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An Over of Transistor and its Type

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Abstract

Transistor-based artificial synapses have been paid much attention in recent years because of their good stability, clear operation mechanism, possibility of multi terminal operation, and can be constructed from a variety of materials. In addition, they can perform concurrent learning to perform synaptic weight updates without interrupting the signal transmission process. Through proper material selection and structural design, transistors can convert external stimulus (light, pressure, temperature, etc.) into the electrical signal, which provides the possibility of implementing sensory synapses with sensorimotor functions as well as achieving synergistic control of one device by two or more signals. However, the development of transistor-based artificial synapses is still in its very early stages. Herein, this article presents a review of recent advances in transistor-based artificial synapses in order to give a guideline for future implementation of synaptic functions with transistors.

Keywords: P-N junctions, BJT Transistor, PNP and NPN types.

Introduction to Transistors

We all know "transistor" is an integral part of any electronic circuit/device. It is very rare to see any circuits built without at least one transistor. This semiconductor device is used either for switching purposes or for amplification purposes in electronic devices. They are either packed separately or found coupled to the integrated circuits. Transistors are, for the most part, the simplest types of active circuit elements that are capable of increasing,or amplifying, the power of electrical signals.

Transistors

A transistor is a semiconductor device consisting of three regions separated by two distinct p-n junctions. The central region is called the base. It may be p-type or n-type semiconductor. The two outer regions are called emitter and collector. The pn transistor is constructed using n type material as the emitter and collector while the base is made of p

type material. The pop transistor is constructed using p type material as the emitter and collector while the base is made of n type.

Types of Transistors

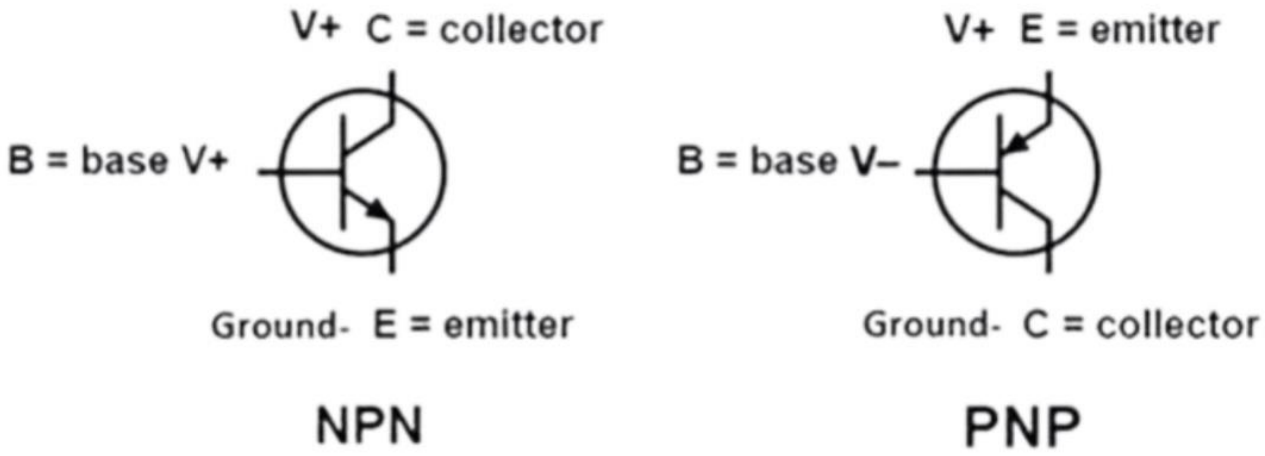
The term transistor is mainly associated with the bipolar junction transistor(BJT).
In BJT, the action of both holes and electrons is important.
There are other types of transistors given below, but we are keeping our discussion to Bipolar junction Transistor only.
Types of Transistors:

1. BJT (Bipolar Junction Transistor)
2. UJT (Unipolar Junction Transistor)
3. FET(Field Effect Transistor)
4. MOS(Metal Oxide Semiconductor)

Depending on the types of semiconductor material used;
Thus, two types of two transistor are available. They are pn and pnp transistor.

SCHEMATIC REPRESENTATION

- In npn transistor , the arrows points away from the base. In this device electrons flow from the emitter into the base and hence the current flows from the base to the emitter. In the pnp transistor , the arrow points towards the base. The holes flow from the emitter into the base and current flows from the emitter into the base.



Biasing the transistor

The two junctions of a transistor can be biases in four different ways.

1. Both the junctions may be forward biased. It causes large currents to flow across the junctions.

The transistor is said to be operating in saturation region.

2. Both the junctions may be reversed biased. Very small currents flow through the junctions. The transistor is said to be in cut-off region.

3. EB-junction may be reversed biased and CB-junction forward biased. The transistor is said to operate in an inverted mode.

EB-junction may be forward biased and CB-junction reversed biased. Such biasing arrangement causes a large current to flow across the EB-junction as well as CB-junction. With such biasing, the transistor is said to operate in active region or normal mode.

Transistor i-v characteristics

Transistor Voltages

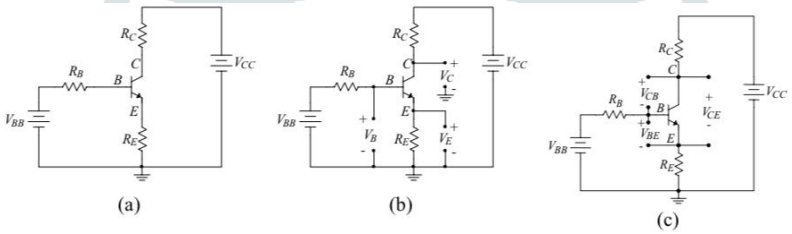
Three different types of voltages are involved in the description of transistors and transistor circuits. They are:

Transistor supply voltages: VCC , VBB .

Transistor terminal voltages: VC , VC , VE

Voltages across transistor junctions: VBE , VCE , VCB

All of these voltages and their polarities are shown on Figure for the npn BJT.



Role of Emitter, Base and Collector

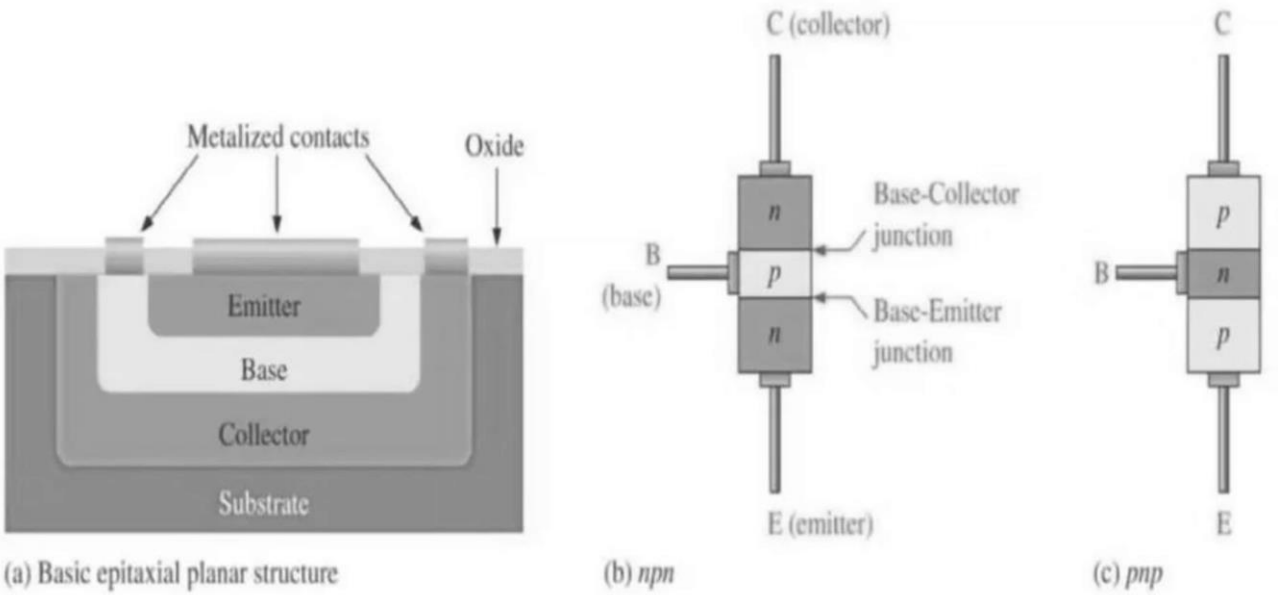
1. Base: Base is lightly doped: If base region is heavily doped, more holes would be present in the base and the incoming electrons would have more chance of undergoing recombination. The number of electrons flowing into the collector would have thus decreased. It leads to lesser collector current and more base
current. To reduce this possibility, base region is lightly doped. • Base region is made narrow: It enables the electrons injected into base to quickly diffuse and come under the action of electric field due to reverse bias across junction, which sweeps them into the
collector, Thus, the chance of electrons recombining with holes and causing a base current is eliminated.

2. Emitter: • Emitter is heavily doped: In a transistor, the emitter is the source of current. It is required that a maximum of the majority carriers is injected into the base so that the emitter current Ie will be large. The function of the emitter is to provide charge carriers in large numbers. Hence emitter is heavily doped
compared to base and collector.

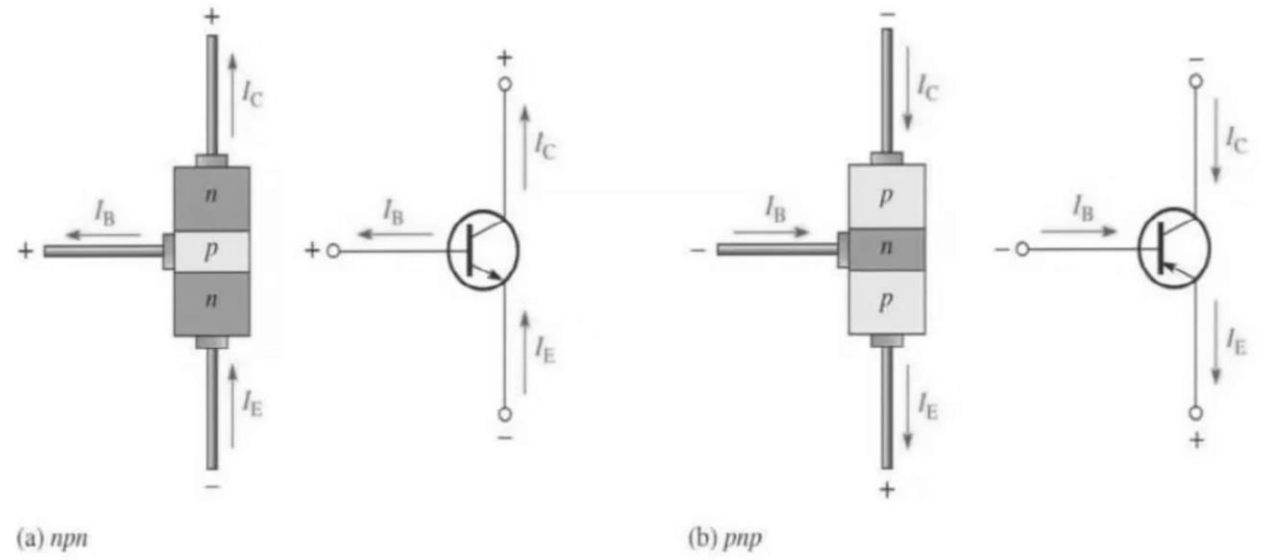
3. Collector:

Collector is wider • Collector current is produced by minority carriers. Current by minority carriers is a drift
current and requires only the presence of electric field acting in a favourable direction. Whatever may be the strength of the electric field, minority carriers are accelerated into the collector region. The minority carriers are in fact rolling down the barrier. Whether the barrier is high or lowit does not matter for rolling down it. The minority carriers rolling down the high potential barrier acquire large kinetic energy. They produce large amount of heat

while transferring part of their energy to the lattice through collisions. In order to dissipate away the
heat, the collector region is made larger.



(a) Basic epitaxial planar structure (b) *npn* (c) *pnp*



(a) *npn* (b) *pnp*

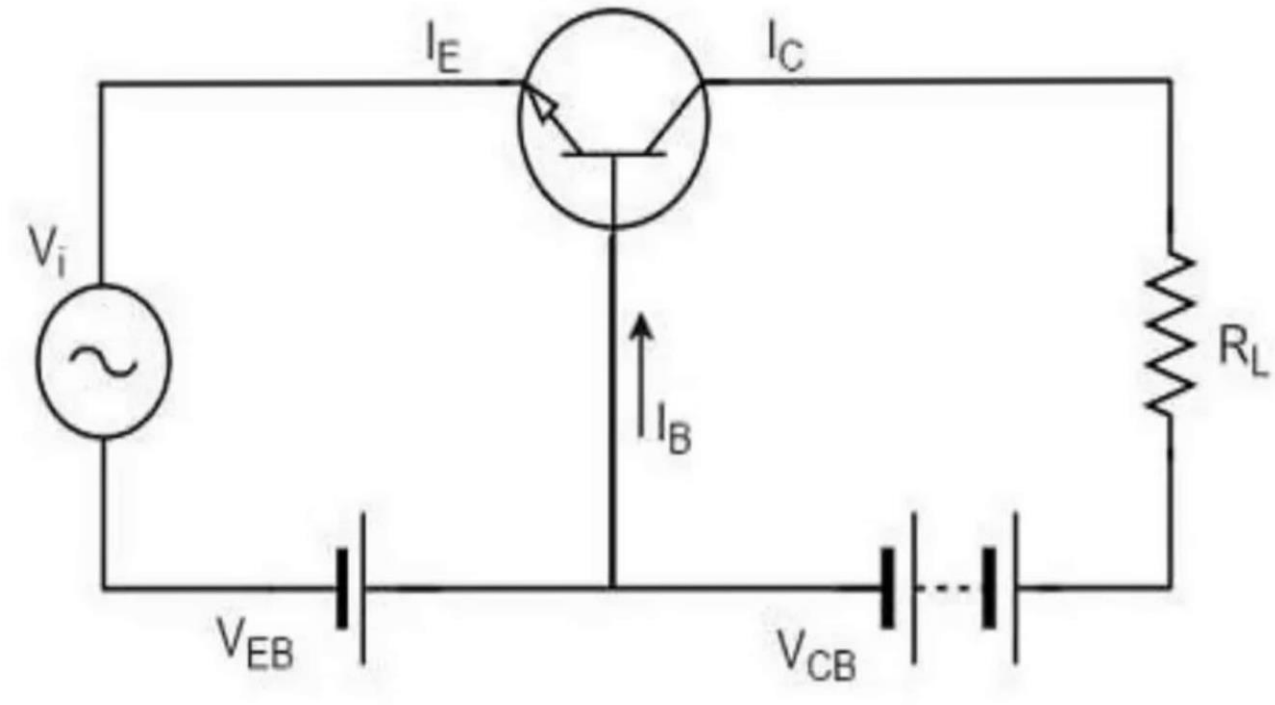
Working

1.Formation of Depletion Regions Each transistor has two p-n junctions. The junction that separates the base and the emitter is called the emitter-base junction(EB) and the one separating the base the collector is called the collector-base junction(CB). Each transistor is actually one
piece of crystalline material that has been doped to create the three elements.
The two p-n junctions can be viewed as two diodes. Therefore, a transistor may be regarded as two p-n junction diodes arranged back-back with the base being common to both the diodes. The built-in barrier
voltages across the two depletion layers are the same and will be of the order of 0.7
V in case of silicon transistor.

Application of transistors

TRANSISTORS AS AMPLIFIER

• Apart from working as switches, transistors work as an amplifier as well, taking tiny electric currents, and producing a much higher current output at the other end. Such transistors are commonly found in products
such as hearing aids, radio, etc.



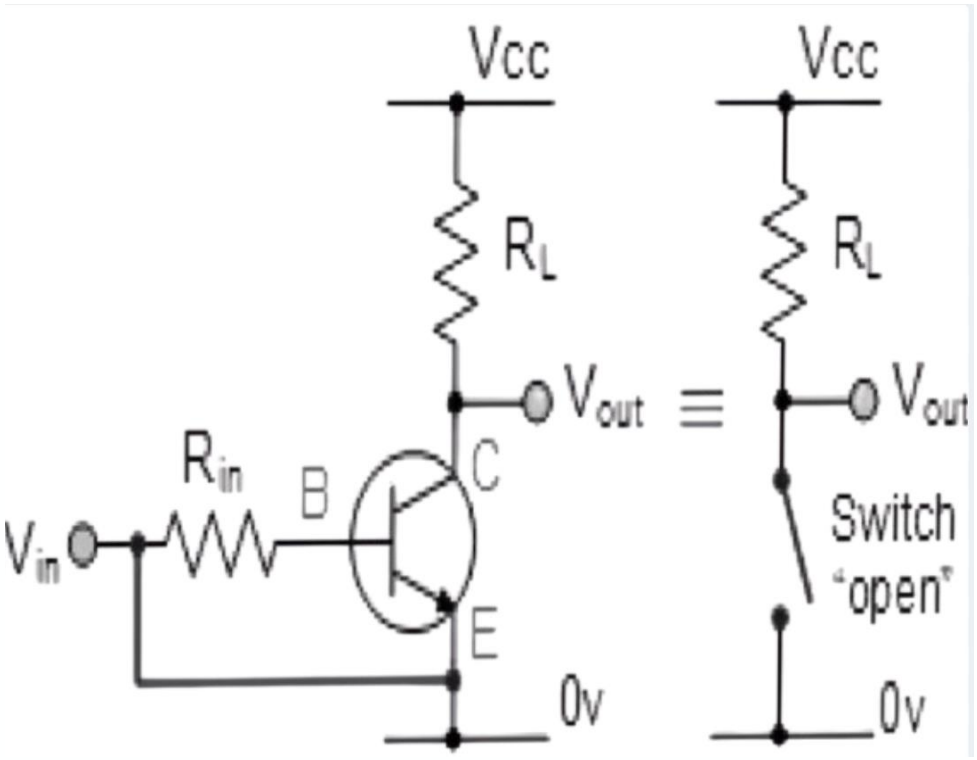
• The low resistance in input circuit, lets any small change in input signal to result in an appreciable change in the output. The emitter current caused by the input signal contributes the collector current, which when flows through the load resistor R,, results in a large voltage drop across it. Thus a small input voltage results in a large
output voltage, which shows that the transistor works as an amplifier.

Transistor As a Switch

• As a transistor switch, it operates in two regions and those are Saturation Region (fully-ON) and the Cut-off Region (fully-OFF)

Cut-off Region

• The operating conditions of the transistor are zero input base current (B=0), zero output collector current(c=0), and maximum collector voltage (cE) which results in a large depletion layer and no current flowing through the device.



Saturation Region

• In this region, the transistor will be biased so that the maximum amount of base current(L) is applied, resulting in maximum collector current(Ic=Vcc/R,) and then resulting in the minimum collector-emitter voltage(VcE~ O) drop. At this condition, the depletion layer becomes as small as the possible and maximum current flowing through the transistor. Therefore
the transistor is switched "Fully-ON".

Active region:

Base-emitter junction forward biased
Collector-base junction is reverse biased
Control, IC = β IB

Breakdown region:

IC and VCE exceed specifications
damage to the transistor.

Conclusion

This article has introduced you to the very basic concepts of active transistor circuits. The types of circuits that can be built using transistors are really quite breathtaking. Transistors are at the heart of every electronic device.

That being said, since the invention of the Integrated Circuit (IC) the need to design complex, discrete transistor circuits has been reduced mostly to engineers designing IC microchips.

However, there is still a need for a basic understanding of transistors, and many designs will use a few discrete transistors. But most designs now tend to use integrated circuits instead of discrete transistor circuits for any complex functions.

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