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BANGALORE

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# Power Electronics Study Material

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**Ideal switches:**

- 1) Have zero conduction and blocking losses
- 2) Can change from ON state to OFF and vice-versa immediately
- 3) Does not require an external energy to change its state from ON to OFF and vice-versa
- 4) Does not require an external source to maintain the given state
- 5) Thermally stable under all operating conditions

**Real Switches:**

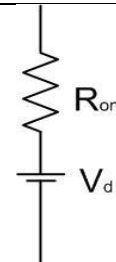
- 1) Have finite conduction and blocking losses
- 2) Takes finite time to change from ON to OFF state and vice-versa
- 3) Requires external energy to change the state as well as to maintain the given state.
- 4) Thermally not stable under all operating conditions (has thermal constraints for stable operation)

**Switch circuit models:**

Device	Circuit model
Diode $R_{on} = on - state\ resistance$ $V_d = on - state\ voltage\ drop$	
MOSFET $R_{on} = on - state\ resistance$ $V_d = on - state\ voltage\ drop$	
BJT $R_{on} = on - state\ resistance$ $V_d = on - state\ voltage\ drop$	



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<p>SCR  <math>R_{on} = \text{on - state resistance}</math>  <math>V_d = \text{on - state voltage drop}</math></p>	
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**Switch types:**

Classification-1 (based on control properties)

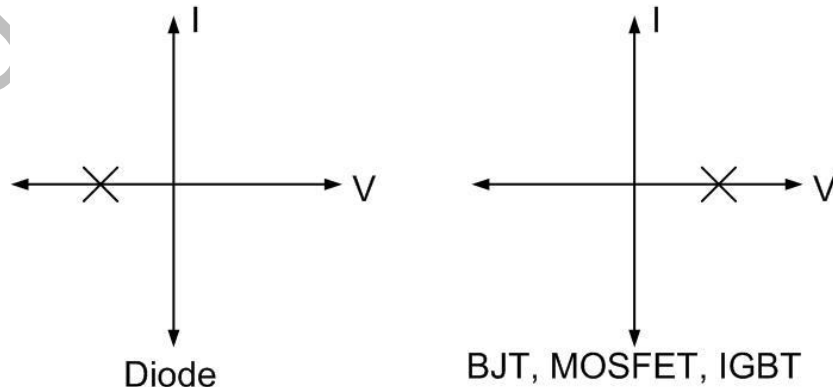
- 1) Uncontrolled switches: Switching states cannot be controlled with control signal  
Eg- Diode
- 2) Semi-controlled (or) Half-controlled switches: only one switching state (either ON or OFF) can be controlled using control signal

Eg- SCR

- 3) Fully-controlled switches: Both the switching states can be controlled by control signal  
Eg- BJT, MOSFET, IGBT

Classification -2 (based on operating point characteristics)

- 1) Unipolar switches: Blocks only one polarity of voltage (either positive or negative) during blocking state  
Eg- diode, BJT, IGBT, and MOSFET



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- 2) Bipolar switches: Blocks both polarity of voltage during blocking state.  
 Eg- SCR, TRIAC
- 3) Unidirectional switches: Allows current to flow in only one direction during conduction mode.  
 Eg – BJT, MOSFET, IGBT, SCR, and GTO
- 4) Bidirectional switches: Allows current to flow in both directions during conduction mode.  
 Eg - TRIAC

For high frequency and low power applications like UPS MOSFET is used.

For low frequency and high power applications like high voltage DC transmission SCR is used.

**Silicon Controlled Rectifier (SCR):**

It is a semi controlled, bipolar, and unidirectional switch which can be operated in 1<sup>st</sup> and 2<sup>nd</sup> quadrant.

Rating – up to 3 KV and 10 KVA

It is a 4 layer 3 junction device.

$N_2$  is heavily doped and thin layer,  $P_2$  is moderately doped and thick layer,  $N_1$  is lightly doped and thickest of all layers, and  $P_1$  is similar to  $P_2$

