INTRODUCTION TO

BASIC ELECTRONICS

- ELECTRONICS PROJECTS/HOBBY KITS
- ELECTRONIC EDUCATIONAL KITS
- ELECTRONIC BOOKS/CD'S & COMPONENTS
- PRINTED CIRCUIT BOARD
- DATA BASE DIRECTORIES & CD'S

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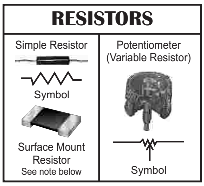
IDENTIFYING ELECTRONIC COMPONENTS

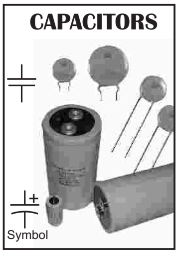
When a budding electronics enthusiast first looks at a circuit board populated with components, he/she is often baffled by the diversity and layout of these components. In the next few sections we shall help you identify some of the simple components and their schematic symbols.

Electronic components:
Electronic components are classified as passive and active devices. A passive device is one that is incapable of providing power gain (amplification) or control action in a circuit or system. Examples are Resistors, Capacitors and Inductors. Active devices are components that are capable of controlling voltages or currents and are thus capable of producing power gain. Examples are transistors and integrated circuits.

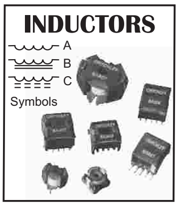
Resistors:
This is the most common passive component used in electronics circuits. It is used mainly to resist/retard the flow of current and drop voltage within a circuit. You can identify a common resistor by its simple cylindrical shape with a wire lead coming out of each end. It uses a system of colour-coded bands to establish its value (measured in Ohms). On the other hand, a surface mount resistor is, in fact, few millimeters in size but performs the same function as its bigger brother, the common resistor. A potentiometer is a variable resistor. It lets you vary the resistance with a dial type control or sliding wiper contact to control relative voltage drop across its two sections, on the fly. Similarly, a rheostat is also a variable resistance used to vary the amount of current flow through a circuit, on the fly.



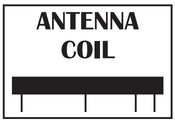
Condensors/Capacitors:
Capacitors abbreviated "caps", vary in size and shape - from a small surface mount tiny model to a huge size like that of a paint can e.g. electric motor capacitor . It stores electrical energy in the form of electrostatic charge. The size of a capacitor generally determines how much charge it can store. A small surface mount or ceramic cap will only hold a minuscule charge. A cylindrical electrolytic capacitor will store a much larger charge. Some of the large electrolytic caps can store enough charge to kill a person, when touched. Another type, called Tantalum Capacitor, can store a larger charge in a smaller package.



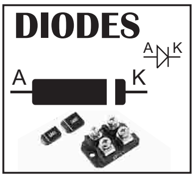
Inductors:
You may recall that electric current flowing through a coil of wire produces magnetic field around it. This is how the inductor works. When a current flows through an inductor, a magnetic field is produced around it and when that field collapses it produces current in the opposite direction. Inductors are used in Alternating Current circuits to oppose changes in the existing current flow. Most inductors can be identified by the "coil-like" appearance. Depending on the core around which it is wound, inductors are categorized as: A. Air Core, B. Iron Core, C. Ferrite Core. An air core means either "no-core" or a core having same permeability (property of concentrating magnetic lines of force) as air.



Antenna Coil:
This consists of several turns of insulated copper wire wound on a plastic tube or ferrite rod. It is used for receiving radio waves. The coils may be wound in two sections: a primary coil and a secondary coil.

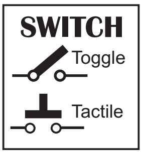


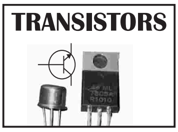
Diodes:
Diodes are basically a one-way valve/device for electrical current. They let the conventional current flow in one direction (from anode to cathode) and not in the opposite direction. They are used to perform rectification or conversion of AC current to DC by clipping off the negative or positive portion of an AC waveform. The diode terminals i.e. cathode and anode can be identified by an arrow sign inside the diode symbol that points towards the cathode, indicating current flow is in that direction when the diode is forward biased and conducting current. Most diodes are similar in appearance to a resistor and will have a painted line on one end showing the direction or flow (white side is negative). In many cases a dot mark is placed near cathode to identify its terminals. If the cathode side is on the negative end of the circuit, current will flow. If the cathode is towards the positive side of the circuit no current will flow.



LEDs (Light Emitting Diodes):
LEDs are simply diodes that emit light of one wavelength/colour or another. They are used as indicator devices. Example: LED lit means machine on. The general-purpose silicon diode emits excess energy in the form of heat when conducting current. If a different semiconductor material such as gallium arsenide phosphide is used, the excess energy can be released at a lower wavelength visible to human eye. They come in several sizes and colors. Some even emit Infrared Light, which cannot be seen by the human eye.

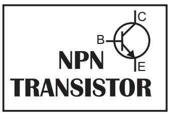
Switch:
This is a mechanical part which when closed makes the current to flow through it. If the switch is opened, the current stops flowing through it. This helps to control current in a circuit.



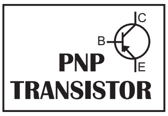


Transistors:
The transistor can perform two basic functions. 1) It can act as a switch turning current on or off. 2) It can act as an amplifier. The amplifer produ-ces an output signal that is a magni-fied version of the input signal. Transi-stors come in several sizes and differ-ent specifications depending on their application. It can be a big power transistor such as is used in power amplifier in your stereo system, down to a tiny surface mount (SMT) device and even in micrometer size as in a microprocessor or Integrated Circuit.

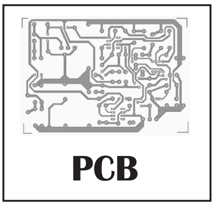
NPN Transistor:
It is one of the two types of bipolar junction transistors. The letters 'N' and 'P' refer to semiconductor materials in which the majority current carriers are negative (electrons) and positive (holes), respectively. Thus an NPN transistor consists of a P doped semiconductor (called 'Base') with two N doped semiconductors on either side. The lesser doped N material is used as collector and higher doped N material is used as emitter. Emitter in NPN transistor is symbolized by an arrow pointing outwards.



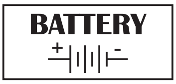
The NPN transistor performs the function of amplification where a small current from base to emitter (in common-emitter configuration) is replicated by a much larger current between the collector and emitter leads.



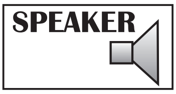
PNP Transistor:
Similar to NPN transistor, the PNP transistors have a wedge of "N" material between two wedges of "P" materials on either side. Emitter in PNP transistor is symbolized by an arrow pointing inwards. The PNP transistor performs the function of amplification when a small conventional current from emitter to base results in a much higher current flowing from emitter to collector (in common-emitter configuration). Thus we observe that directions of input and output (amplified) current are opposite to that of NPN transistor.



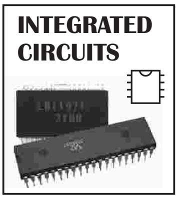
PCBs:
PCB stands for printed circuit board, which is used for wiring up of the components of a circuit. PCBs are made of paper-phenolic FR2 grade (low cost, for low frequency and low power circuit assembly) and glass epoxy FR4 grade (for high frequency, high power circuits) copper clad laminates (available in 1.6mm, 2.4mm and 3.6mm thickness). Single-sided PCBs have copper foil only on one side while double-sided PCBs have copper foil on both side of the laminate. Thickness of copper foil is 35 micrometer on cheaper PCBs and 70 micrometer on slightly costlier PCBs. Tracks (conductive paths) are made by masking (covering) the track part of copper with etch-resist enamel paint before dipping the laminate in ferric chloride solution to dissolve all copper except under the masked part. Holes in PCBs are drilled after etching is over. The tracks on two sides of a PCB are joined using plated through hole (PTH) technique, which is equivalent to using slotted copper rivets for joining tracks on both sides. On cheaper double-sided PCBs, PTHs are not provided, only Pads (i.e. circular copper land with centre hole) are provided and you have to join the tracks on both sides by soldering a copper wire (jumper) to the pads on top and bottom side of the PCB. In single-sided PCB, components are mounted on the side (called component side), which has no track. In a double-sided PCB, the component side is defined (marked before hand). The legend marking layer to indicate identification and placement of components on the top or bottom side of the board using white/yellow epoxy ink is termed as silk screen layer. Green masking is the process of applying a layer of green-colour insulation varnish on all parts of tracks except the pads, to protect the tracks from exposure to atmosphere and thus prolong its life and reliability.



Batteries:
The battery symbol consists of two parallel lines representing a cell. The longer of the two parallel lines represents the positive terminal of a cell. The battery voltage is specified next to the battery symbol.



Speakers:
Speakers convert electrical signals to acoustic vibrations. It comprises a permanent magnet and a moving coil (through which electrical signal is passed). This moving coil is wound over the diaphram which vibrates to produce sound.



ICs (Integrated Circuits):
Integrated circuits, or ICs (nicknamed chips), are complex circuits inside a a single package. Silicon and metals are used to simulate resistors, capacitors, transistors, etc. It is a space saving device. These ICs come in a wide variety of packages and sizes. Their applications are as varied as their packages. It can be a simple timer, to a complex logic circuit, or even a microcontroller or a microprocessor or a system on chip.

Microprocessors/Microcontrollers (μPs/μCs):
Microprocessors and other large scale ICs are very complex ICs comprising 100s or more of transistors, diodes and other components capable of control by software, which provides the logic for controlling various equipment such as TVs, cameras etc.

SOLDERING INSTRUCTIONS

1.1 Cleaning before soldering:

1. Ensure that parts to be soldered and the PCB are clean and free from dirt or grease.
2. Use isopropyl alcohol with the help of non-static bristol brush for cleaning.
3. Use lint-free muslin cloth for wiping or alternatively use mild soap solution followed by thorough rinsing with water and drying.

1.2 Tips for good Soldering:

1. Use 15 to 25 watt soldering iron for general work involving small joints. For CMOS IC's, FETS and ASICs, use temperature controlled soldering station ensuring that the tip temperature is maintained within 330-350 deg. Centigrade.
2. For bigger joints, use elevated temperature as per job.
3. Before using a new tip, ensure that it is tinned and before applying the tip to the job, wipe it using a wet sponge.
4. Use 60 : 40 (tin : lead) resin core (18-20 SWG) solder.
5. Ensure that while applying the tip to the job, the tip of the soldering iron is held at an angle such that the tip grazes the surface to be heated and ensure that it does not transfer heat to other joints/ components in its vicinity at the same time heating all parts of joint equally.
6. Heat the joint for just the right amount of time, during which a very short length of solder flows over the joint and then smoothly withdraw the tip.
7. Do not carry molten solder to the joint.
8. Do not heat the electronic parts for more than 2-4 seconds since most of them are sensitive to heat.
9. Apply one to three mm solder which is neither too less nor too much and adequate for a normal joint.
10. Do not move the components until the molten solder, at the joint has cooled.

1.3 Tips for de-soldering:

1. Remove and re-make if a solder joint is bad or dry.
2. Use a de-soldering pump which is first cocked and then the joint is heated in the same way as during soldering, and when the solder melts, push the release button to disengage the pump.
3. Repeat the above operation 2-3 times until the soldered component can be comfortably removed using tweezers or long nose pliers.
4. Deposit additional solder on the joint before using the de-soldering pump. This will help you to suck out all the solder from the joint.
5. Alternatively, use de-soldering wick using soldering flux which is nothing but a fine copper braid used as a shield in coaxial cables etc. and then press a short length of the wick using the tip of the hot iron against the joint to be desoldered so that the iron melts the solder. The molten solder at the joint will be transferred and deposited on the wick.
6. Do not allow the solder to cool while the braid is still adhering to the joint.
7. Solder the component again after cleaning by repeating the steps mentioned in 1.2 above.
8. Allow it to cool and check for continuity.

1.4 Precautions:

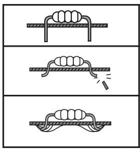
1. Mount the components at the appropriate places before soldering. Follow the circuit description and components details, leads identification etc. Do not start soldering before making it confirm that all the components are mounted at the right place.
2. Do not use a spread solder on the board, it may cause short circuit.
3. Do not sit under the fan while soldering
4. Position the board so that gravity tends to keep the solder where you want it.
5. Do not over heat the components. Excess heat may damage the component or board.
6. The board should not vibrate while soldering otherwise you have a dry or cold joint.

7. Do not put the kit under or over voltage source. Be sure about the voltage either dc or ac while operating the gadget.
8. Do not spare long bare ends of the components leads otherwise it may short circuit with other components. To prevent this, use sleeves at the component leads or use sleeved wire for connections.
9. Do not use old dark colour solder. It may give dry joint. Be sure that all the joints are clean and well shiny.

1.5 Illustrations showing correct/wrong insertion of components and soldering:

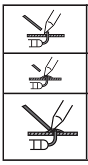
Corrected assembling and soldering process can provide the product in the best performance.

Correct component assembly



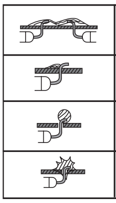
Insert component onto PCB.
Bend component legs, then cut the extra part.
Add the solder to join the component leg & PCB.

Correct soldering method



Place the iron tip onto the position of the solder joining & PCB for transferring heat.
Put the solder wire onto the solder joint.
Suitable amount of solder added to ensure fully covered solder joint. Keep for 2-3 sec till solder melt onto the joint & PCB.

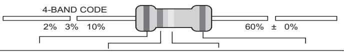
Bad solder joints



Too much solder may cause short with other components.
Solder not sufficient.
Heating not enough, may be soldering time was too short.
Soldering time too long that caused solder flow to the bottom.

COMPONENTS & LEADS IDENTIFICATION

Resistor :



Technical Specifications

COLOUR	1st BAND	2nd BAND	3rd BAND	MULTIPLIER	TOLERANCE1
BLACK	0	0	0	1	
BROWN	1	1	1	10	± 1% (F)
RED	2	2	2	100	± 2% (G)
ORANGE	3	3	3	1K	
YELLOW	4	4	4	10K	
GREEN	5	5	5	100K	± 0.5% (D)
BLUE	6	6	6	1M	± 0.25% (C)
VIOLET	7	7	7	10M	± 0.10% (B)
GREY	8	8	8		± 0.05%
WHITE	9	9	9		
GOLD				0.1	± 5% (J)
SILVER				0.01	± 10% (K)

1st band = first digit, 2nd band = second digit and 3rd band indicates the multiplier (number of zeroes to be placed after the two digits). The 4th band gives tolerance (gold +/-5%, silver+/-10% etc).

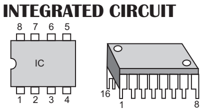
Capacitor:

Hints to identify Capacitor

CAPACITANCE CONVERSION GUIDE & CODES			
PICO FARAD (pf)	NANO FARAD (uf)	MICRO FARAD (uf or MFD)	CAPACITANCE CODE/MARKING
1000	1	0.001	102
1500	1.5	0.011	152
2200	2.2	0.0022	222
3300	3.3	0.0033	332
4700	4.7	0.0047	472
6800	6.8	0.0068	682

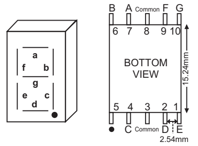
Capacitor Code decoding
First/Second digit - same
Third digit - Index to the base 10 (Multiplier)
Example: 472 = 47×10^2 = 4700 Pico Farad

INTEGRATED CIRCUIT

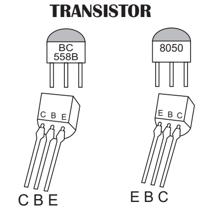


8 PIN IC 16 PIN IC

FND 7-SEGMENT DISPLAY

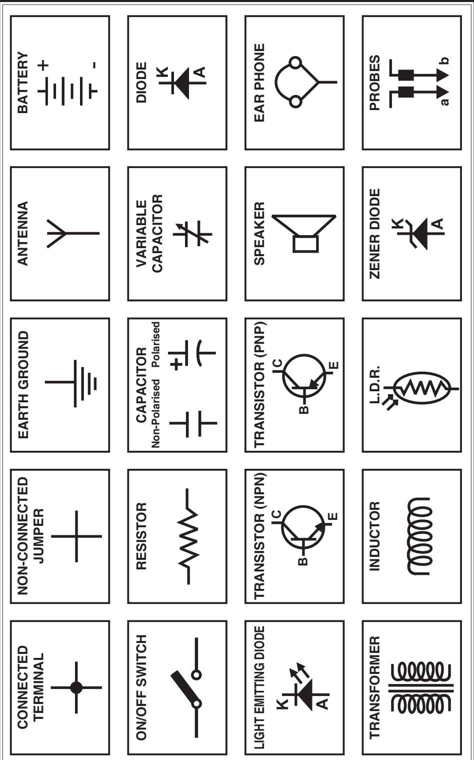


TRANSISTOR



C B E
548 (NPN)
558 (PNP)
368 (NPN)
369 (PNP)

E B C
8550 (PNP)
8050 (NPN)



ELECTRONIC SYMBOL CHART