

# **Four Layer P-N-P-N Switching Devices (Uni Junction Transistor)**

## **Lecture – 2**

**TDC PART – II  
Paper - III (Group - A)  
Chapter - 4**

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## Lecture – 2

TDC PART – II

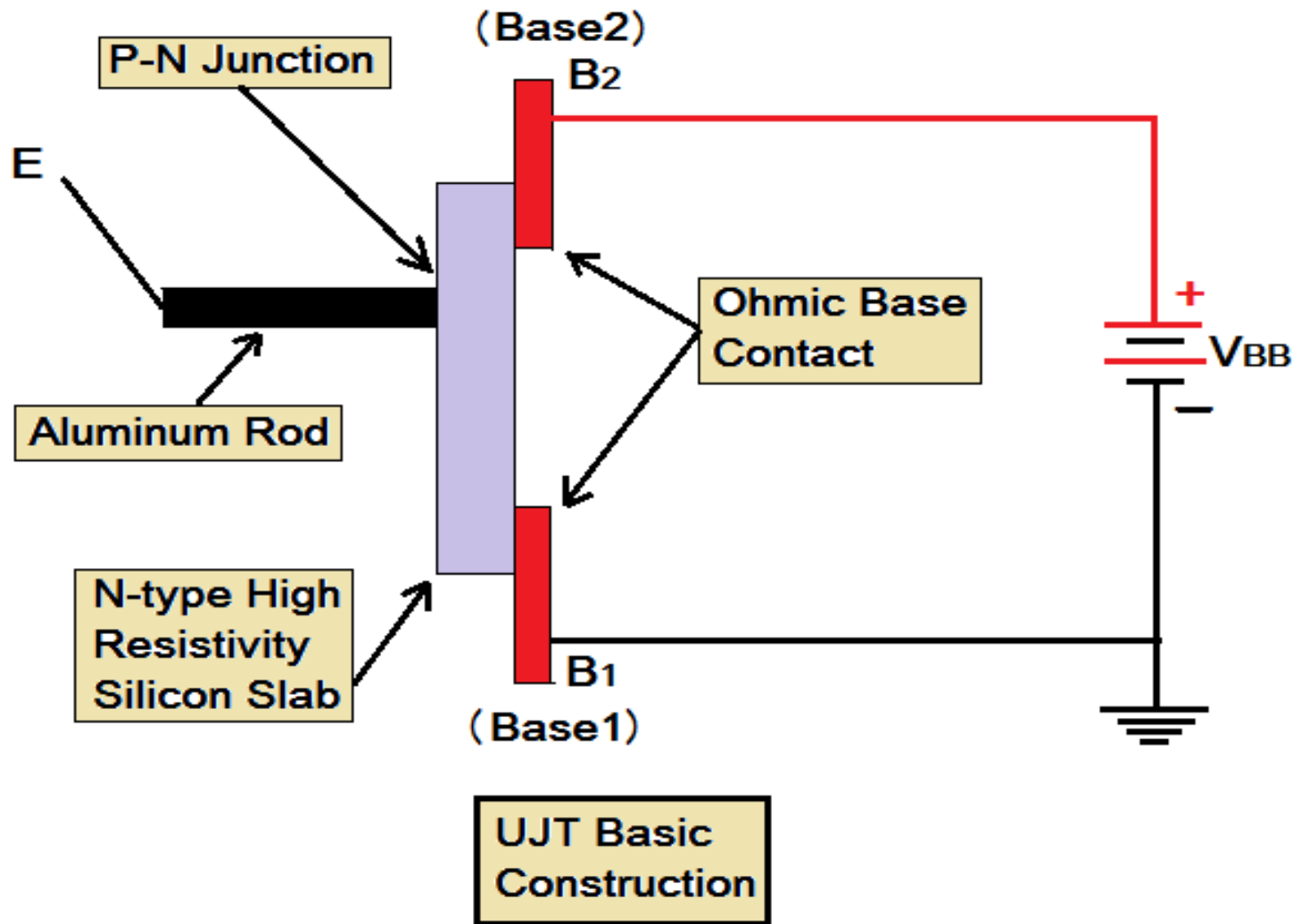
Paper - III (Group - A)

Chapter - 4

- (Uni Junction Transistor)
- Lecture Content :-
  - UJT Basic Construction
  - UJT Construction
  - UJT Construction in Summary

## UJT Basic Construction

- The UJT is a **Three Terminal Device** having the basic construction Shown in below **Figure (2)**. A **Slab of Lightly Doped** (increased resistance characteristics) **N-type Silicon-Material** has **Two Base Contacts** attached to both ends of one surface and an **Aluminium Rod Alloyed to the opposite surface**. The **P-N Junction** of the device is formed at the boundary of the **Aluminium Rod** and the **N-type Silicon Slab**.



■ Fig (2) Show UJT Basic Construction.

- The **Single P-N Junction** accounts for the terminology “**Uni-Junction**”. It was originally called a **Duo (double) Base Diode** due to the presence of **Two Base Contacts**. From above **Figure (2)**, the **Aluminium Rod** is **Alloyed** to the **Silicon Slab** at a point closer to the **Base2** contact than the **Base1** contact and that the **Base2 Terminal** is made **Positive** with respect to the **Base1 Terminal** by  $V_{BB}$  volts. The effect of each will become evident in the paragraphs to follow.

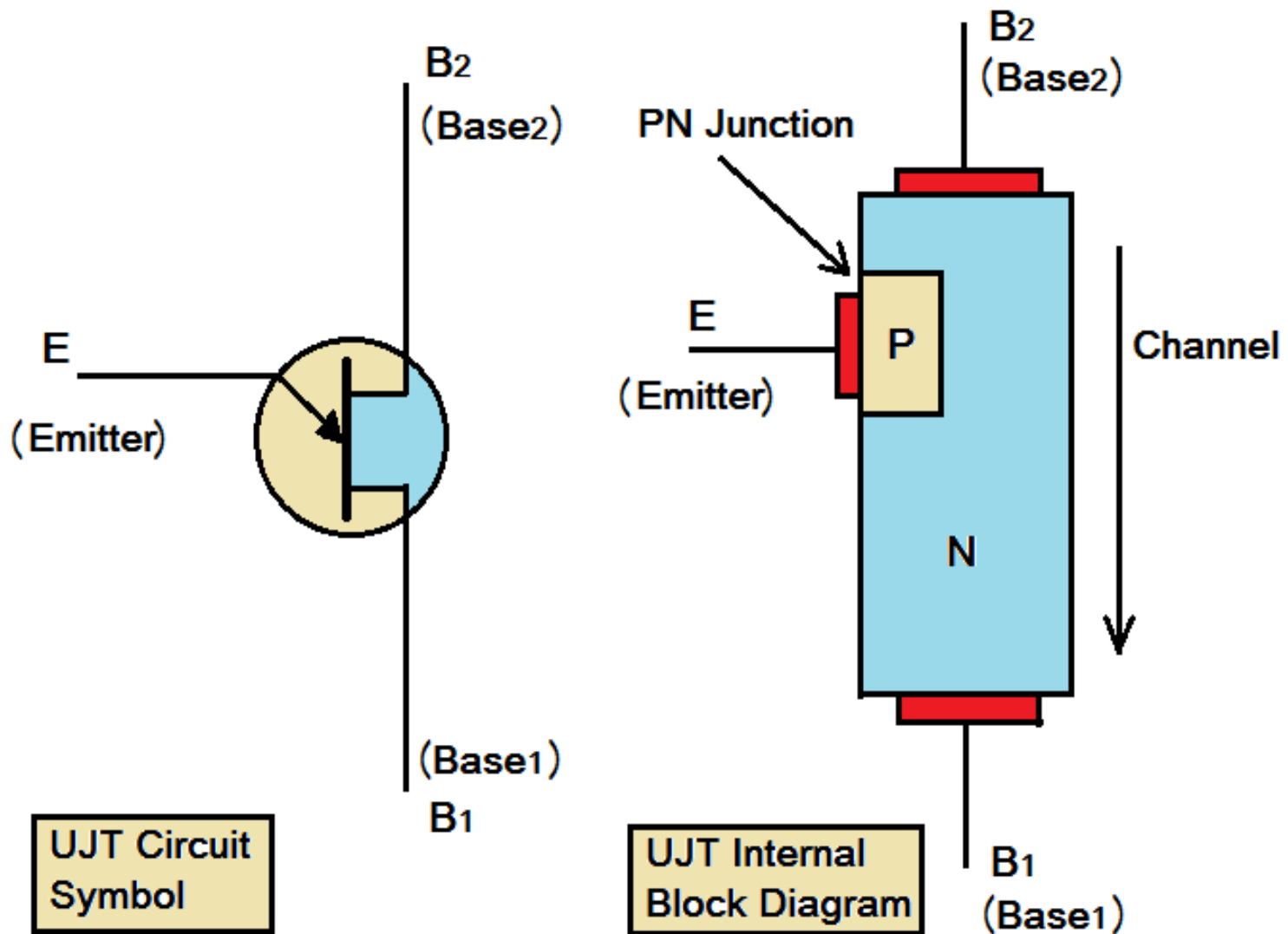
## UJT Construction

- An UJT is made up of an **N-type Silicon Base** to which **P-type Emitter (E)** is embedded, shown in below **Figure (3)**. 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 the **(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**. Between **Bases B1** and **B2**, the **UJT** behaves like an ordinary resistance.  **$R_{B1}$**  and  **$R_{B2}$**  are the **Internal Resistance** respectively from **Bases B1** and **B2** to **“Eta-Point A**, shown in **Figure (7)** and **Figure (8)**. Since the **N-type Silicon Bar** is **Lightly Doped**, the **Resistance** between **(Base1) B1** and **(Base2) B2** is **Very High** (typically **5 K $\Omega$**  to **10 K $\Omega$** ).

- 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 **UJT Circuit Symbol**, and **Internal Block Diagram** is shown in the **Figure (3)** below, and **Simplified Equivalent Internal Circuit Model** of a **UJT** is shown in the **Figure (4)** below.

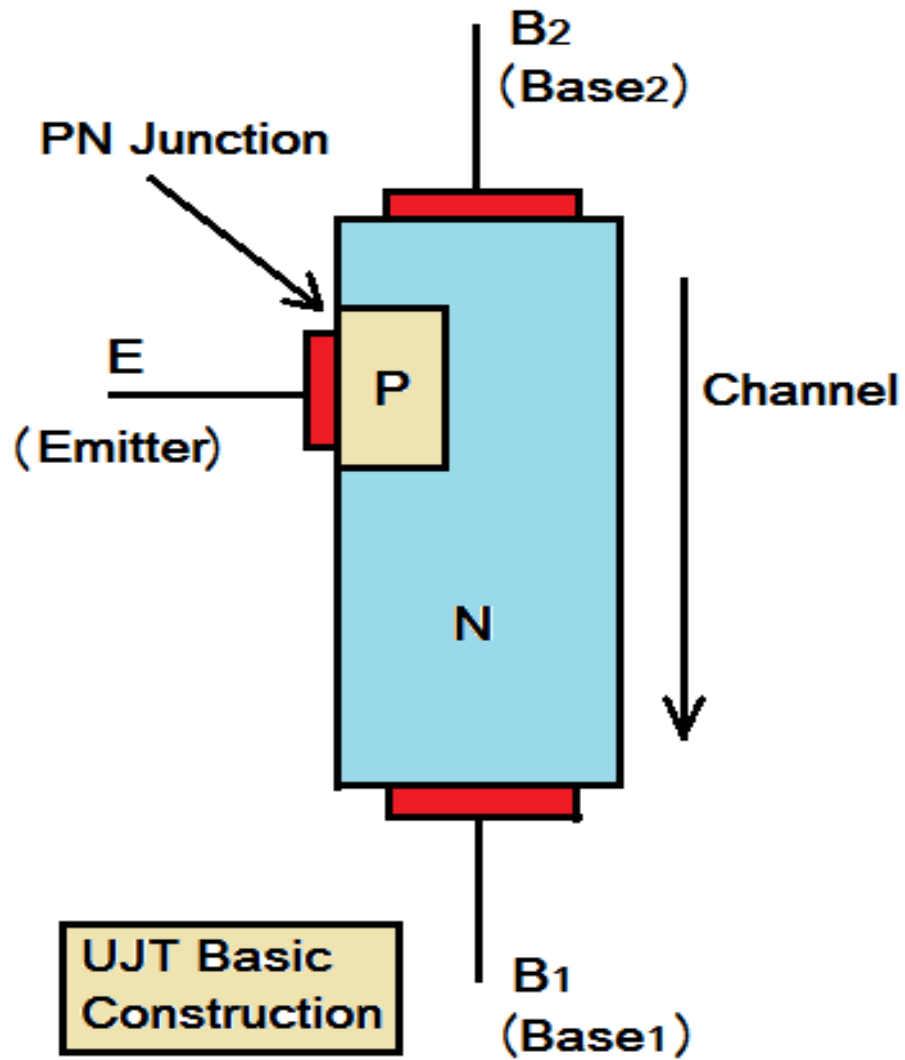




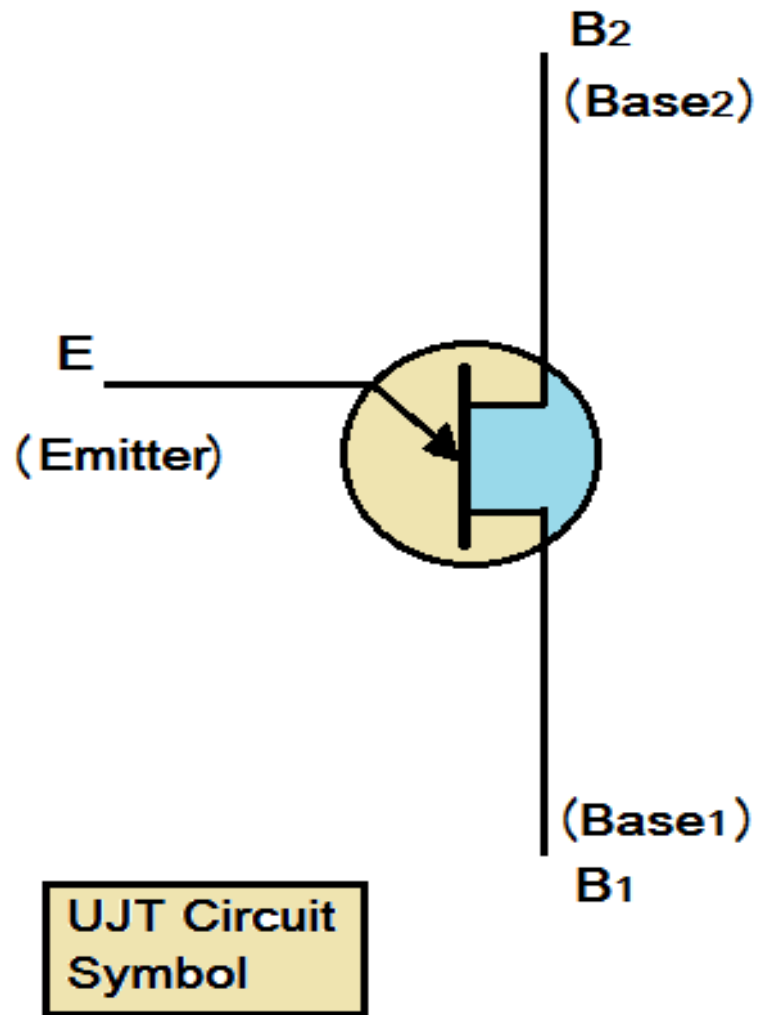
■ **Fig (3)** Shown **UJT** Circuit Symbol and Its Internal Block Diagram.

- **Basically 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) B2 for producing Single P-N Junction.**

- As shown in below **Figure (4)** UJT Basic Construction and its Block Diagram, there are Three Terminals: One Emitter (E) and Two bases Base (B2) and Base (B1) 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 UJT Circuit Symbol in below **Figure (5)**.

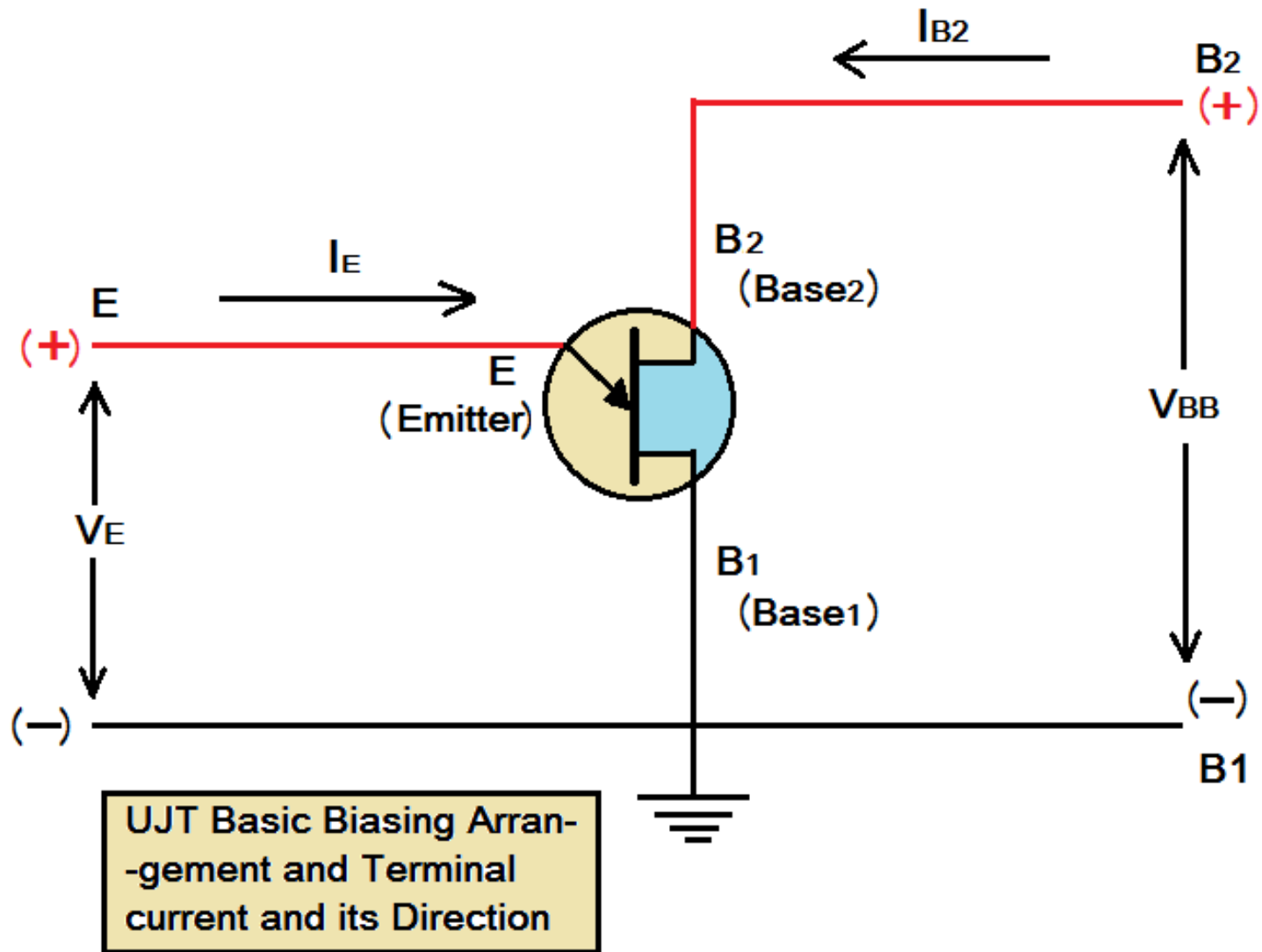


■ Fig (4) Shown UJT Basic Construction and its Block Diagram.



■ Fig (5) Shown UJT Circuit Symbol.

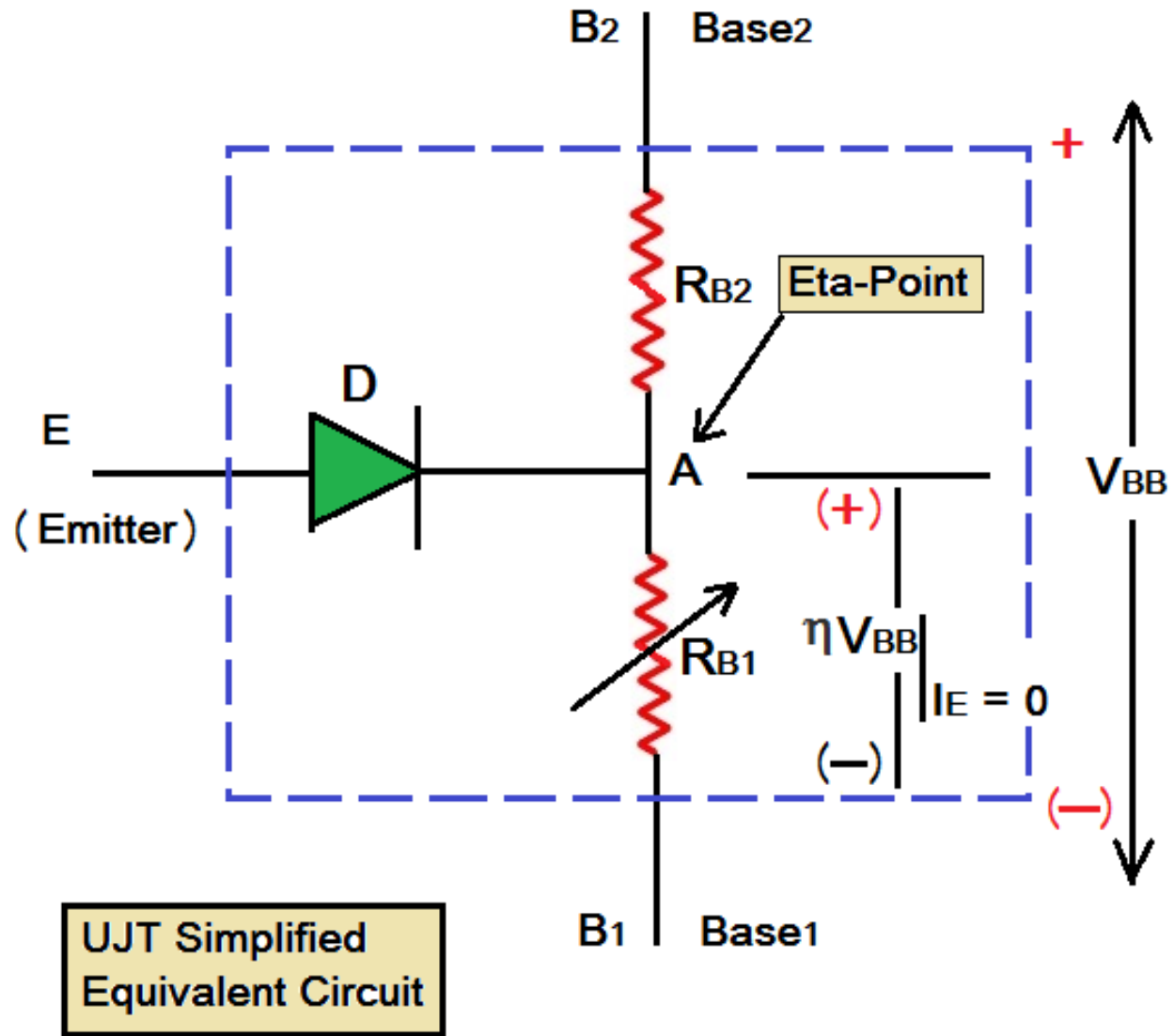
- The **Circuit Symbol** for the **Uni-Junction Transistor (UJT)** is shown in above **Figure (5)** and also in **Figure (6)** shown below the UJT terminal current and its direction. Note that the **Emitter (E)** leg is drawn at an angle to the vertical line representing the slab of **N-type material**. The arrowhead is pointing in the direction of conventional current (**Hole**) Flow when the device is in the **Forward Biased, Active, or Conducting State**.



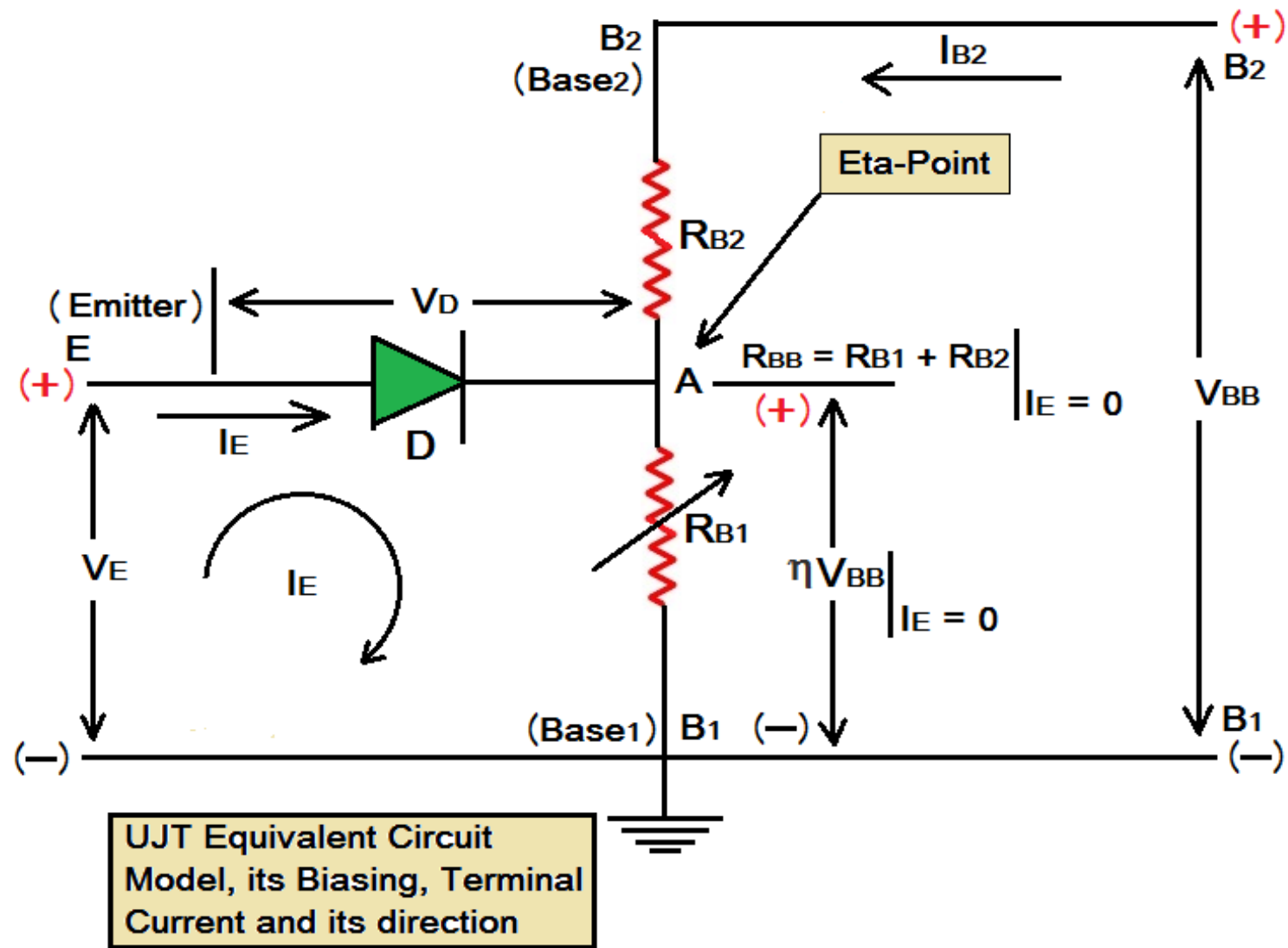
- **Fig (6)** Shown UJT Circuit Symbol with Basic Biasing Arrangement and Terminal Current and its Direction.

- The **Simplified Equivalent Internal Circuit Model of UJT** is shown in **Figure (7)** and **UJT Simplified Equivalent Internal Circuit model with Basic Biasing Arrangement, Terminal Current and its Direction** is shown in **Figure (8)** below. From **Figure (7)** the **Diode symbol** shown in the **Simplified Equivalent Internal Circuit Model** represents the **P-N Junction** formed between the **Heavily Doped P-type Region Emitter (E)** and the **Lightly Doped N-Type Bar**.





■ Fig (7) Shown UJT Simplified Equivalent Internal Circuit model.



- Fig (8) Shown UJT Simplified Equivalent Internal Circuit model with Basic Biasing Arrangement, Terminal Current and its Direction

- The **Equivalent Circuit of the UJT** is shown in **Figure (8)**. Carefully Noted here, that the relative simplicity of this **Equivalent Circuit Diagram of UJT**; **Two Resistors  $R_{B2}$  and  $R_{B1}$**  (one fixed, one variable) and a **single Diode**. The **Resistor  $R_{B1}$**  is shown as a **variable Resistor** since its Magnitude will vary with the **Emitter Current  $I_E$** . In fact, for a representative **Uni-Junction Transistor (UJT)**,  **$R_{B1}$**  may vary from  **$5\text{ K}\Omega$**  down to  **$50\text{ K}\Omega$**  for a corresponding change in **Emitter Current  $I_E$**  from  **$0\mu\text{A}$**  to  **$50\mu\text{A}$** .

## UJT Construction in Summary

- 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 .....**