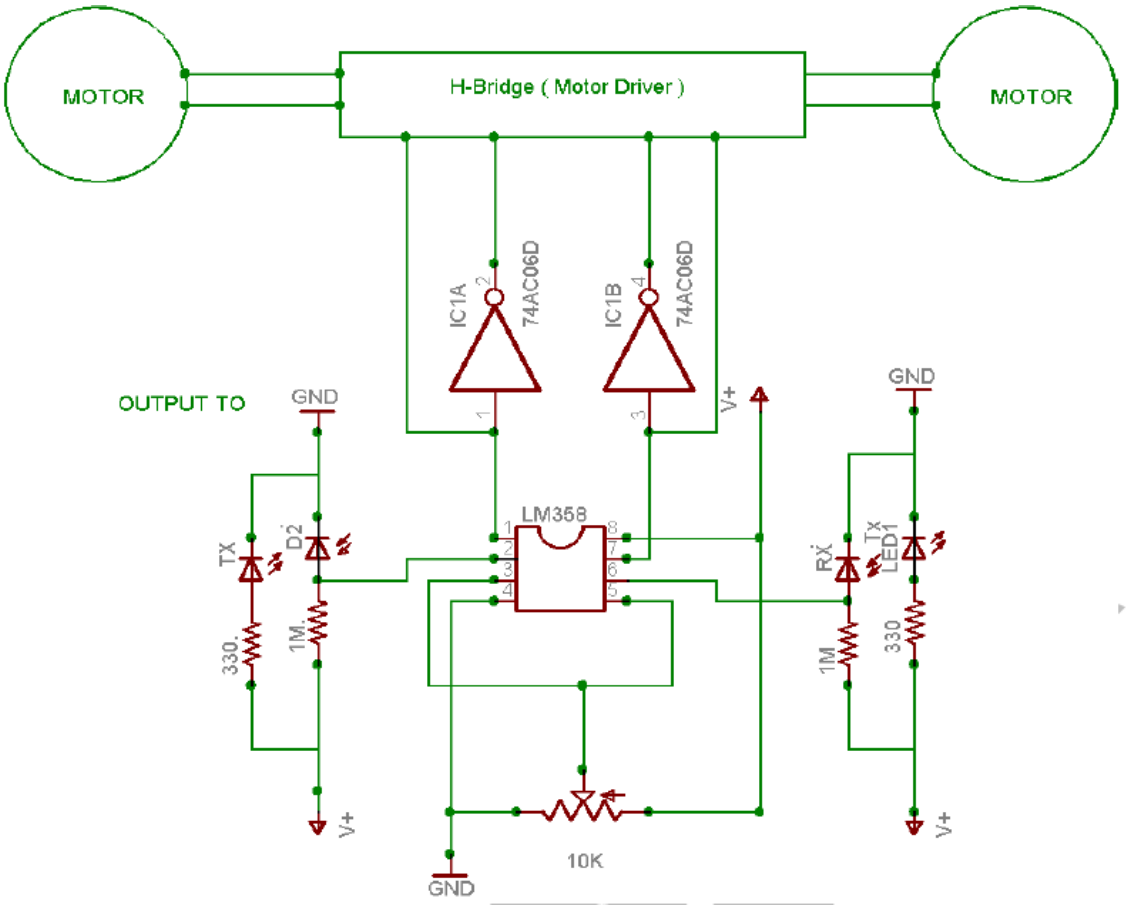
The electronic part is based on the principle of selective reflection and absorption of light. The mechanical part is based on the principle of differential mechanism. According to this principle if there are two wheels in a vehicle and 1 moves forward &other moves back ward then the vehicle turns left or right as:- CASE1:- if the right wheels moves clockwise and the left wheel moves anticlockwise then it will turn left. CASE2:-if the left wheel moves clockwise and right wheel moves anticlockwise then vehicle will turns right.

Requirements: IR sensor ,resistance(100 ohm,330 ohm, 1Mohm),PCB,IC LM358, variable resistance(10K), NOT gate IC7404, IC L293D,Push to on switch, battery, (9volt).

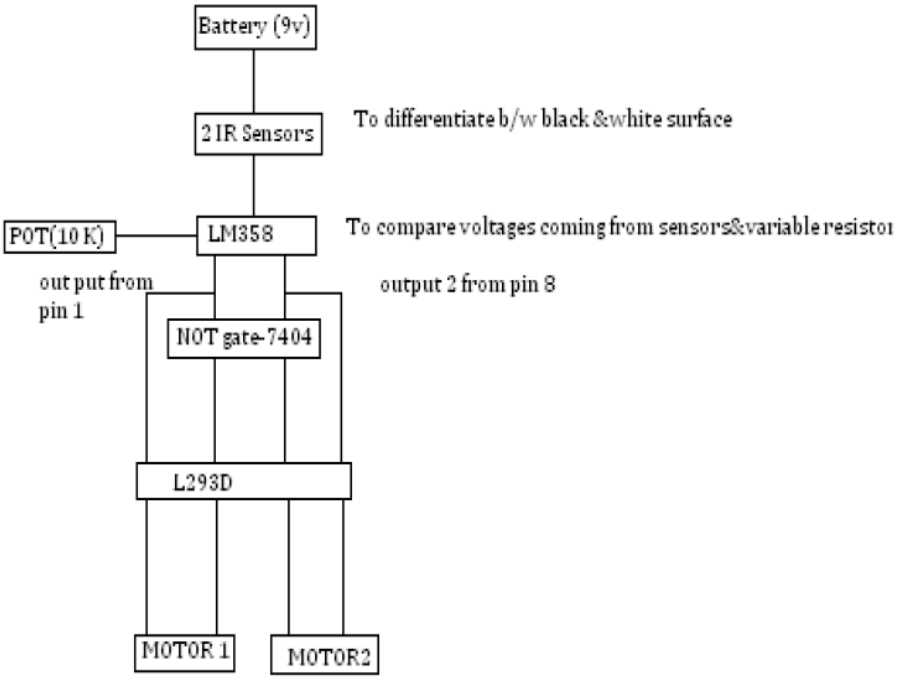


AUTO-CAD DRAWING OF THE LINE FOLLOWER ROBOT

Circuit Diagram:


MOTOR
H-Bridge (Motor Driver)
MOTOR
IC1A
74AC06D
IC1B
74AC06D
OUTPUT TO
GND
V+
LM358
GND
TX
D2
330.
1M
RX
LED1
1M
330
10K
GND
V+
V+

Flowchart:


Battery (9v)
2 IR Sensors
To differentiate b/w black &white surface
POT(10 K)
LM358
To compare voltages coming from sensors&variable resistor
out put from pin 1
output 2 from pin 8
NOT gate-7404
L293D
MOTOR 1
MOTOR2

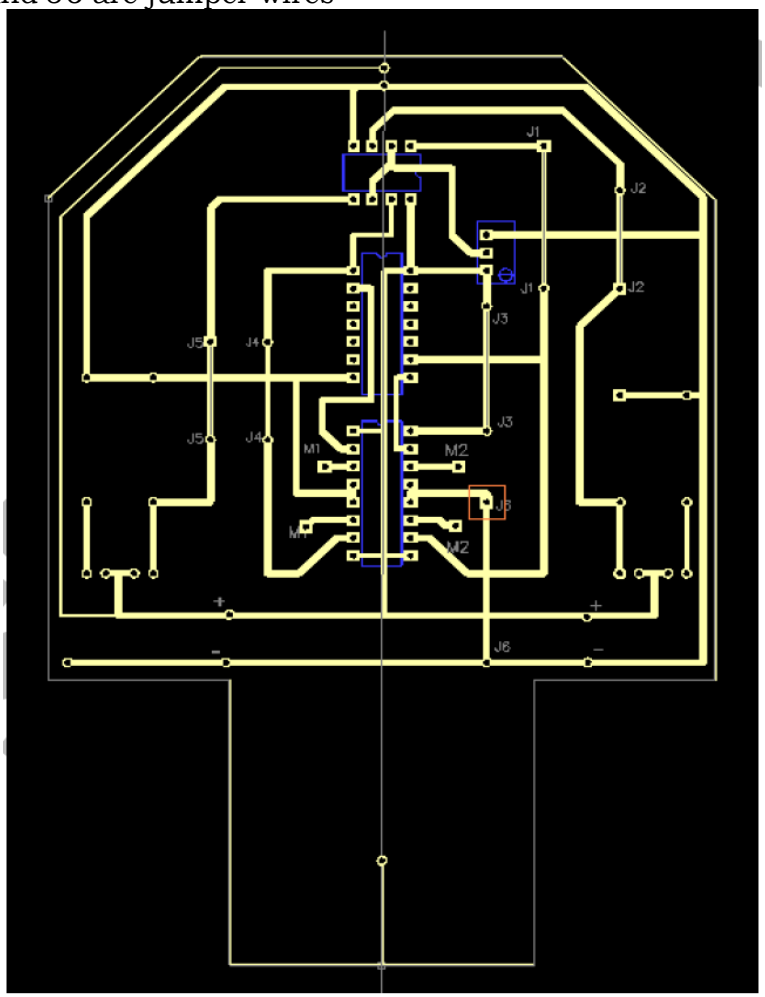
Working: The power supply given to the circuit through battery (9 volt).IR sensors sense the light,and if it is placed on a white surface transmitter send the light signal to the receiver by reflection through white surface so the output voltage of the potential divider circuit on both sides rises to 3 volt .the output of potential divider connected to (3 pin)i.e. positive pin of IC –LM358 and act as its non inverting input. The output voltage of (sensor2),is connected to (5pin).(2 pin) & (6 pin) of LM358 are short circuit and are given inverting input from potentiometer output voltage of which is set to 2.8volt .output voltage of comparator is taken out through pin1& pin7.Comparator compares the voltages coming from potentiometer and IR sensors. If the voltage at positive pin is more than negative pin output signal send is 1i.e.(+Vsat) And if voltage at negative pin is more than positive pin the output voltage is0 (-Vsat)If there is white surface below the line follower, it reflects light i.e. input signal sent is (3volt) At positive pin and is more than the voltage on negative pin i.e. output voltage coming from sensors is high but if line follower move on the black surface below any of the sensor i.e. output at negative in is higher than that of positive pin. So output voltage sent is zero. The two output voltage of LM358 is sent to NOT gate .output 1 is connected to pin 1A and output 3 is connected to pin 6A.four output are taken out from pin 1A pin1Y ,pin6A , pin6y .which are connected to ICL293D.Now four cases arises:-

CASE1:-the output from both sensors is 1. It means there is white surface below both the sensors therefore output of NOT gate is 0. Hence signal obtained from both NOT gate is 1&0.
CASE2:-the output from first sensor is 1and from second is 0 i.e. second sensors appear below the black line. So respective output voltage from NOT gate will be 0&1.Hence the two signals are like (1&0) for first sensor and (0&1) for second sensor.
CASE3:-if the output from sensor 1is0and from sensor2 is 1, i.e. black surface appears below sensor 1then output signal for two sensor are (0&1) and(1&0).
CASE4:-If the output voltage from both the sensors is 0i.e. black surface appears below both the sensors but this is not possible as there is no crossing or overlapping of two black lines.
Then these four output are send to ICL293D that act as amplifier.

Three cases for outputs will be:-
CASE1:- (5&0) and (5&0), therefore, both motors moves forward, hence, ***robot moves forward.***
CASE2 :-(5&0) and (0&5), therefore, Motor 1 moves forward and Motor 2 turns backwards, ***robot turns right***.
CASE3 :-(0&5) and (5&0), therefore, Motor 1 moves backward and Motor 2 turns forward, ***robot turns left***. This motion of motor is based on differential mechanism.

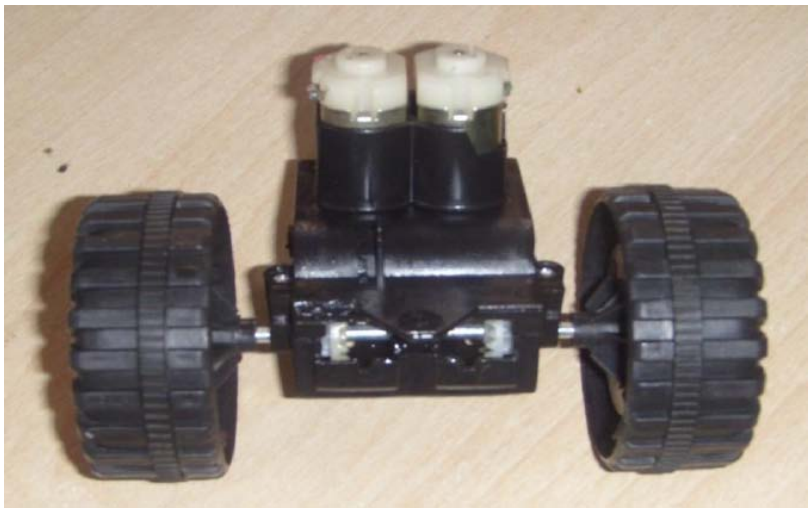
PCB DESIGN OF THE ROBOT:

J1,J2,J3,J4,J5 and J6 are jumper wires

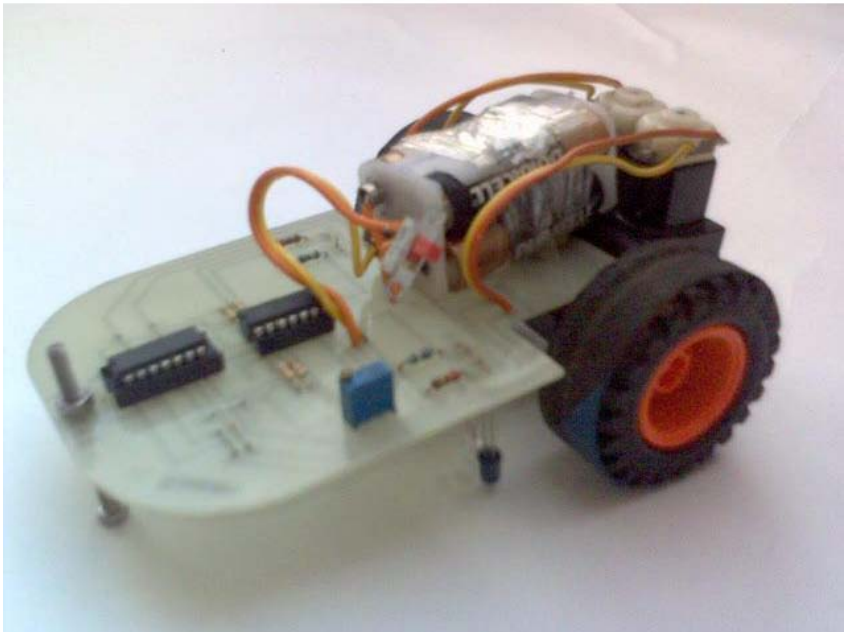


STEP-WISE ASSEMBLY OF LINE FOLLOWER ROBOT:

DESIGN 1: Using Plastic Dc Geared Motors



Plastic Gear Box (including 2 dc geared motors and tires)
Gear box is taken from JCB Crane toy

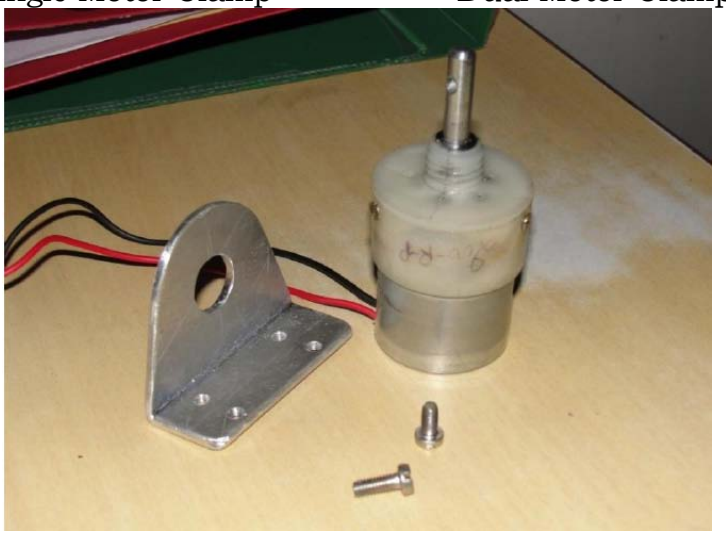


Assembled robot

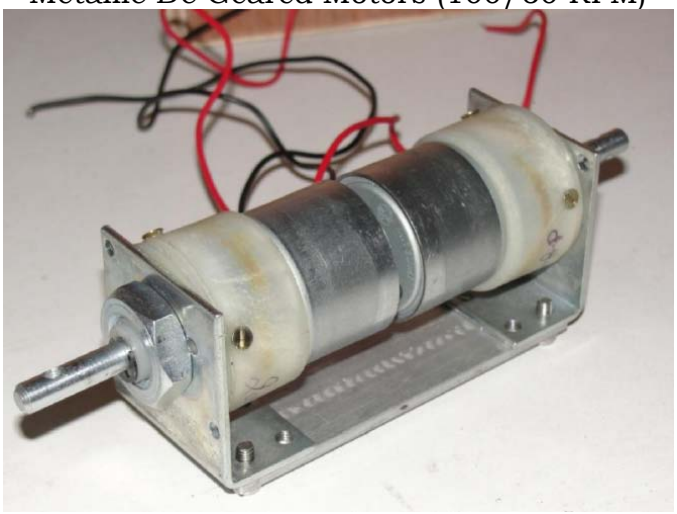
DESIGN 2: Using Metallic Dc Geared Motors and customized wheels

Single Motor Clamp

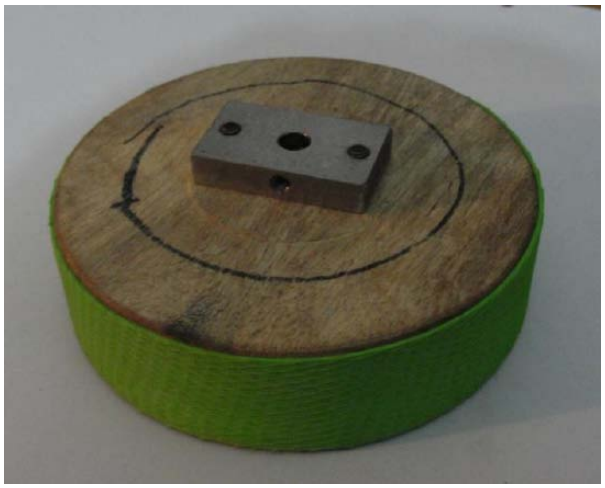
Dual Motor Clamp



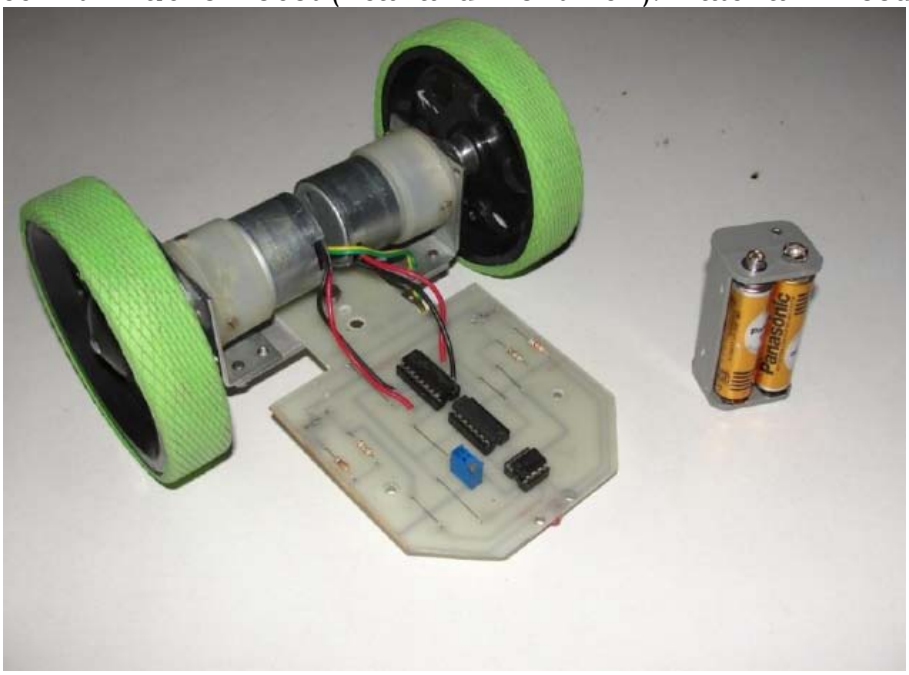
Metallic Dc Geared Motors (100/60 RPM)



Motors with Clamps



Tires with Hub for robot (Rear and Front view): Material – Wooden



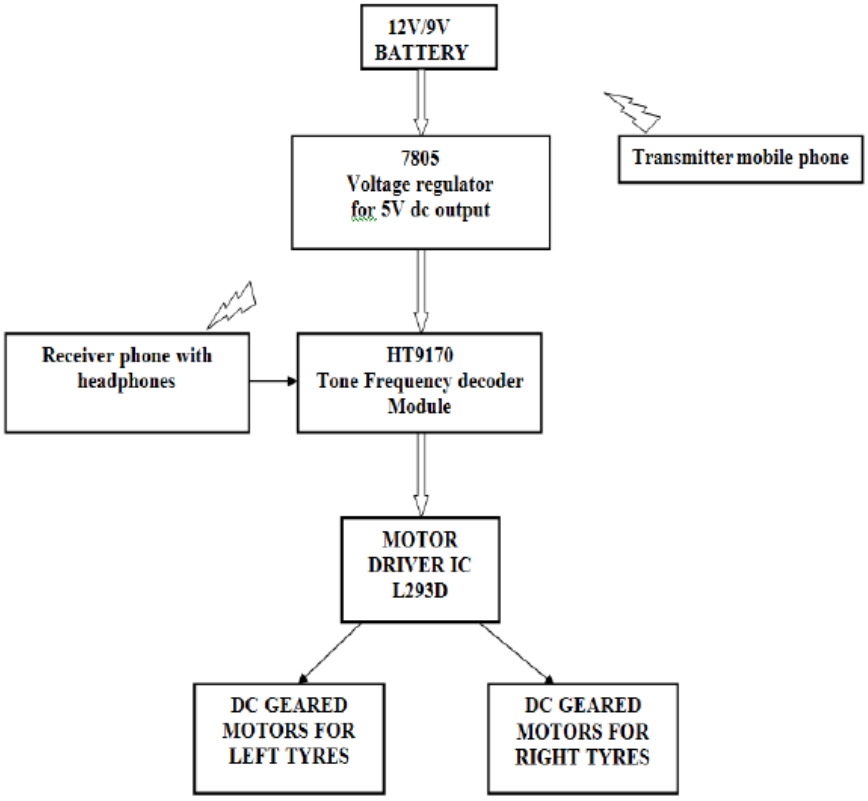
Assembled Robot

View video assembly of this robot at U-Tube (search by — strobotix‖)
http://www.youtube.com/watch?v=QsSXkVcCz6Y

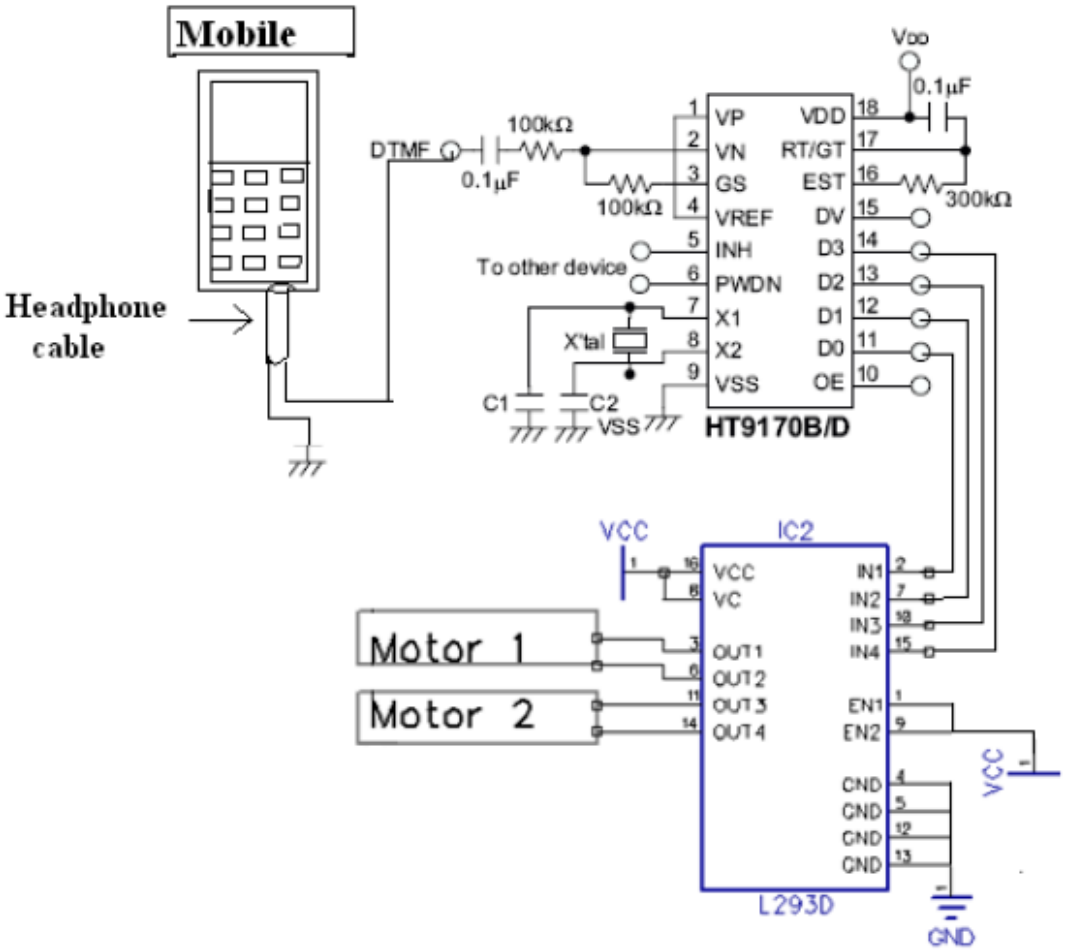
MOBILE CONTROLLED ROBOT

Problem Statement: To make a robot that could be controlled using your mobile phone keypad.
Basic Principle: DTMF, i.e. Dual Tone Multi Frequency concept.
Theory: This robot is based on a simple logic of controlling the direction of motors using mobile phone and involves use of only 2 IC's DTMF 9170 and a motor driver IC L293D and ***does not require any microcontroller*** for working.
Requirements: DTMF IC HT9170B, L293D, 2 DC geared motors, a mobile phone at the receiver section and its headphone jack, crystal oscillator 3.059592 MHz, resistance: 100KΩ and 300KΩ, Capacitors: 0.1μF, 20pF.

Block Diagram:



Circuit Diagram:

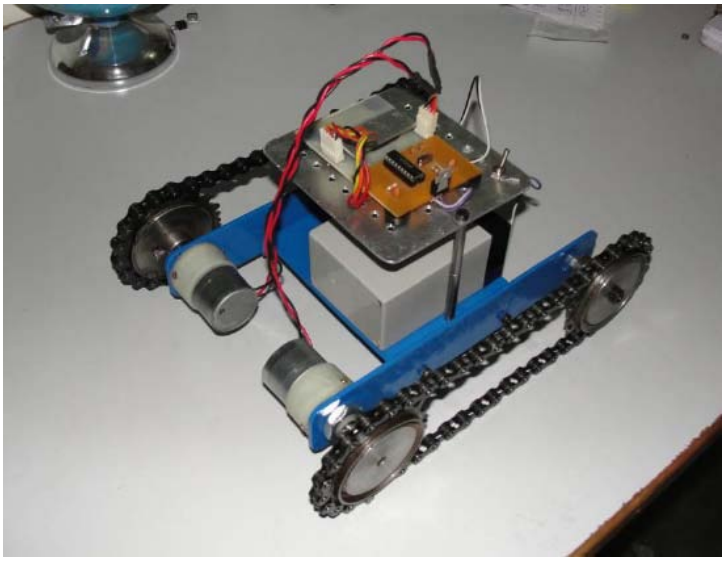


Watch video of this Robot at http://www.youtube.com/watch?v=qbbDluXG1I8

Working:

Robot is controlled by mobile phone using DTMF technique. The Robot is guided by a mobile phone that makes a call to the mobile phone attached to the robot. In the course of a call, if any button is pressed, a tone corresponding to the button pressed is heard at the other end of the call. This tone is called DTMF (dual-tone-multiple-frequency).The robot perceives this DTMF tone with the help of the phone stacked in the robot.The decoder decodes the DTMF tone into its equivalent binary digit and this binary number is sent to the motor driver in order to drive the motors in forward direction or backward direction or turn. The mobile phone that makes a call to mobile phone stacked in the robot act as a remote.

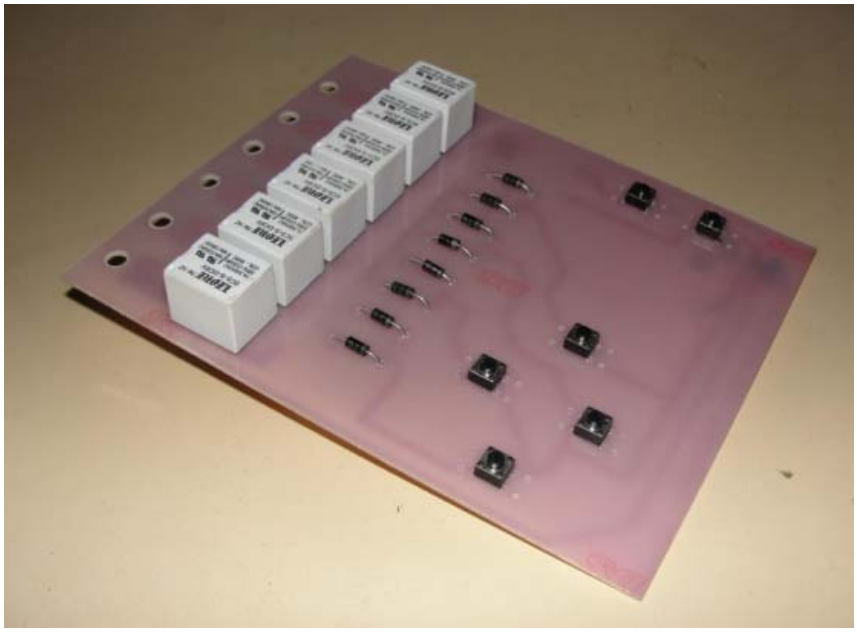
Assembled DTMF Controlled Robot:



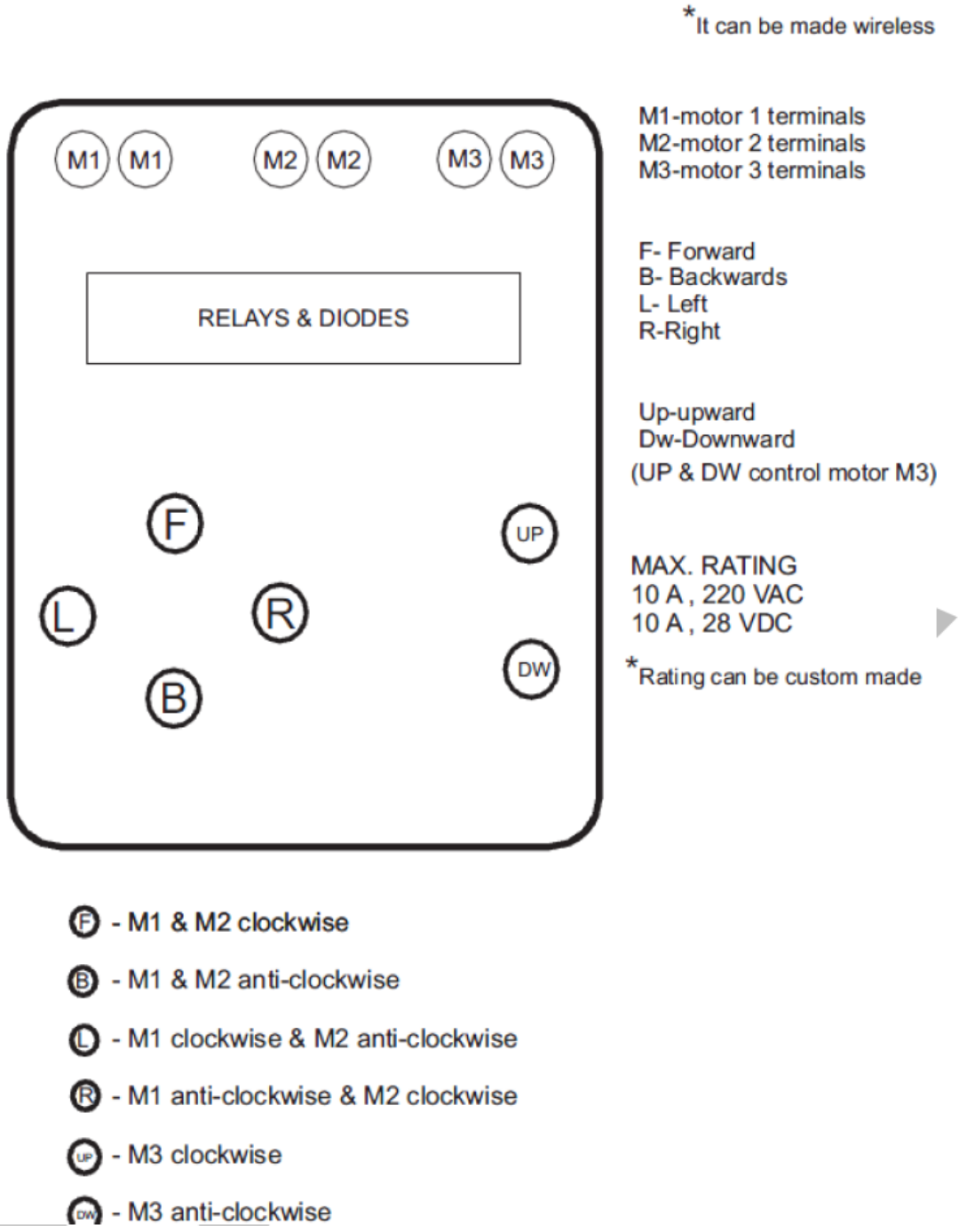
View video of this robot on: http://www.youtube.com/watch?v=rbHDgBRxaOQ

REMOTE CONTROL FOR ROBOTS

All the above ideas that are given are meant for autonomous robotics, but in case of manual robotics for events such as Robowars, Robo-race, etc. manual controlling is essential and most important point and your controlling depends entirely on the remote that you have made. After making different types of remotes and their circuits, I came to a very simple and unique design, that is very easy to operate and effective for a high voltage operation. See the picture below; you would be clear about the simple design and controlling with this remote.

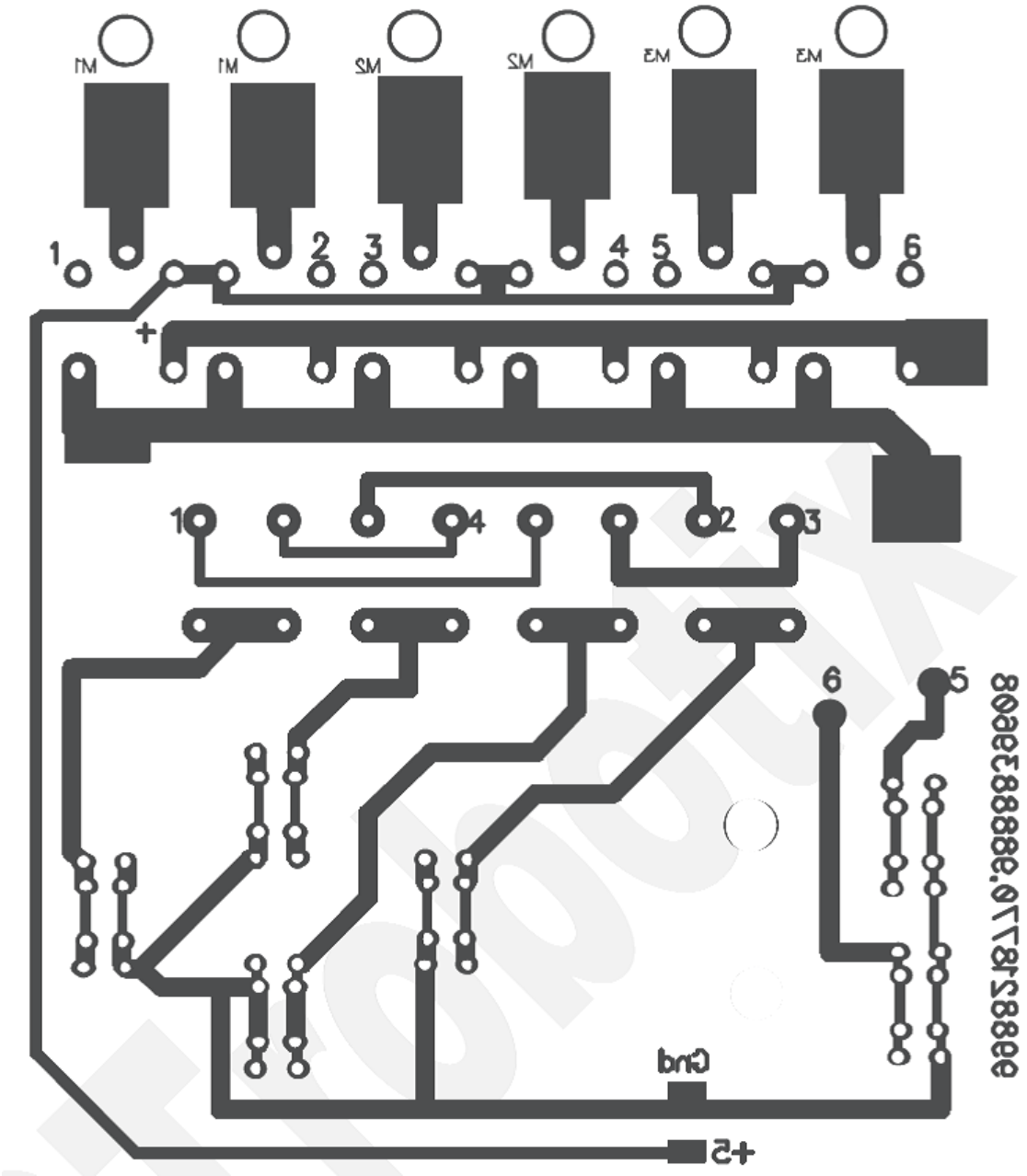


This is six degrees of freedom remote that is we can control 6 different outputs. You could turn on/off 6 dc motors using this remote or reverse the direction of three motors. I made this remote for a pick and place robot. The four tactical switches used to turn robot forward, reverse, left or right and the two switches on the entire right to turn the arm up or down. Diodes here are used to prevent the flow of current in reverse direction and for making the logic to move this robot F,R,L or R using the 4 switches respectively.
The design would be clear from the following schematic of the remote:



Why to use this remote ? In manual controlled Robots, remote plays an important role, if your robot has best design and poor control then you will lose the competition, because 2nd thing matter after good design is good controlling. In normal remote made by using DPDT switches to move robot forward we have to press two switches at a time and similar for left , right and backward , but in our remote for every direction we have to press single button, this type of remote made the controlling of robot very accurate.

PCB DESIGN OF REMOTE:



NOTE: By using some RF components this remote can be converted to wireless remote.

REFERENCE:

[1] ROBOTICS FOR BEGINNER BASED ON ANALOG AND DEIGITAL ELECTRONICS BY ER.TEJINDER DEVGON.

[2] TUTORIALS OF WWW.STROBOTIX.COM.