Four Layer P-N-P-N Switching Devices (Shockley Diode) Lecture – 2

TDC PART – II

Paper - III (Group - A)

Chapter - 4

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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 :-**
  - **(1) Basic Introduction**
  - **(2) Introduction to Shockley Diode**

P-N-P-N Diode or Shockley Diode

- **Basic Introduction**
- The **SCR** is a **Four Layer (P-N-P-N)** structure that effectively blocks the current through two terminals until it is **Turn ON** by a small signal at a third terminal. There are many varieties of the basic **P-N-P-N** structure, and we shall not attempt to cover all of them; however, we can discuss the basic operation and physical mechanisms involved in the devices.

- We shall begin by investigating the current flow in a **Two-Terminal P-N-P-N Device** and then extend the discussion to include triggering by a third terminal. We shall see that the **P-N-P-N Structure** can be considered for many purpose as a combination of **PNP and NPN Transistors;** before discussing the control of an **SCR** using a third terminal, it is important to understand the basic transistor action at work in a **P-N-P-N Structure.** Therefore, in this section we analyze the four-layer **P-N-P-N Structure** with only **Two Terminals.**

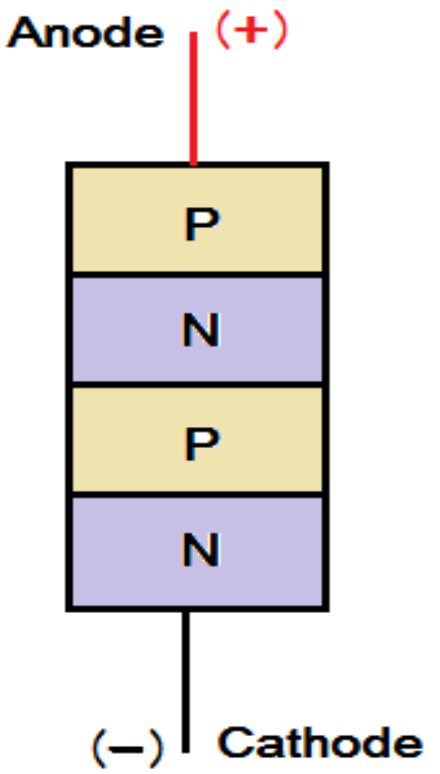
- In this Lecture, we will learn about **P-N-P-N Diode or Shockley Diode.** Even though it is not available commercially (production stopped in **1950's)** and it is not particularly useful, the model technique of **P-N-P-N Diode or Shockley Diode** is very useful in creating other types of **Thyristors like SCR, DIAC and TRIAC etc.**

- **Shockley Diode** is the first member of **Thyristor family** devices and it is named after the inventor **William Bradford Shockley.** Once we understand this basic operation of **Shockley Diode,** we will easily understand the next concepts covered in **Thyristors like SCR, DIAC and TRIAC** etc. Let us know about the **P-N-P-N Diode or Shockley diode** working and applications.

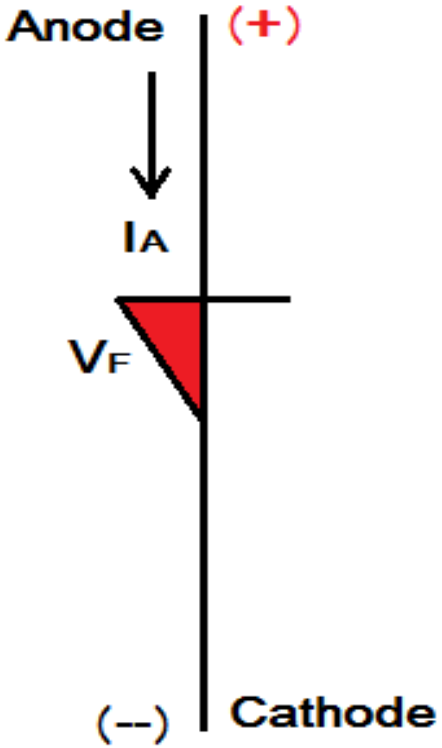
Introduction to Shockley Diode

- The **Shockley Diode or P-N-P-N Diode** is a **Four Layer (P-N-P-N), Two Terminals (namely Anode (A) and Cathode (K)) Semiconductor Switching Device.** It is also called as **Four Layer Diode.** It functions like a **normal diode** without any **trigger inputs,** in **Reverse Biased condition,** no **Current flows** through it and in **Forward Biased condition Current flows through it when the voltage across it is more than the Break-over Voltage of it.**

- These **Shockley Diodes** have only **Two States**, either **ON or OFF** that's why these are classified as a **Thyristors.** The **Basic Construction** and **Circuit Symbol** of the **Four Layer P-N-P-N Shockley Diode** are shown in below **Figure (1).**



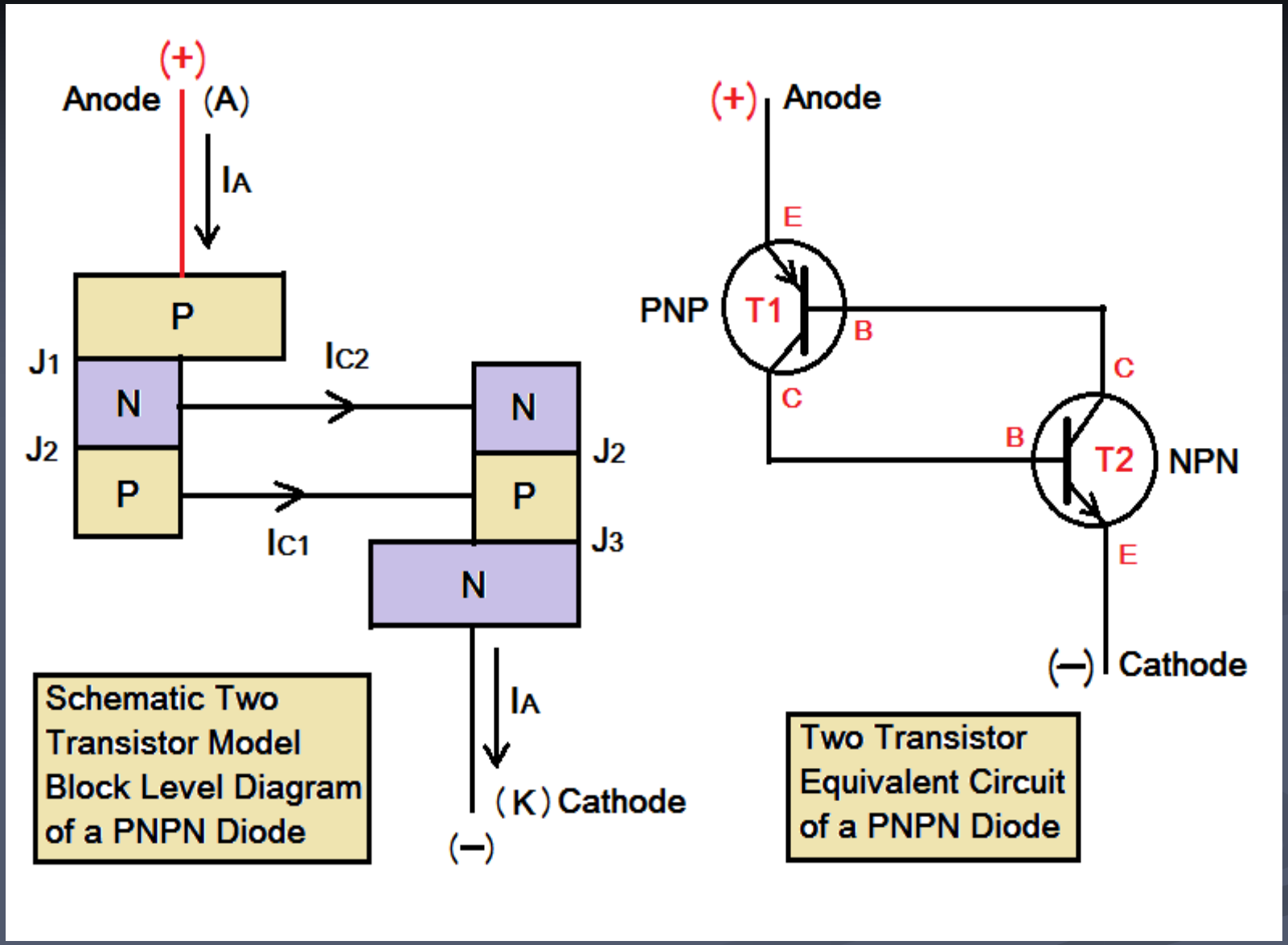
A Two Terminal PNPN Diode Basic Construction



A Two Terminal PNPN Diode Circuit Symbol

- **Fig (1)** Shown Basic Construction and Circuit **Symbol** of a Four Layer **P-N-P-N Shockley Diode**

- The construction of this **Diode** is simple: it is constructed by joining the **Four Layers** to form **P-N-P-N Junction.** Two Transistor Model Block Diagram and Two Transistors Equivalent Circuit of a Four Layer **P-N-P-N** Shockley Diode is shown in above **Figure (2)** where in the collector of a **Transistor T1** is connected to the **Base of Transistor T2.**



- **Fig (2) Shown** Two Transistor Model Block Diagram and Two Transistor Equivalent Circuit of a Four Layer **P-N-P-N** Shockley Diode

- The **Junction J1** is formed at the **Emitter Base Junction** of **Transistor T1**, **Junction J2** is at **common** connected **Base Collector Junction** between **Transistor T1 and T2,** and the **Junction J3** is at **Base Emitter Junction** of **Transistor T2.** Therefore, as the **Base Emitter Junctions, J1 and J3** must be **Forward Biased** and as a **Collector Base Junction, J2** must be **Reverse Biased for linear operation.**

to be continued .....