Basics of Electronics Engineering (EC142)

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Semiconductor Diodes and Applications

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- Introduction to Electronics
- Familiarization with basic electronic components.
- Semiconductor Theory
- Review of PN junction operation
- Plot and analyse V-I Characteristics of PN-Junction Diode
- Diode Applications – Rectifier, Clipper
- Special purpose diodes
  - Light Emitting Diode
  - Zener Diode
  - Varactor Diode
  - Photodiode

Varactor Diode

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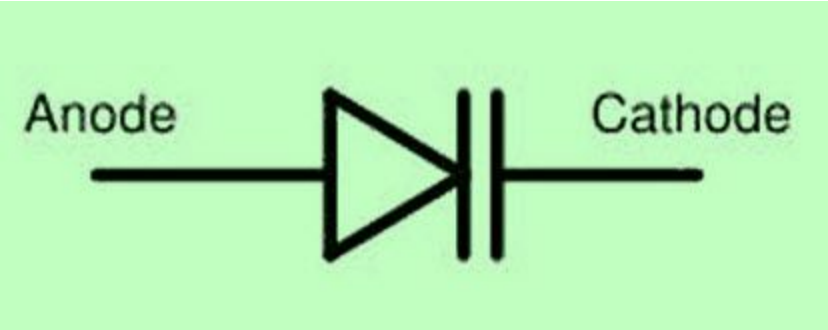
- Varactor Diode is a reverse biased PN junction, whose capacitance can be varied electrically.
- As a result these diodes are also referred to as varicaps, tuning diodes, voltage variable capacitor diodes, parametric diodes and variable capacitor diodes.

Symbol



The symbol of the Varactor diode looks like a common PN-junction diode that includes two terminals namely the cathode and the anode. And at one end this diode is inbuilt with two lines that specify the capacitor symbol.

Transition Capacitance

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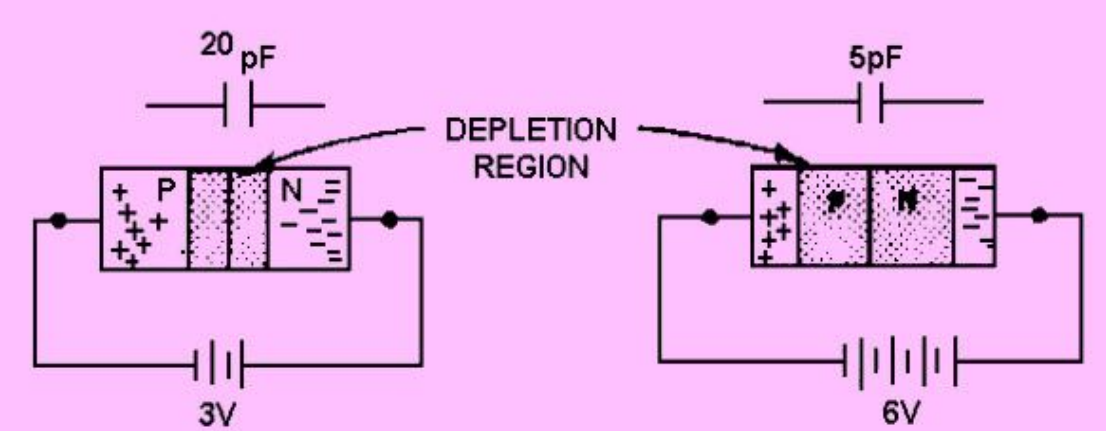
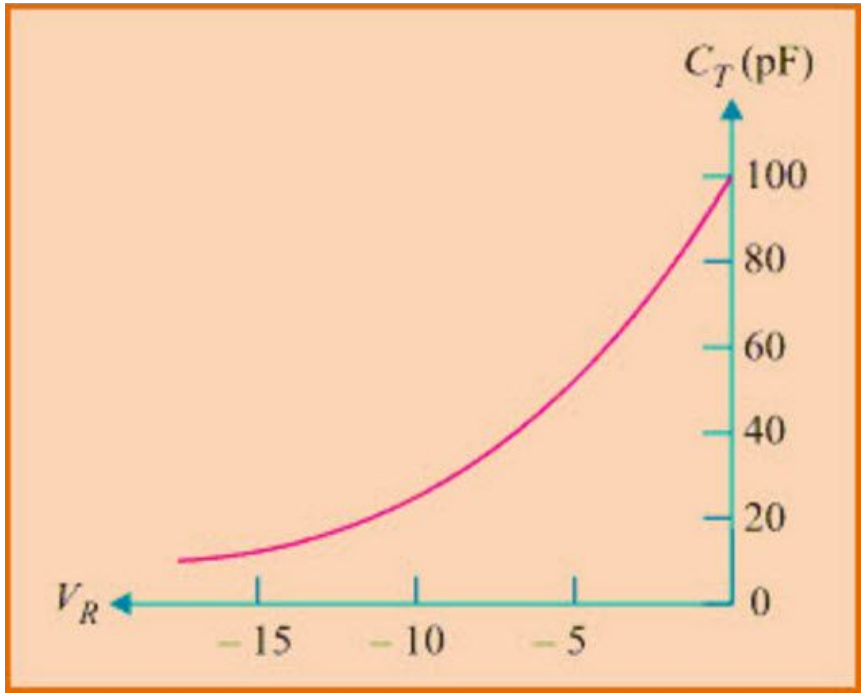
- The capacitance at the junction is termed as transition capacitance. It is designated as C_T. As we know the capacitance is given by:

$$C_T = \frac{\varepsilon A}{W}$$

ε = permittivity of the material
A = area of the junction
W = depletion region width

Working Principle and output characteristics





Applications

Owing to the special property of varying capacitance with varying voltage, varactor diodes are mostly used in frequency modulation or tuning circuits where the value of capacitance determines the output modulation frequency. Some of the other applications include:

- Automatic Frequency Controllers (AFCs)
- Ultra High Frequency Television sets
- High frequency Radios
- Frequency Multipliers
- Band Pass Filters
- Harmonic Generators

Photodiode

- A **photodiode** is a semiconductor device that converts light into electrical current.
- The current is generated when photons are absorbed in the photodiode.
- Photodiodes may contain optical filters, built-in lenses, and may have large or small surface areas.
- Photodiodes usually have a slower response time as their surface area increases.

Photodiode

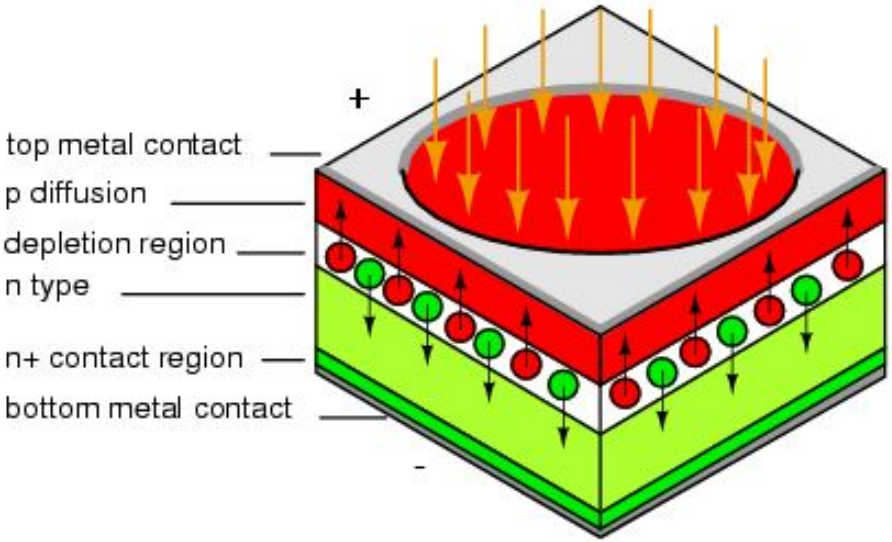
- Sometimes these diodes also called photo-detector, light detector, and photo-sensor.
- These diodes are particularly designed to work in reverse bias conditions, it means that the P-side of the photodiode is connected with the negative terminal of the battery, and the n-side is connected to the positive terminal of the battery.

The Practical Photodiode

PHOTODIODE

Symbol & Structure

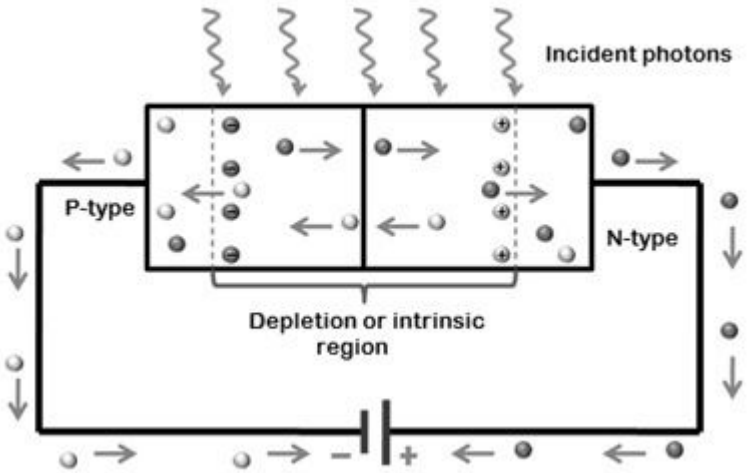
Characteristics

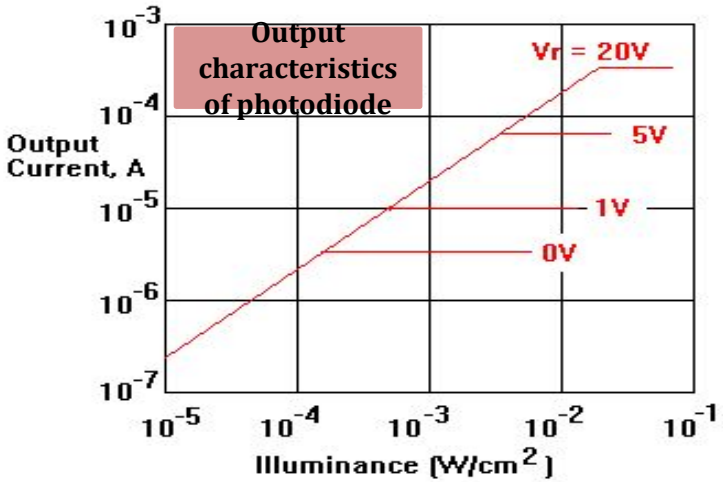


Structure of a Photodiode

Working Principle

- When a photon of ample energy strikes the diode, it generates an electron-hole pair. This mechanism is also called as the photoelectric effect.
- Now, due to reverse biasing, holes move towards the anode, and electrons move toward the cathode, and a photocurrent will be generated.
- The entire current through the diode is the sum of the dark current (during absence of light) and the photocurrent.
- The dark current must be reduced to maximize the sensitivity of the device.



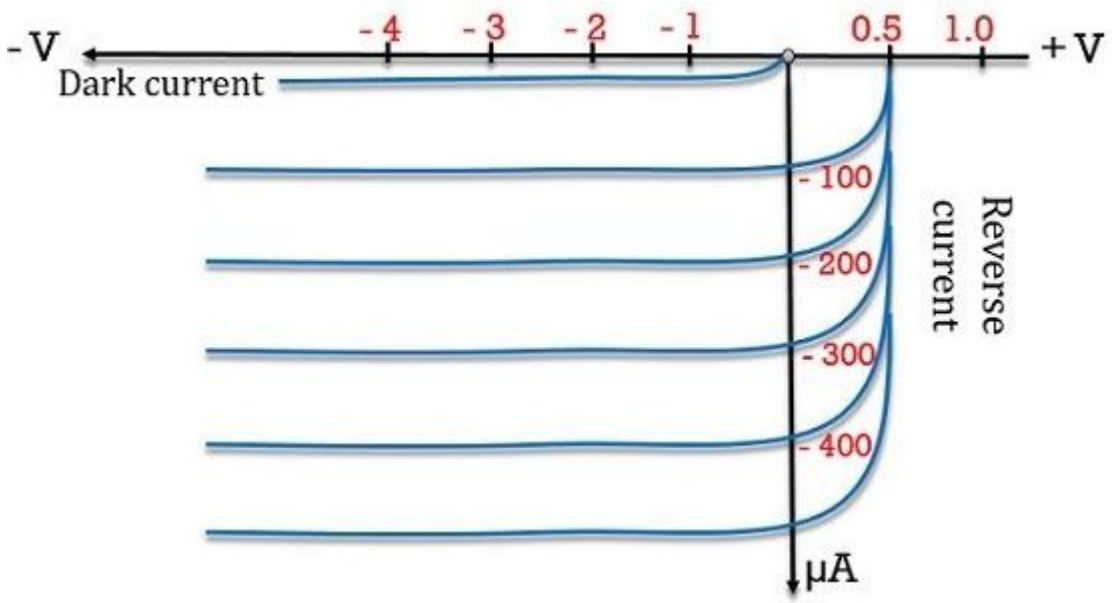


Output characteristics

PHOTODIODE

Symbol & Circuit

Characteristics



V-I Characteristics

Advantages of Photodiode

- It shows a quick response when exposed to light.
- Photodiode offers high operational speed.
- It is a low-cost device.
- Long life span
- Doesn’t use high voltage
- Solid and low-weight
- Dark current is lees
- Less noise

Disadvantages of Photodiode

- It is a temperature-dependent device. And shows poor temperature stability.
- When low illumination is provided, then amplification is necessary.

Applications of Photodiode

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1. Photodiodes majorly find its use in counters and switching circuits.
2. Photodiodes are extensively used in an optical communication system.
3. It is widely used in burglar alarm systems. In such alarm systems, until exposure to radiation is not interrupted, the current flows. As the light energy fails to fall on the device, it sounds the alarm.

Exam Questions

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- A varactor diode has a capacitance of 18 pF when reverse bias voltage applied across it is 4V. Determine the capacitance if the diode bias voltage is doubled.
- What is Dark current in a device used to convert light energy in to electrical energy when connected in reverse bias? Also discuss the mechanism involved for this conversion.

Useful links

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- https://drive.google.com/file/d/12U9Udy-8p50VJDJG1J3FxSGN9UFXVDtd/view?ts=5fc87446
- https://drive.google.com/file/d/1s01MsT_HkL-0fjvJF4WgWrKWDcXaf_ir/view?ts=5fc77c06
- https://drive.google.com/file/d/1KRmYDGoxGQYaJcJjSieH0bXmeT3J3fXW/view?ts=5fc77bfa
- https://drive.google.com/file/d/1jfpunnz9IYMCScZwHbbc4O10V3IfCP2M/view?ts=5fc77c12

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Thank You