Uni-Junction Transistor (UJT)
Lecture – 1

TDC PART – I

Paper - I (Group - B)
Chapter - 8

by:

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Introduction of UJT

- The **Uni-Junction Transistor** or **UJT** in short, is a solid state three terminal device that exhibits negative resistance and switching characteristics for use as a relaxation oscillator and in phase control applications.

- Basically, it is a three-terminal silicon diode. Like **diodes, uni-junction transistors** are constructed from separate P-type and N-type semiconductor materials forming a single **(hence its name Uni-Junction)** P-N junction within the main conducting N-type channel of the device.

- It differs from an ordinary diode in that it has **three** leads and it differs from a FET and BJT in that it has **no ability to amplify**. Although the Uni-junction Transistor has the **name of a transistor**, its switching characteristics are very different from those of a conventional bipolar or field effect transistor as it can not be used to amplify a signal but instead it is used as a ON-OFF switching transistor. However, it has the ability ***to control a large ac power with a small signal.*** **UJT**'s have unidirectional conductivity and it is also exhibits a negative resistance characteristic which makes it useful as an oscillator.

What is UJT? In Summary

- **Uni-junction transistor (abbreviated as UJT)**, also called the double-base diode is a 2-layer, 3-terminal solid-state (silicon) switching device.
- The device has only one junction, so it is called the **uni-junction** device.
- A Uni-junction transistor is a **three terminal** semiconductor device having only one P-N junction like diode but has three terminals.
- The device, because of one P-N junction, is quite similar to a diode but it differs from an ordinary diode as it has three terminals.

- The structure of a UJT is quite similar to that of an N-channel JFET. The main difference is that P-type (gate) material surrounds the N-type (channel) material in case of JFET and the gate surface of the JFET is much larger than emitter junction of UJT.

- In a uni-junction transistor the emitter is heavily doped while the N-region is lightly doped, so the resistance between the base terminals is relatively high, typically 4 to 10 kilo Ohm when the emitter is open.

- The N-type silicon bar has a high resistance and the resistance between emitter and base-1 is larger than that between emitter and base-2. It is because emitter is closer to base-2 than base-1.

- UJT is operated with emitter junction forward- biased while the JFET is normally **o**perated with the gate junction reverse-biased**.**

- UJT does not have ability to **amplify** but it has the ability to **control a large ac power** with a **small signal.** It exhibits a **negative resistance characteristic** and so it can be employed as an **oscillator**.

- It is low cost Device.

- The device is in general, a low-power-absorbing device under normal operating conditions.

- This device has a unique characteristics that when it is triggered, the emitter current increases **regeneratively** until is limited by emitter power supply.

- The **uni-junction transistor** can be employed in a variety of applications like switching pulse generator, saw tooth generator, relaxation oscillator, Sine wave generator, Timing and trigger circuits, Pulse generation, Phase control, Switching etc. The basic construction of UJT and its symbol is shown in **fig. (1)** in next slide.

Construction of UJT

- From the name itself, the **UJT** or **Uni Junction Transistor** is a semiconductor device that has only one junction. The UJT has three terminals designated **(Base1) B1, (Base2) B2** and **(Emitter) E.** The base material for a UJT is a **lightly doped N-Type Silicon bar** with **ohmic contacts** given at the **lengthwise ends**. These end terminals are called **(Base1) B1** and **(Base2) B2**. Since the **N-type silicon bar is lightly doped**, the resistance between (Base1) B1 and (Base2) B2 is very high (typically 5 KΩ to 10 KΩ).

- A **heavily doped P-type region** is constructed on one side of the bar close to the **(Base2) B2** region. This **heavily doped P-type region** is called **Emitter** and it is designated as **(Emitter) E**. Resistance between **(Emitter) E** & **(Base1) B1** is higher than the resistance between **(Emitter) E** & **(Base2) B2** because **(Emitter) E** is constructed close to **(Base2) B2**. The circuit symbol, internal block diagram and simplified equivalent internal circuit model of a UJT is shown in the **Fig. (1)** in next slide,

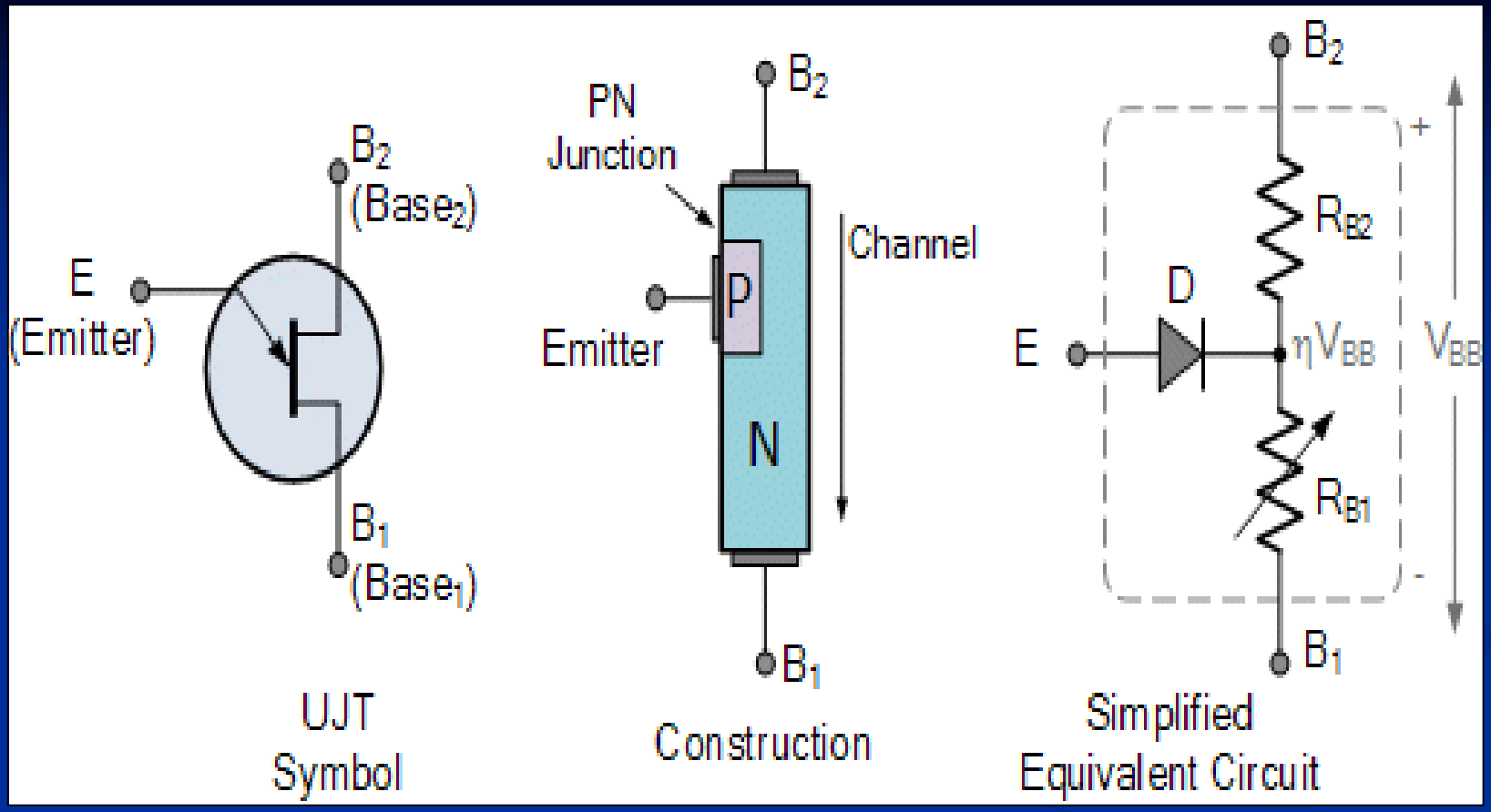

Fig. (1) Shown Circuit Symbol of a UJT, The internal block diagram, and UJT Simplified Equivalent Internal Circuit model.

- The diode symbol shown in the internal circuit model represents the P-N junction formed between the **heavily doped P-region Emitter (E)** and **the lightly doped N-Type bar**.

- UJT consists of a **N-type lightly-doped silicon** bar with a **heavily-doped *P*-type** material alloyed to its one side closer to (Base) *B*2 for producing single ***P-N* junction.**

- As shown in **Fig. (2) (*a*),** there are **three terminals** : one **Emitter (*E*)** and two bases **Base (*B*2)** and **Base (*B*1)** at the top and bottom of the silicon bar. The emitter leg is drawn at an angle to the vertical and arrow points in the direction of ***conventional*** current when UJT is in the conducting state which is shown in **Fig. (2) (b).**

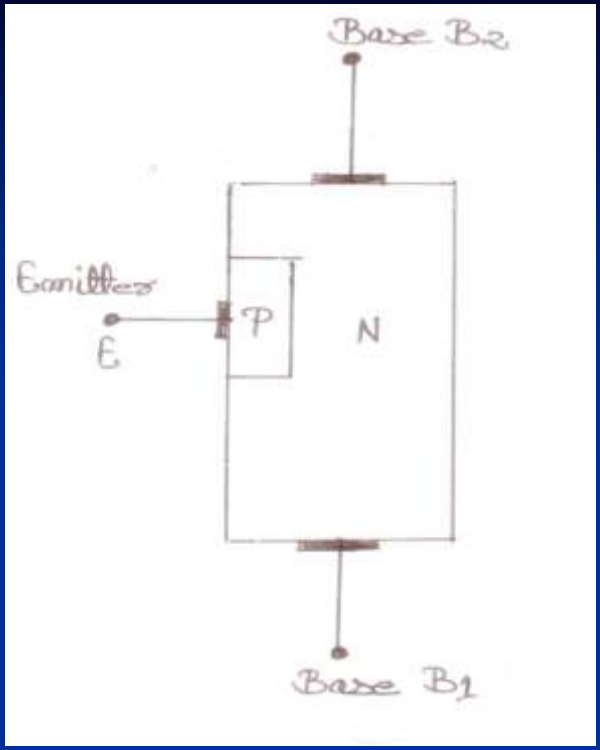

Fig. (2) (a)

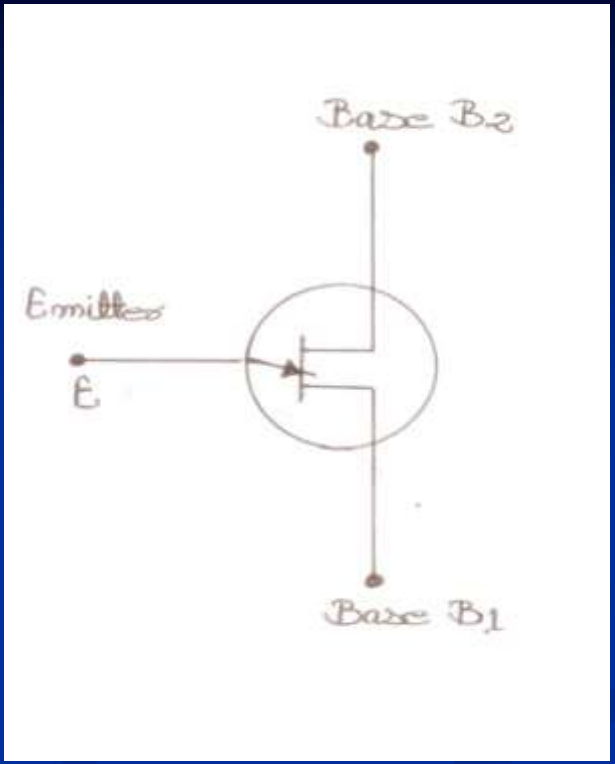

Fig. (2) (b)

- **Fig. (2) (a)** Shown UJT Block Diagram and
- **Fig. (2) (b)** Shown UJT Circuit Symbol.

Construction of UJT in Summary

- The device has only one junction, so it is called the uni-junction device.
- The device, because of one P-N junction, is quite similar to a diode but it differs from an ordinary diode as it has three terminals.
- The structure of a UJT is quite similar to that of an N-channel JFET. The main difference is that P-type (gate) material surrounds the N-type (channel) material in case of JFET and the gate surface of the JFET is much larger than emitter junction of UJT.
- In a uni-junction transistor the emitter is heavily doped while the N-region is lightly doped, so the resistance between the base terminals is relatively high, typically 4 to 10 kilo Ohm when the emitter is open.

- The N-type silicon bar has a high resistance and the resistance between emitter and base-1 is larger than that between emitter and base-2. It is because emitter is closer to base-2 than base-1.

- It consists of a **lightly-doped silicon** N-type silicon bar with an electrical connection on each end and the leads to these connections are called base leads, **Base 1 (B1), Base 2 (B2).**

- The small **heavily doped P-type region** is doped at one side of the bar near to **(Base2) B2** terminal and the lead taken from this **P-type region** is known as **emitter (E).**

- Thus a P-N junction is formed between the **Emitter (E)** and **lightly doped N-type silicon bar**. The **Emitter (E)** region is **heavily doped**, while the base region is lightly doped.

- **Due to N-type lightly-doped silicon** base the resistivity of **N-type silicon** base material is **very high**.

to be Continued .....