Four Layer P-N-P-N Switching Devices (Shockley Diode) Lecture – 7

TDC PART – II

Paper - III (Group - A)

Chapter - 4

by:

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Four Layer P-N-P-N Switching Devices (Shockley Diode)
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- **P-N-P-N Diode or Shockley Diode**
- **Lecture Content :-**

➢ **(6) Various States in V-I Characteristics of Two Terminals P-N-P-N Diode or Shockley Diode**

➢ **(II) Forward Conducting State (ON-State)**

P-N-P-N Diode or Shockley Diode

- **(6) Various States in V-I Characteristics of Two Terminals P-N-P-N Diode or Shockley Diode**

- A careful observation and detailed study of the **V-I characteristics** reveal that the **Two Terminal P-N-P-N Diode or Shockley Diode** has **three basic State of operation** namely the,

- **(I) Forward Blocking State (OFF-State),**
- **(II) Forward Conduction State (ON-State), and**
- **(III) Reverse Blocking State (OFF-State)**

- The above basic State of Operations is discussed in great details below, to **understand the overall characteristics of a Two Terminal P-N-P-N Diode or Shockley Diode**. Let us now discuss each of the **Three State** one by one,

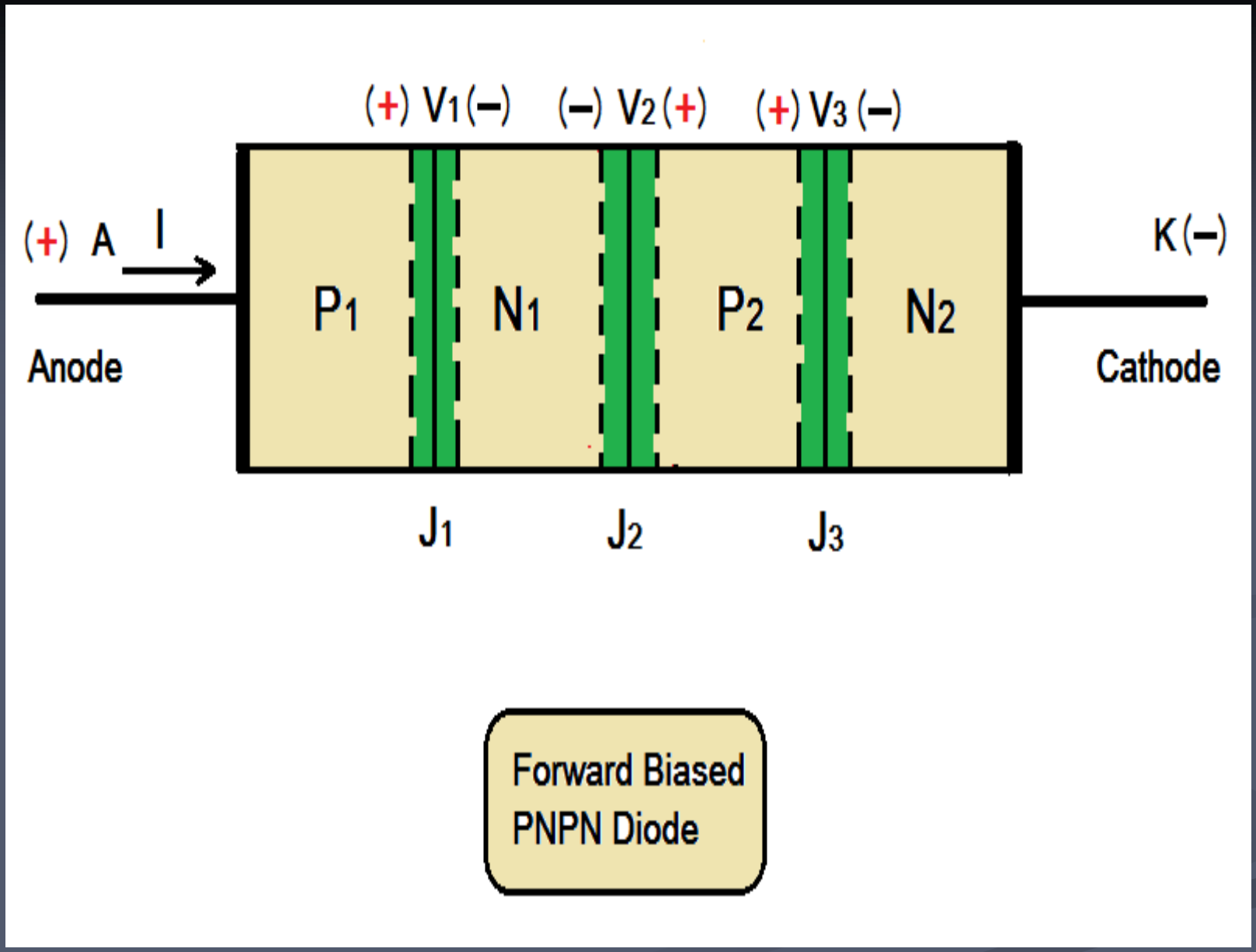
(II) Forward Conducting State (ON-State)

- The **Charge Transport Mechanism** changes dramatically when transistor action begins. As **$\alpha 1 + \alpha 2$** approaches **Unity** by one of the mechanisms described above, many **Holes injected** at **Junction J1** survive to be swept across **Junction J2** into **P2 region.**

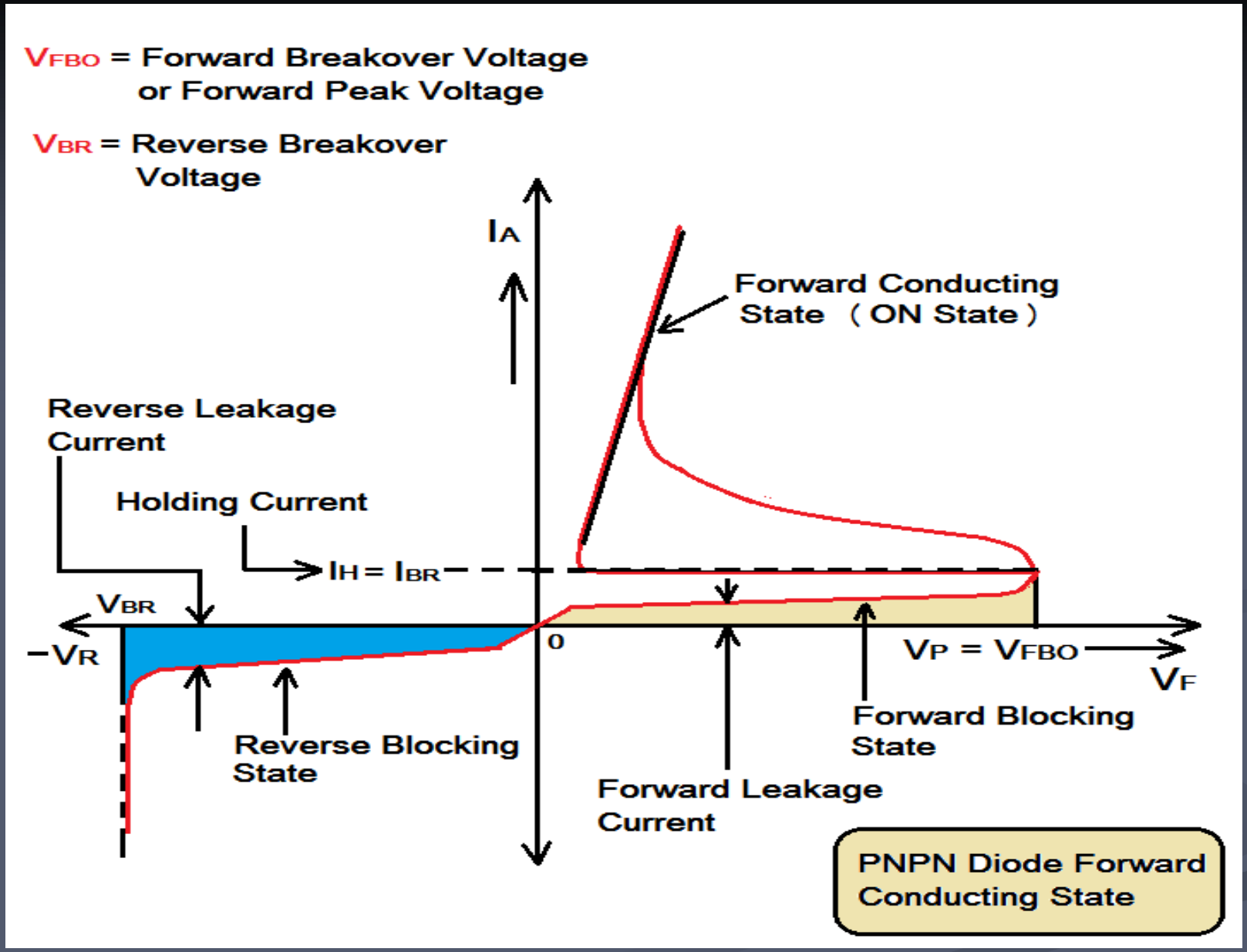
- This helps to feed the **recombination in P2 region** and to support the **injection of Holes into N2 region.** Similarly, the **transistor action of Electrons injected at Junction J3 and collected at Junction J2 supplies Electrons for N1 region.** Obviously, the **Current the device can be much Larger** once this mechanism begins.

- The **Transfer of Injected Carriers** across **Junction J2** is **Regenerative,** in that a **greater supply of Electrons to N1 region** allows **greater injection of Holes at Junction J1** while **maintaining space charge neutrality;** this **greater injection of Holes further feeds P2 region** by **transistor action**, and the process continues to repeat itself.

- If **$\alpha 1 + \alpha 2$ is Large enough,** so that **many Electrons are collected in N1 region** and **many Holes are collected in P2 region,** the **depletion region at Junction J2** begins to **Decrease.** Finally the **Reverse Bias Disappears** across **Junction J2** and is **replaced by a Forward Bias,** in **analogy with a transistor biased deep in Saturation.** When this occurs, the **Three Small Forward-Bias Voltages V1, V2, and V3 appear** as shown in **Figure (14)** below.



- **Fig. (14)** Shown Forward Biased P-N-P-N Diode.



- **Fig. (15)** Shown Forward Conducting State of a P-N-P-N Diode V-I Characteristics

- **Two of these Voltages essentially cancel** in the **overall V,** so that the **Forward Voltage Drop** of the device from **Anode (A) to Cathode (K) in the Conducting State** is not **much greater** than that of a **single P-N Junction**. For **Silicon (Si)** this **Forward Drop is less then 1 V, until Ohmic Losses becomes important at High Current Levels.**

- We have discussed here the **Current Transport Mechanisms** in the **Forward Blocking and Forward-Conducting State,** but we have not indicated how **Switching is initiated from one state to the other.**

- Basically, the requirement is that the **Carrier Injection at Junction J1 and J2** must some how be **increased** so that **significant Transport of Injected Carrier across Junction J2 occurs.** Once this **Transport of Injected Carrier** begins, the **Regenerative Nature** **of the Process takes over and Switching is completed.**

to be continued .....