Objectives

Describe the purpose of a transistor.

Describe types of a transistor.

Identify transistor schematic symbols.

Identify leads on transistors.

Describe the purpose of DC bias in transistors.

Describe NPN transistor bias.

Describe PNP transistor bias.

The transistor replaced most vacuum tube.

As a result, electronics continue to become smaller because of the revolutionary component.

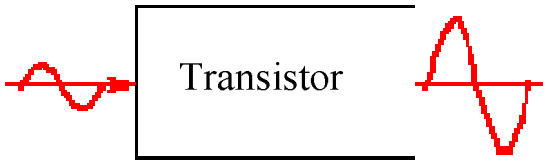
Transistors are used as:

Amplifiers: Electronic circuits that increase or provide power gain.

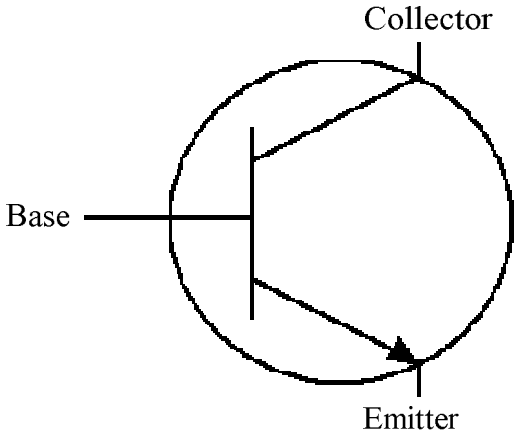
Oscillator: A circuit that converts DC into AC.

Electronic Switch: A circuit that controls the direction of current flow much like a mechanical switch or relay.

Purpose: Control large signals with smaller ones.

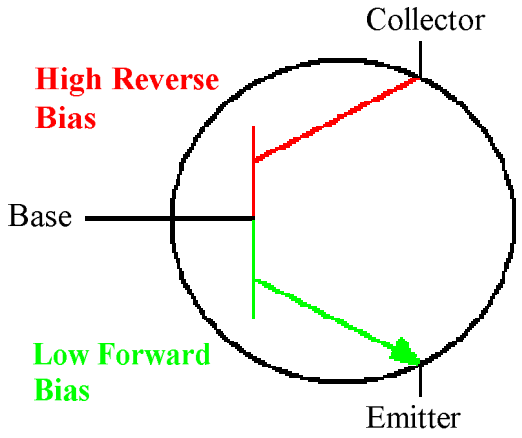


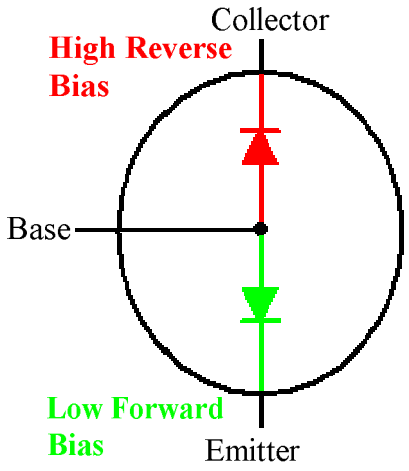
The word TRANSISTOR is derived from the words TRANSfer and resISTOR



A transistor is similar to two diodes tied back-to-back.

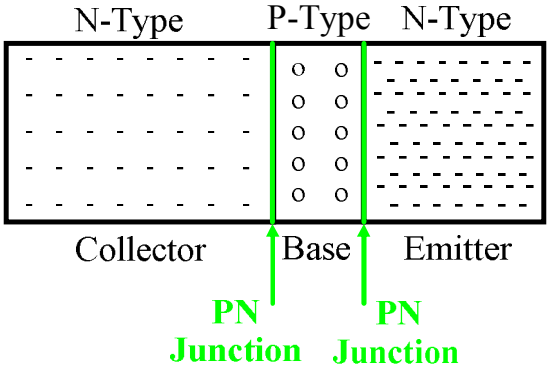
For a transistor to operate properly, the base-to-emitter junction must be forward biased, and the base-to-collector junction must be reversed biased.





Transistors are solid state devices constructed of P-type and N-type dopants.

Solid State Device: An electronic component which operates by the movement of electrons within a solid piece of semiconductor material.

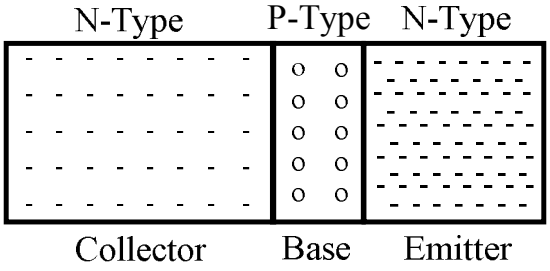


Transistors are made of three different sections and two PN junctions.

Remember, the PN junction between the base and collector are normally reversed biased.

The PN junction between the base and emitter are normally forward biased.

Transistors are made of semiconductors which are elements that have four electrons in their outer valence shell.

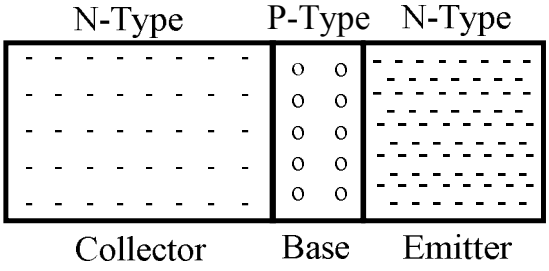


Emitter: **Heavily doped** to produce large numbers of current carriers.

Base: Very thin and **lightly doped**. Passes most of the current carriers from the emitter to the collector.

Collector: **Moderately doped** to collect the current carriers from the base. Largest of the three areas to dissipate heat.

Dopants: Classified as either electron acceptors or donors; accept electrons if they are positively doped (p-type) and donate electrons if they are negatively doped(n-type).



P-type dopants come from IUPAC group 13 and have three electrons in their outer valance shell compared to silicon which has four. They have one less electron.

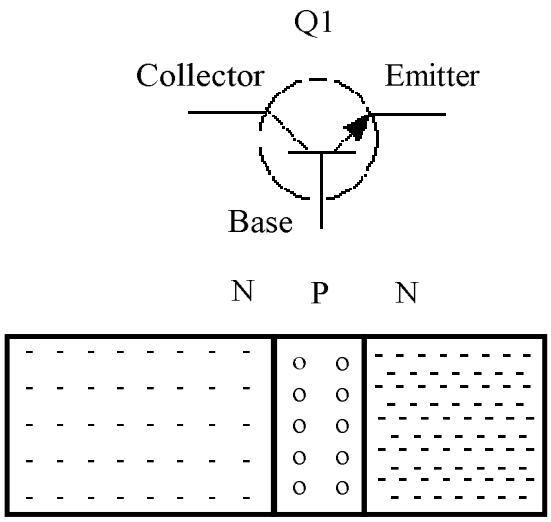
P-type acceptors include: boron (B), aluminium (Al), gallium (Ga), indium (In), thallium (Tl), and ununtrium (Uut)

N-type dopants come from IUPAC group 15 and have five electrons in their outer valance shell. They have one extra electron.

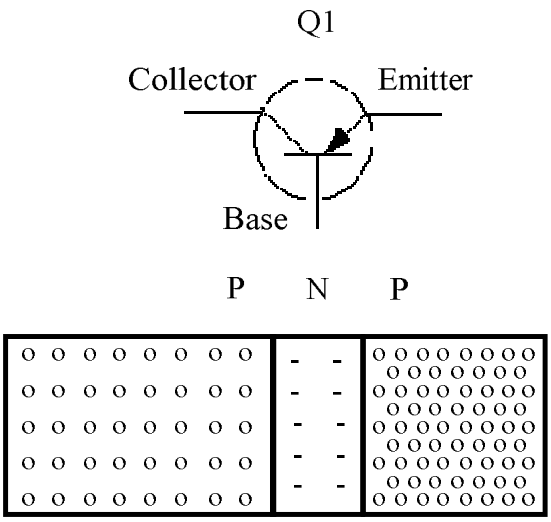
N-type donors include: nitrogen (N), phosphorus (P), arsenic (As), antimony (Sb), bismuth (Bi) and ununpentium (Uup)

Transistor designation: Q

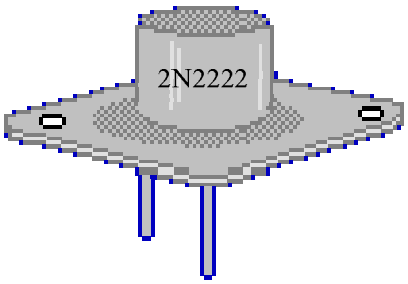
Arrow **N**ot **P**ointing i**N**

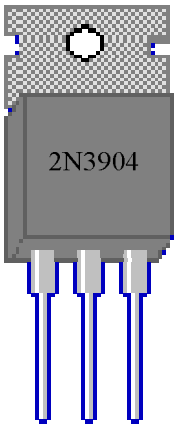


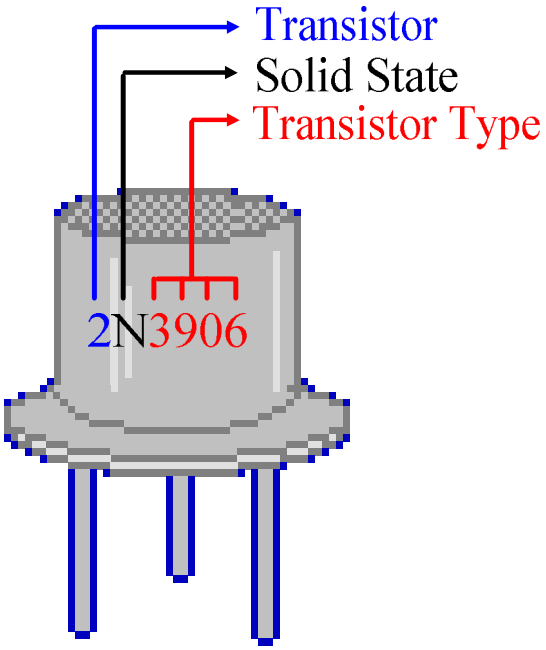
Arrow **P**ointing i**N** **P**eople



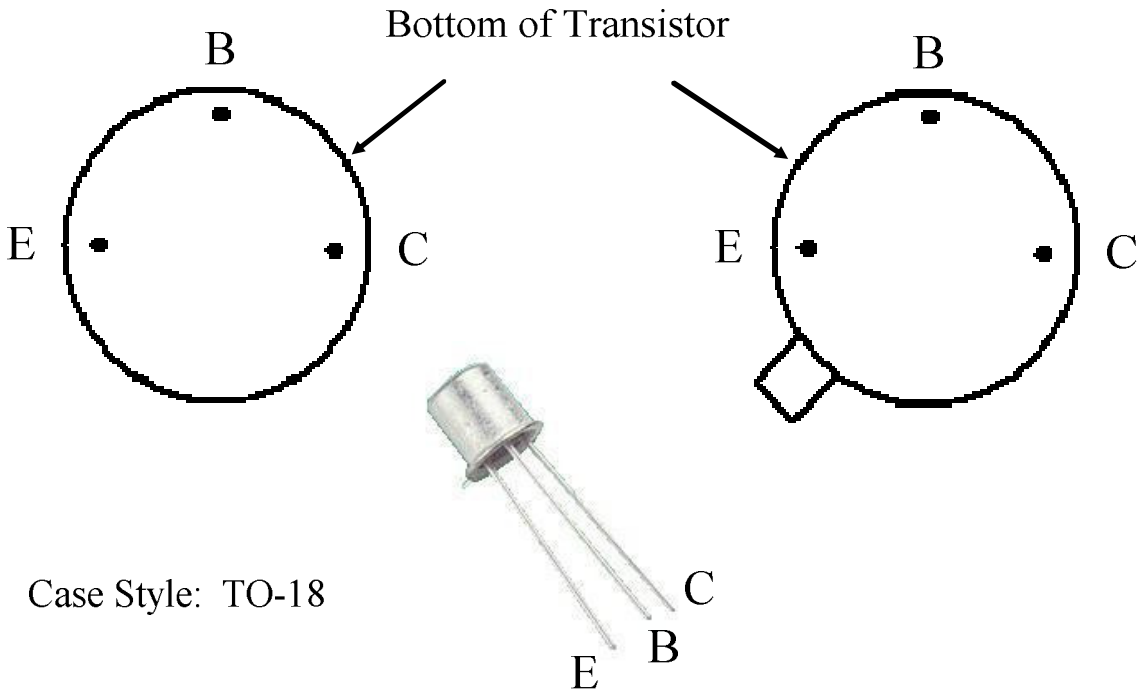
Identification Numbers







Identifying Leads



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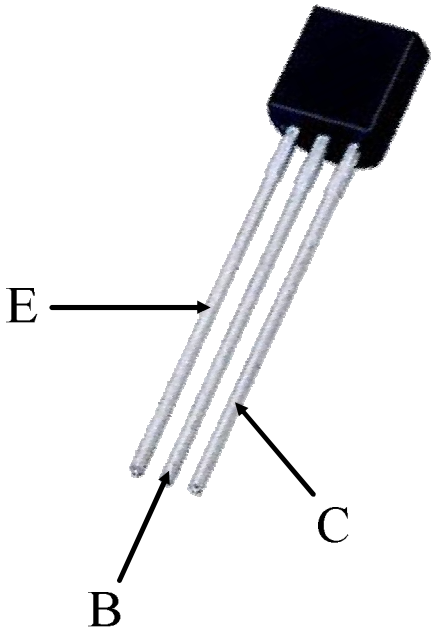

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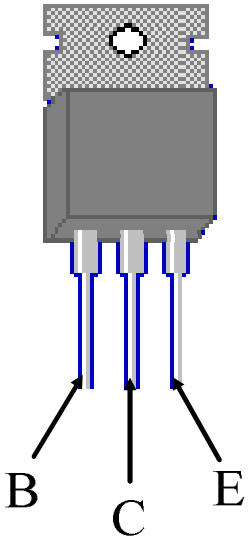

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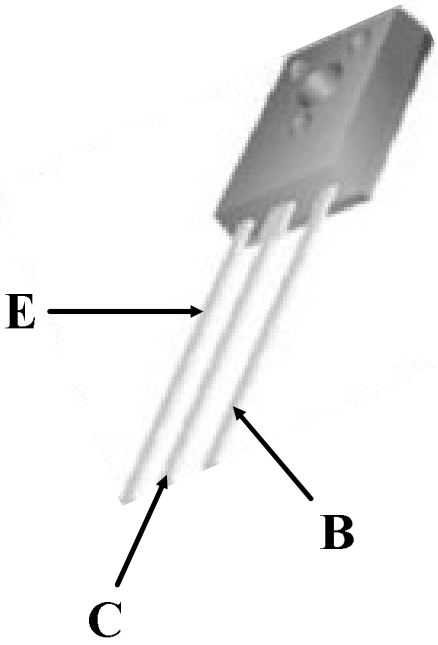
Identifying Leads



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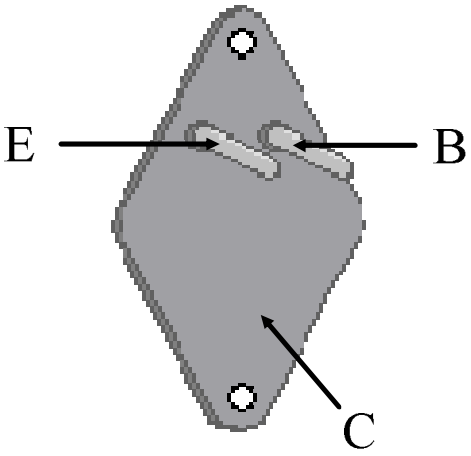
Identifying Leads



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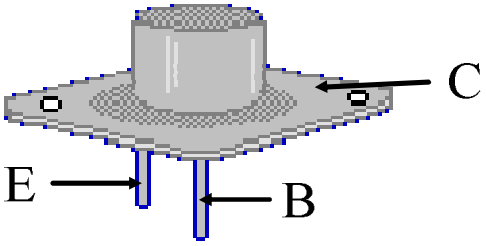


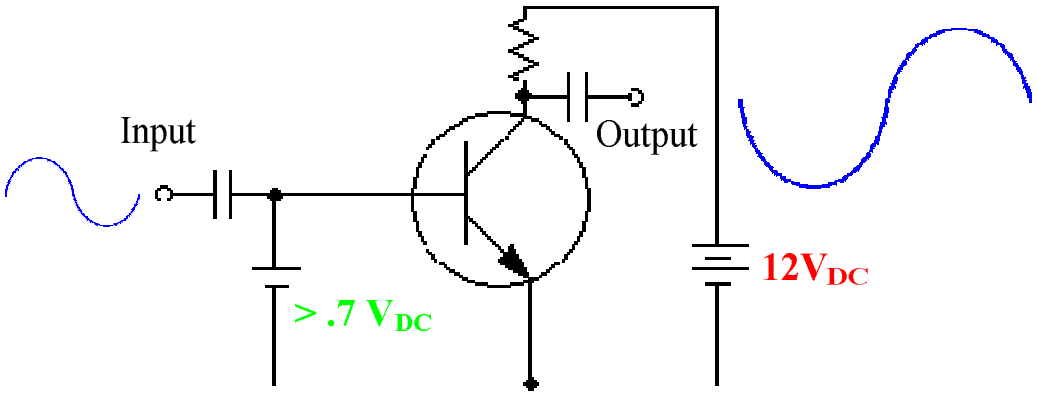
Transistor Bias

Two types of voltage in a transistor circuit: Input voltage and bias voltage.

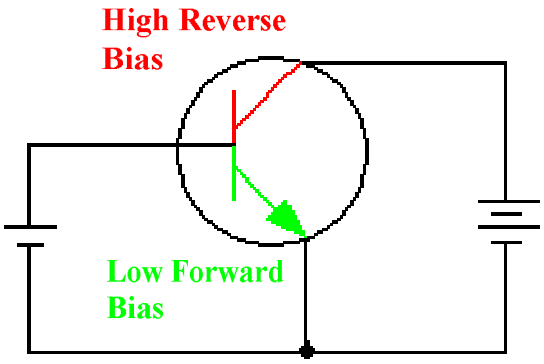
Input voltage: Signal that causes a change in the output signal. Is either AC or DC.

Bias voltage: Bias is always DC and provides the extra power that a transistor needs to amplify the signal.

The transistor must be biased with a DC voltage in order for it to work.

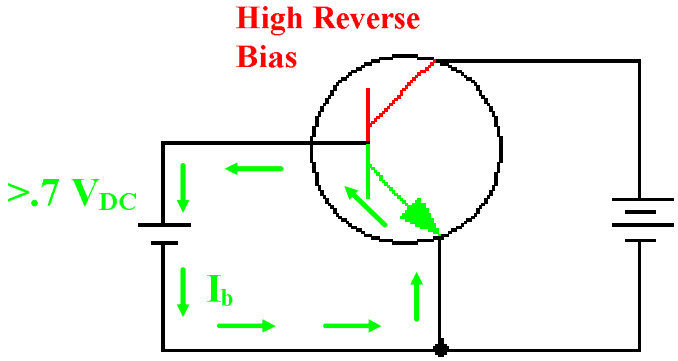


First, lets talk about NPN transistor bias.



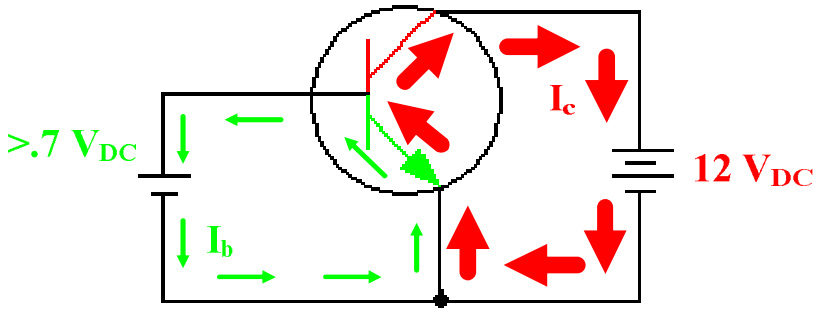
The transistor is properly biased when the base-to-emitter junction is forward biased and the base-to-collector junction is reversed bias.

By placing a positive voltage on the base compared to the emitter, a small amount of current flows from the emitter, through the forward biased EB junction, to the base.



This current is called I_b for base current.

Placing a large positive voltage on the collector will reverse bias the collector-to-base PN junction.

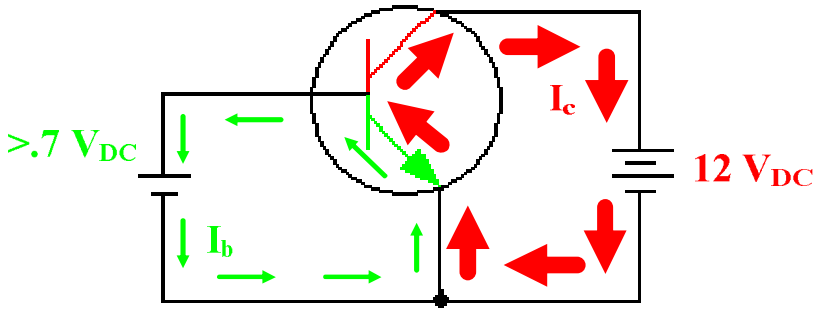


Since the collector-to-base PN junction is reversed bias, no current flows from the base to collector.

A large current does flow from the emitter to collector.

This current is called I_c for collector current.

Remember that the base is thin and lightly doped. Therefore, most of the current carriers from the emitter are passed onto the collector because of the large positive voltage attached to the collector.

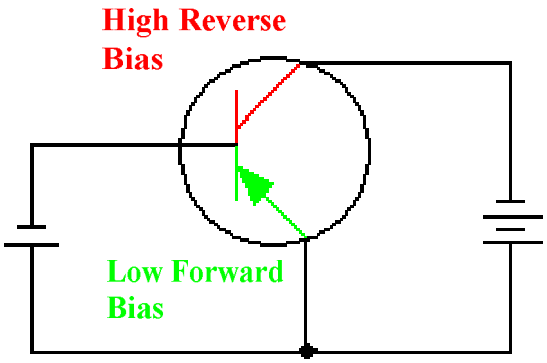


Notice that I_b and I_c are traveling through the emitter. Both base current and collector current are common in the emitter.

Emitter current is called I_e.

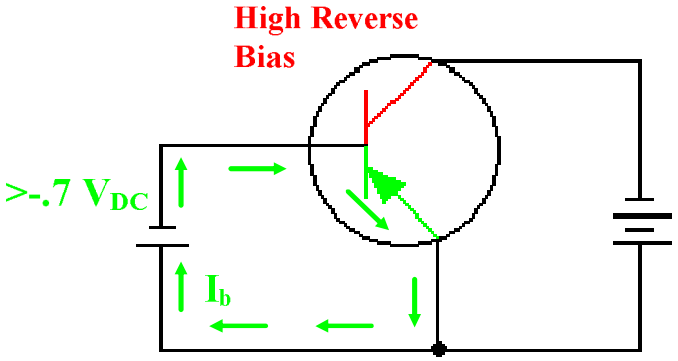
$$I_e = I_b + I_c$$

Now lets talk about PNP transistor bias. It is essentially the same; however, the voltage potential has been reversed.



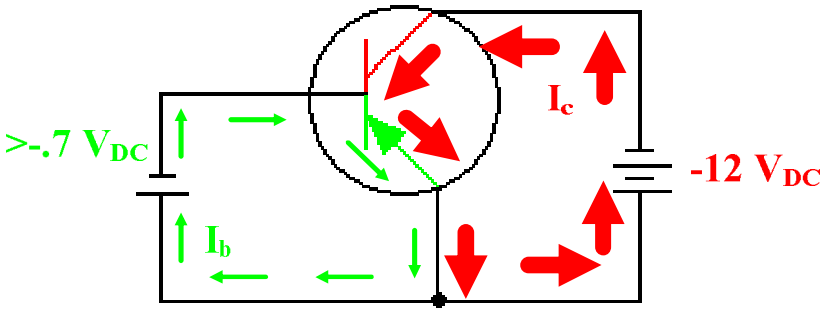
The transistor is properly biased when the base-to-emitter junction is forward biased and the base-to-collector junction is reversed bias.

By placing a negative voltage on the base compared to the emitter, a small amount of current flows from the emitter, through the forward biased EB junction, to the base.



This current is called I_b for base current.

Placing a large negative voltage on the collector will reverse bias the collector-to-base PN junction.

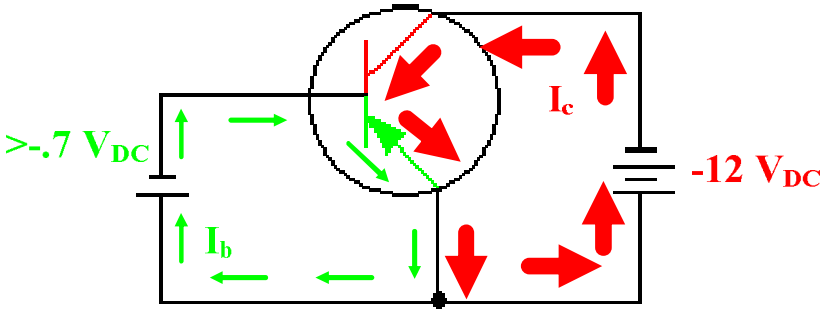


Since the collector-to-base PN junction is reversed bias, no current flows from the base to collector.

A large current does flow from the emitter to collector.

This current is called I_c for collector current.

Remember that the base is thin and lightly doped. Therefore, most of the current carriers from the emitter are passed onto the collector because of the large negative voltage attached to the collector.



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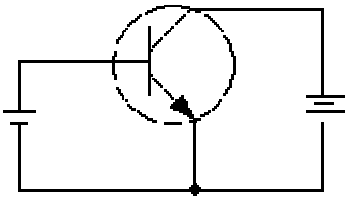
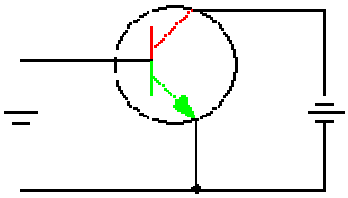
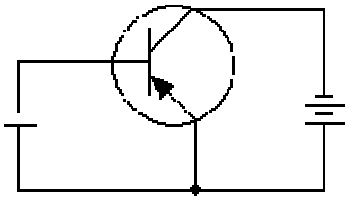
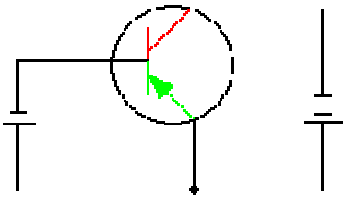
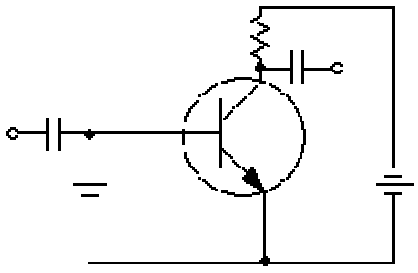




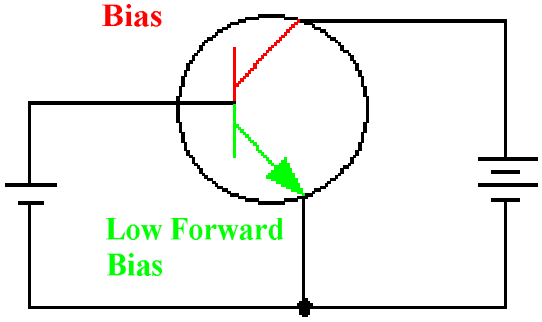


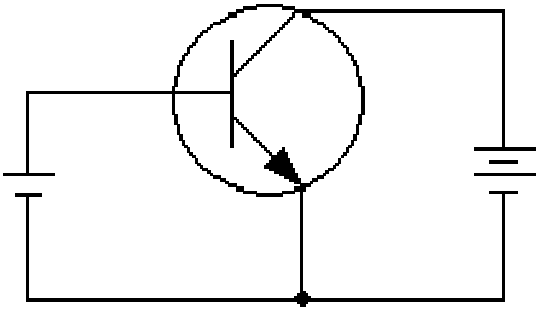




High Reverse Bias

Low Forward Bias





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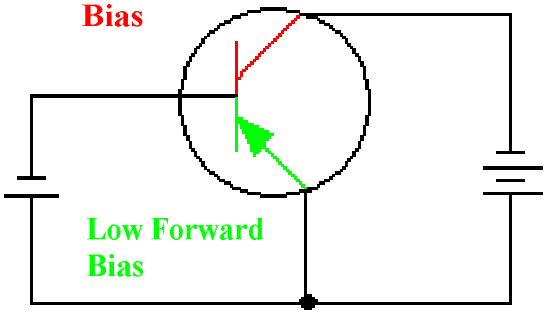
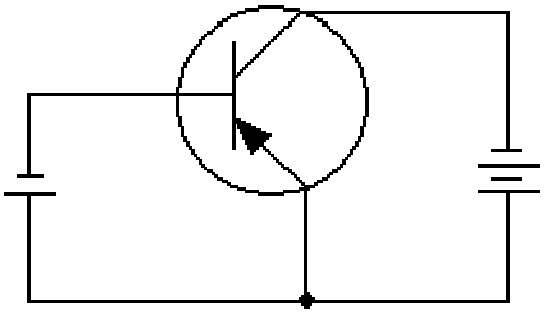
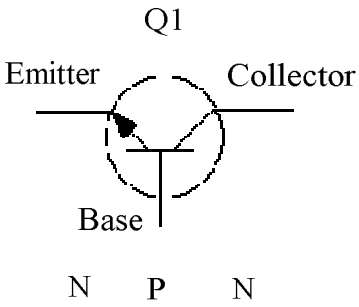
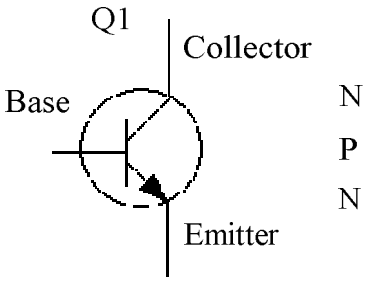
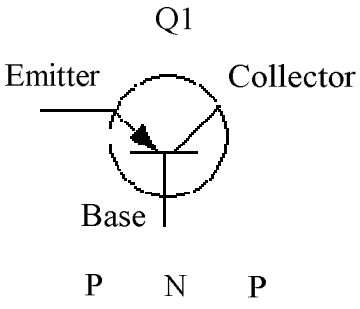
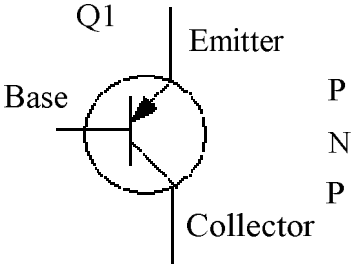




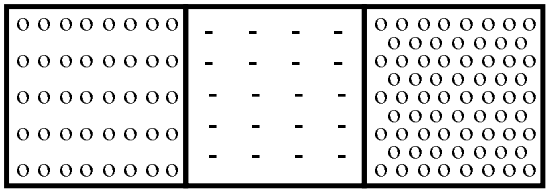








Transistor designator: Q



Collector	Base	Emitter
Moderately Doped	Lightly Doped	Heavily Doped

Emitter: Heavily Doped to produce large numbers of current carriers.

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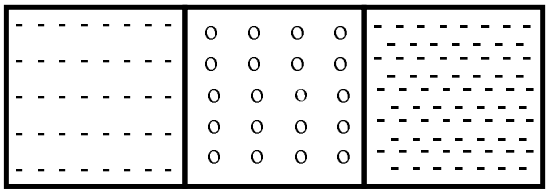

Current Carriers

Doping: The process of adding controlled impurities to a semiconductor.

Dopants: Classified as either electron acceptors or donors; accept electrons if they are positively doped (p-type) and donate electrons if they are negatively doped(n-type).

P-type dopants are known as IUPAC group 13 and have three electrons in their outer valance shell compared to silicon which has four. They have one less electron.

P-type acceptors include: boron (B), aluminium (Al), gallium (Ga), indium (In), thallium (Tl), and ununtrium (Uut)

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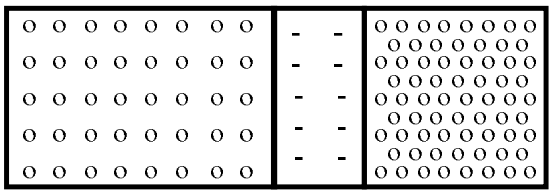

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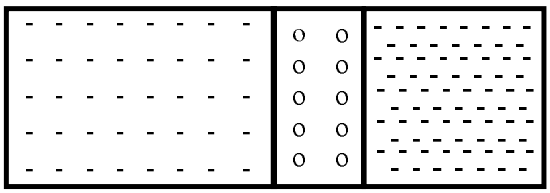

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