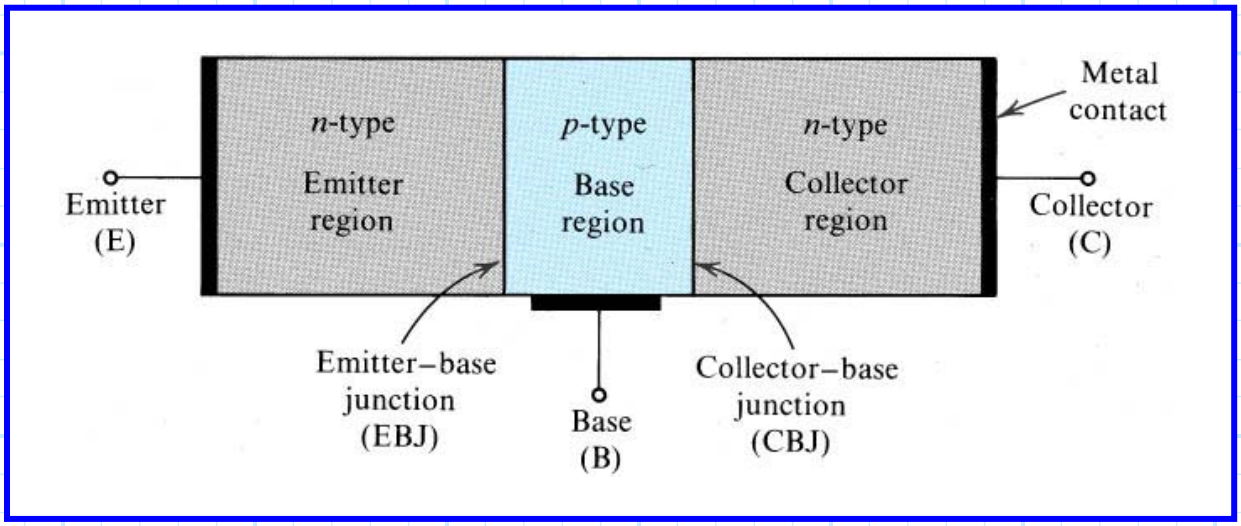
BJT Structure and Modes of Operation

First, let's start with the ***npn*** Bipolar Junction Transistor (BJT). As the **name** implies, the *npn* BJT is simply an hunk of *p*-type Silicon sandwiched between two slices of *n*-type material:



Each of the **three Silicon regions** has one terminal electrode connected to it, and thus the *npn* BJT is a **three terminal** device.

The three terminals are **named**:

1. *Collector*
2. *Base*
3. *Emitter*

Note that this *npn* BJT structure creates **two *p*-*n* junctions !**

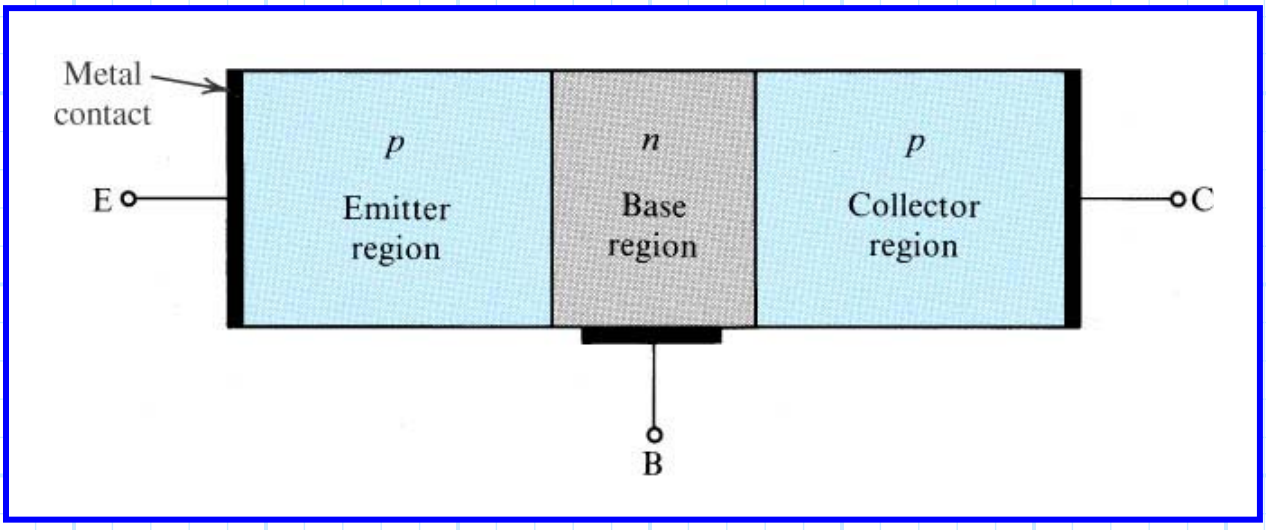
* The junction between the ***n*-type collector** and the ***p*-type base** is called the **Collector-Base Junction** (CBJ).

Note for the **CBJ**, the **anode** is the **base**, and the **cathode** is the **collector**.

* The junction between the ***n*-type emitter** and the ***p*-type base** is called the **Emitter-Base Junction** (EBJ).

Note for the **EBJ**, the **anode** is the base, and the **cathode** is the emitter.

Now, we find that the ***pnp*** BJT is simply the **complement** of the *npn* BJT—the *n*-type silicon becomes *p*-type, and vice versa:



Thus, the *pnp* BJT **likewise** has **three** terminals (with the same names as the *npn*), as well as **two** *p-n* junctions (the CBJ and the EBJ).

* For the *pnp* BJT, the **anode** of the **CBJ** is the **collector**, and the **cathode** of the **CBJ** is the **base**.

* Likewise, the **anode** of the **EBJ** is the **emitter**, and the **cathode** of the **EBJ** is the **base**.

Note that these results are precisely **opposite** that of ***npn*** BJT.

Now, we know that **each** *p-n* junction (for either *npn* or *pnp*) has **three** possible **modes**:

1. *forward biased*
2. *reverse biased*
3. *breakdown*

We find that **breakdown** is **not** generally a useful mode for transistor operation, and so we will **avoid** that mode.

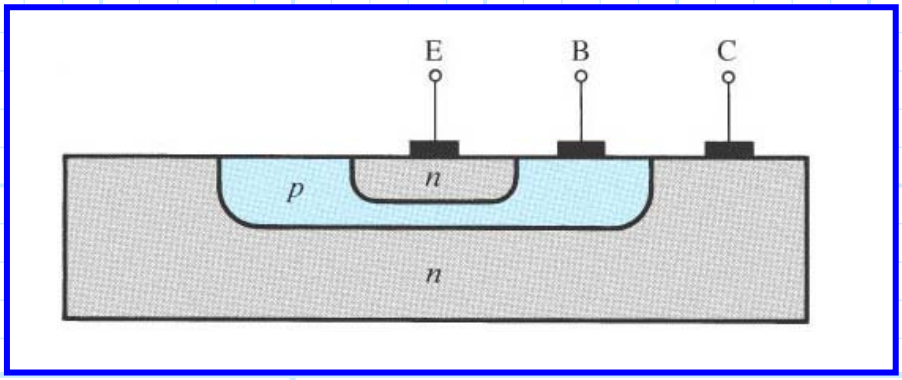
Given then that there are **two** **useful** *p-n* junction modes, and **two** *p-n* junctions for each BJT (i.e., CBJ and EBJ), a BJT can be in one of **four** modes!

MODE	EBJ	CBJ
1	Reverse	Reverse
2	Forward	Reverse
3	Reverse	Forward
4	Forward	Forward

Now, let's give each of these four BJT modes a **name**:

MODE	EBJ	CBJ
Cutoff	Reverse	Reverse
Active	Forward	Reverse
Reverse Active	Reverse	Forward
Saturation	Forward	Forward

We will find that the **Reverse Active** mode is of **limited** usefulness, and thus the **three basic operating modes** of a BJT are Cutoff, Active, and Saturation.



An Integrated Circuit BJT