ELECTRONIC WORKSHOP # 07

Diodes & Transistors

Roll. No:	**Date:**
Checked by:	**Grade:**

Object: To become familiar with semiconductor Diodes and Transistors

Apparatus:

1). A Digital Multimeter (DMM)
2). Few Diodes
3). Few Transistors (BJTs and FETs)

Theory:

All the components discussed so far (resistors, capacitors and inductors) were passive components. Semiconductor diode and transistor on the other hand are active electronic devices that allow conduction in only one direction (within specified limits).

Diodes

Diode is constructed by fusing two different types of doped semiconductors (P-type and N-type) together. The word Diode is an abbreviation of Di-Electrode meaning a device with two electrodes i-e Positive (also called as Anode) and Negative (also called as Cathode).

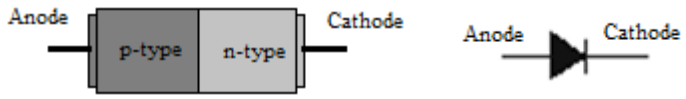

Figure-1: Constructional view and symbol of a Diode

A junction is created at the point where the p-type and n-type material meet, this junction gives the diode its unique behavior. The voltage at which the diode starts to conduct is called the Barrier potential and it dependents on the type of semiconductor and the impurity used to dope it, for silicon it is 0.7V and for germanium it is 0.3v.

There are two ways in which a diode can be connected to a power supply. First is Forward Bias (anode to positive terminal of battery and cathode to the negative terminal) in which current can flow from the

anode to the cathode and Reverse Bias (anode to negative terminal of battery and cathode to the positive terminal) in which the diode does not allow any current to flow through the diode.

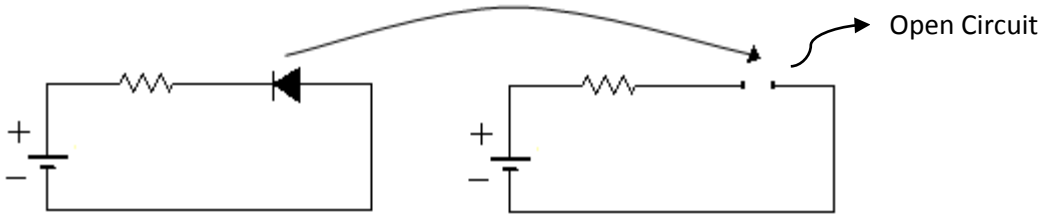

Figure-2: A diode connected in Reverse Bias

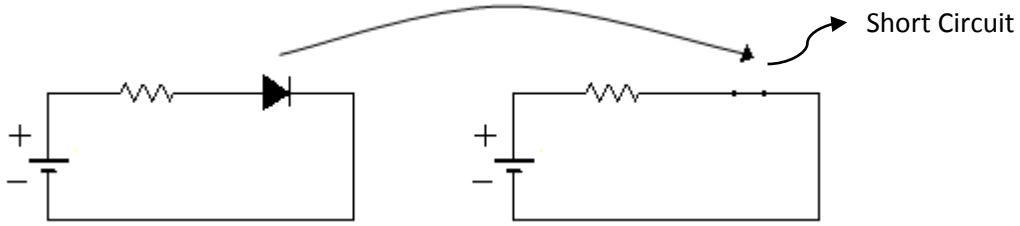

Figure-3: A diode connected in Forward Bias

For identification purpose, the cathode side of a diode has a colored ring near its end. Another way to identify the terminals is by using the continuity function on a multimeter, it will show a finite reading with the anode connected to the positive probe and cathode connected to the negative probe and infinity otherwise. Diodes are widely used for rectification purpose (conversion of AC into DC).

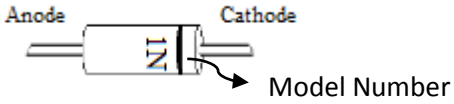

Figure-4: A real look of a diode

The Light Emitting Diode (LED) is a special type of diode that lights up whenever it is forward biased. Unlike the ordinary diode which is made using either Silicon or Germanium, an LED is made using Gallium Arsenide (GaAs) and some other semiconductor material compound that emits light. The semiconductor material determines the color of the light emitted by an LED and also the forward voltage required to light up the LED. LEDs are widely used for lighting purposes (ultra bright LEDs) and in displays.

Figure-5: Symbol of an LED

Like a diode, an LED needs to be forward biased to light up, in the reverse bias though, it behaves like an ordinary diode. The anode and cathode of an LED can be identified by using a multimeter set on the diode function or by making use of the fact that the anode terminal of an LED is longer than the cathode. LEDs come in various sizes, 3mm, 5mm and 10mm. There are also bi-color LEDs having 3 terminals, which light up with one color with one polarity and with another for another polarity. These can either be made using an NPN or a PNP combination thus changing the polarities required to light them up. A special type of LED is the RGB (Red- Green- Blue) LED which has four terminals, one for each of the three colors

and the remaining one for ground. There is also another type of LED that works in the infrared region of light (below the visibility range). This type is used in remote controls of televisions, air conditioners etc.

Transistors

A transistor is a 3 terminal device that is used in a variety of applications such as amplification and switching. There are two types of transistors categorized according to their construction:

1. Bipolar Junction Transistor
2. Field Effect Transistor

The Bipolar Junction Transistor (BJT) or simply known as a transistor comes in two flavors, NPN and PNP and depending on the type is made up of a layer of extrinsic semiconductor sandwiched between two layers of the opposite type of semiconductor thus creating two junctions. A contact protrudes from each layer of the transistor and each has its own name. Figure shows the schematic symbol and the construction of both types of BJTs.

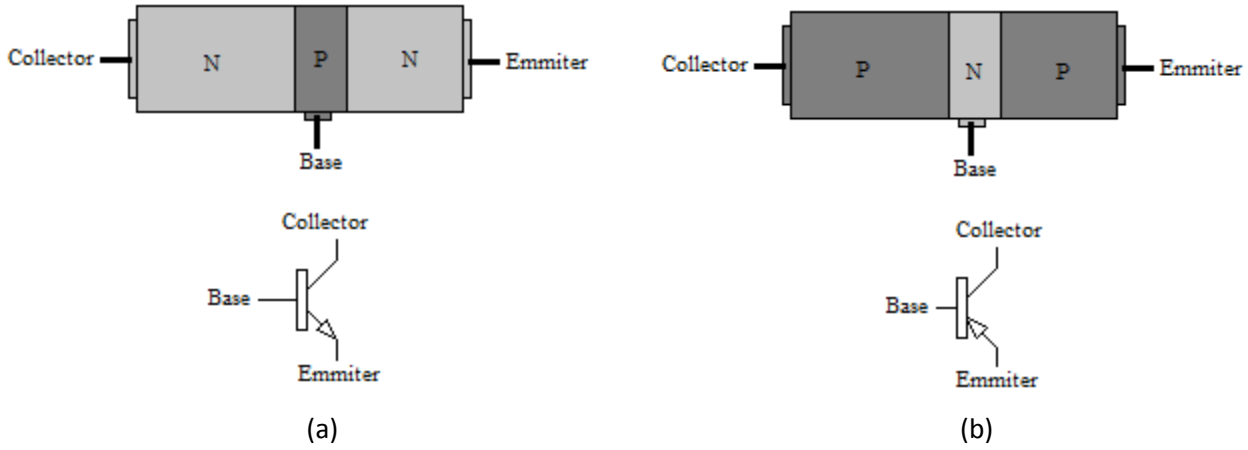

Figure-6: Constructional view and symbol for an NPN (a) and a PNP (b) Transistor

The three terminals are named as Collector, Emitter and Base, as seen from the above figure, the collector is the thickest of them all and it is also the most heavily doped, following it is the emitter which is moderately doped, the base is the thinnest and it is lightly doped. The base is common for the both the collector as well as the emitter. The difference between the NPN and the PNP transistors is the polarity of the supply required at their different terminals for operation. Since there are two junctions in the transistor (the base-emitter junction and the base-collector junction), we can make the diode equivalent of the transistors as follows:

Figure-7: Diode equivalent of a NPN (a) and a PNP (b) Transistor

This allows us to check for the terminals of the transistor and also make sure if it's working or not by using the multimeter on the diode function. The voltage drop across the emitter-base junction would be slightly higher than the voltage the voltage drop across the base-collector junction. Terminal identification of transistors is necessary also because there is no standard sequence followed.

The second type of transistor is the Field Effect Transistor (FET). It is a two layer three terminal device made up of two pieces of semiconductors. Like the BJT, this comes in two flavors too, N-Channel and P-Channel. The construction and schematic symbol are shown below:

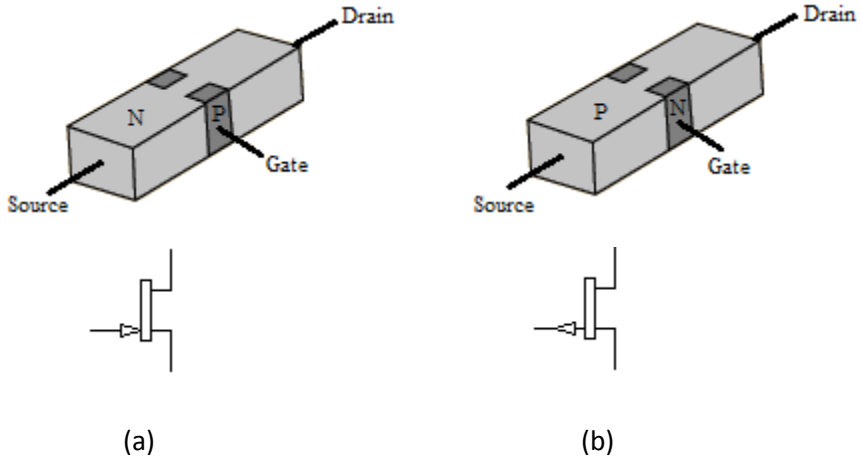

Figure-8: Constructional view and symbol for an N-Channel (a) and a P-Channel (b) JFET

The three terminals are called Gate, Source and Drain. The symbol and construction shown above are for the Junction Field Effect Transistor (JFET) in which there is a p-n junction between the gate and source, there is also another type of FET in which the gate is insulated from the source by means of a layer of SiO_2 called as the MOSFET (Metal Oxide Semiconductor Field Effect Transistor). Its construction and schematic symbol is shown in the figure:

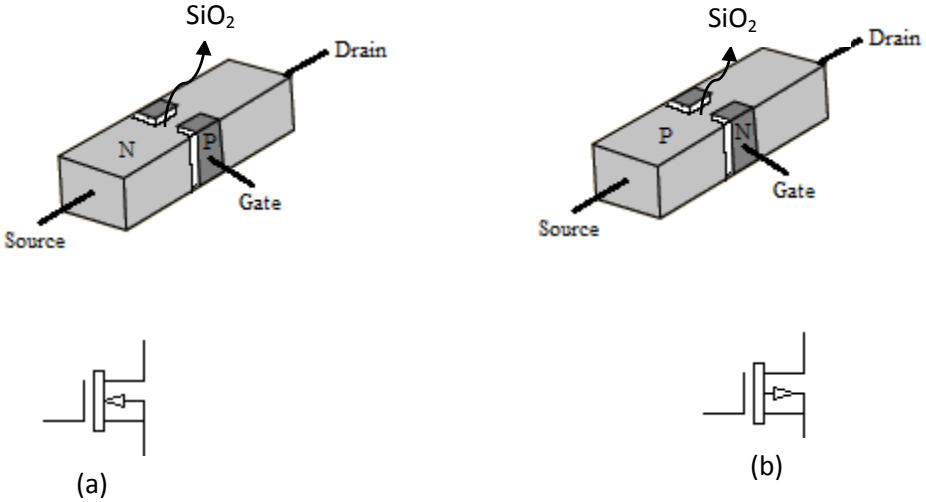

Figure-9: Constructional view and symbol for an N-Channel (a) and a P-Channel (b) MOSFET

Unlike other components discussed so far, transistors come in a housing also called a Package. Some types of packages available for transistors are shown below:

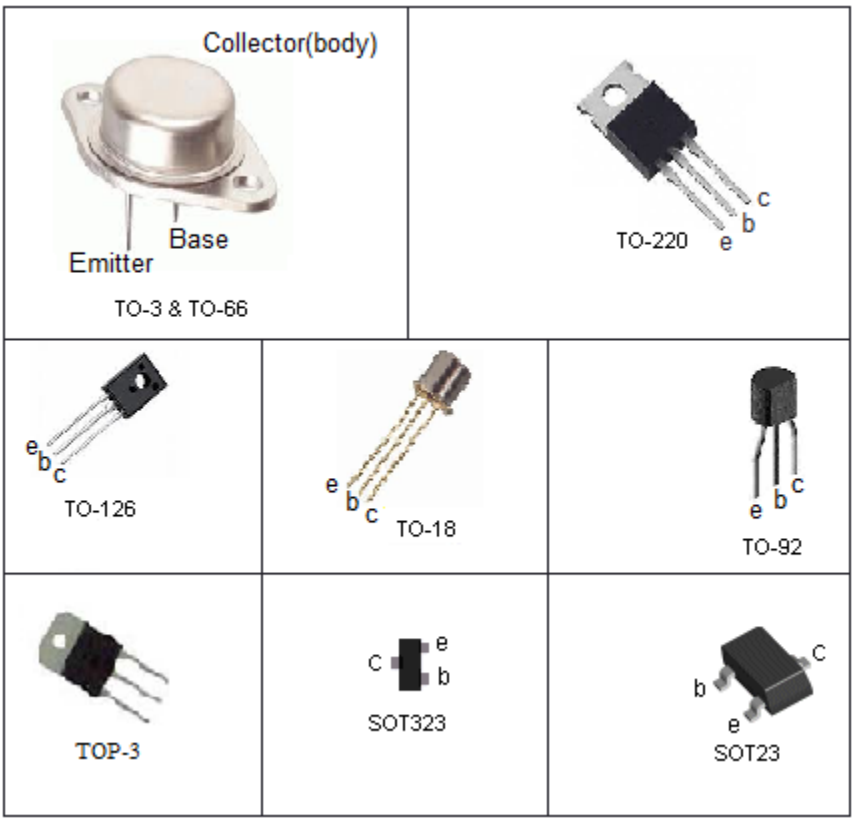

Figure-10: Different packages in which transistors are commercially available

Procedure:

1. Take a Multimeter and set it to the continuity function.
2. Take a diode and check it using the method described in theory and fill in the table-1.
3. Take an LED and check it in the same way as the diode and fill the table-2.
4. Take a Bipolar Junction Transistor and name the terminals A, B and C. Do the following and write down your observations in the table-3:
    i. Place the Red (+ve) probe of the DMM on A and the Black (-ve) probe on B. See if the DMM reading is infinite or finite.
    ii. Interchange the probe positions and observe the DMM reading.
    iii. Do this for all the combinations of probe positions for all three terminals, identify the three terminals of the Bipolar Junction Transistor and write the terminal names of A,B and C respectively. Also determine the type of the transistor (NPN and PNP). If the base is of N type, the transistor is NPN else it is PNP.

Observations:

S. N.o	Model	Voltage		Implication
		Reverse Bias	Forward Bias	
1.				
2.				
3.				
4.				
5.				

Table-1: Checking a Diode

S. N.o	Color	On/Off		Implication
		Reverse Bias	Forward Bias	
1.				
2.				
3.				
4.				
5.				

Table-2: Checking an LED

S N.o	**Terminals of the BJT**			**Type of Transistor**	**Implication**
	A	**B**	**C**	**NPN/PNP**	
1.					
2.					
3.					
4.					
5.					

Table-3: Checking a BJT transistor

Questions:

1. What is meant by Barrier Potential?

_____
_____

2. What is meant by rectification?

_____
_____

3. Write down the names of some types of diodes?

_____
_____

4. What is the difference between a PNP and an NPN transistor?

_____
_____

5. Write down the name of some of the packages in which transistors are available?

_____
_____

6. What is difference between FETs and BJTs?

_____
_____