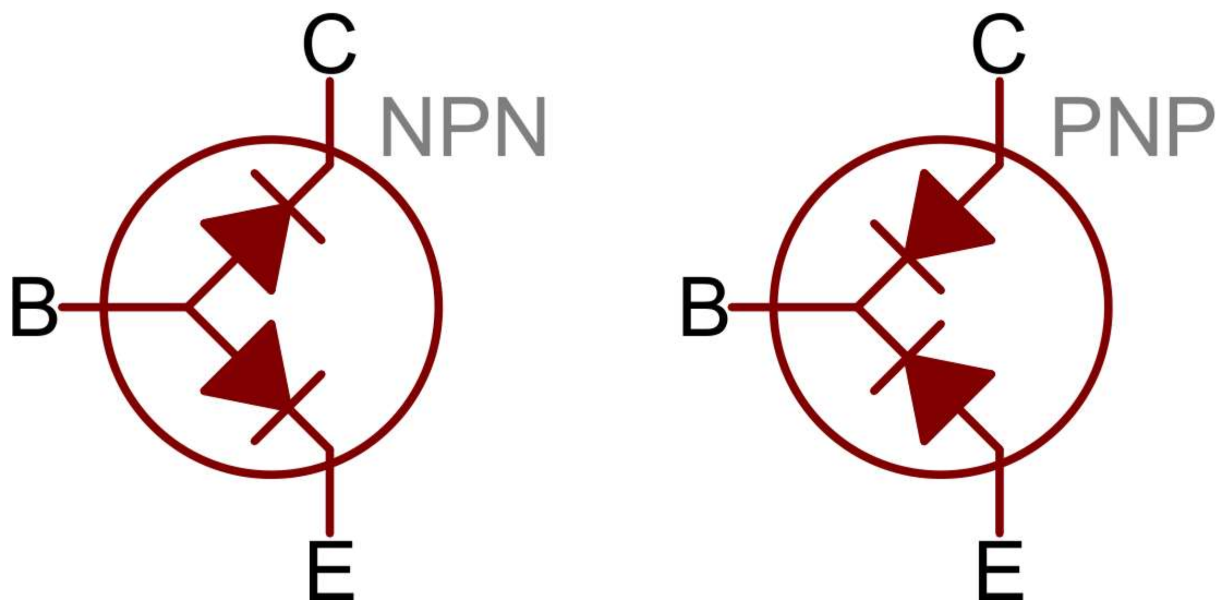
Chapter Two

Transistor as Switch



Chapter Outline: -

2.1: Bipolar Junction Transistor Switching Circuit

Transistor switches can be used to switch a low voltage DC device (e.g. LED's) ON or OFF by using a transistor in its saturated or cut-off state.

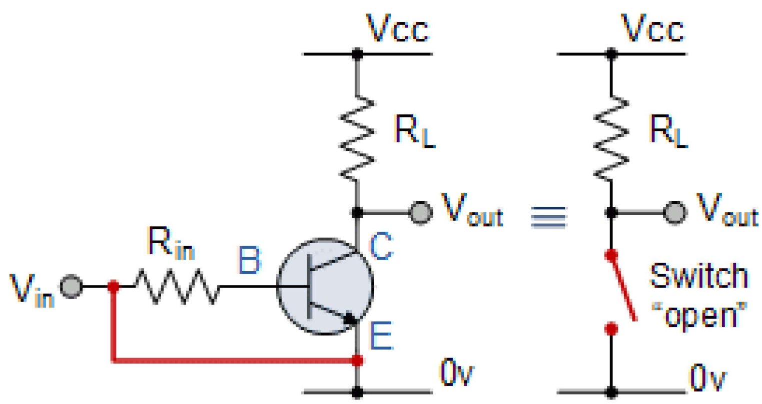


Fig. (2-1) Power switching circuits

The areas of operation for a transistor switch are known as the **Saturation Region** and the **Cut-off Region**. This means then that we can ignore the operating Q-point biasing and voltage divider circuitry required for amplification, and use the transistor as a switch by driving it back and forth between its "fully-OFF" (cut-off) and "fully-ON" (saturation) regions as shown below.

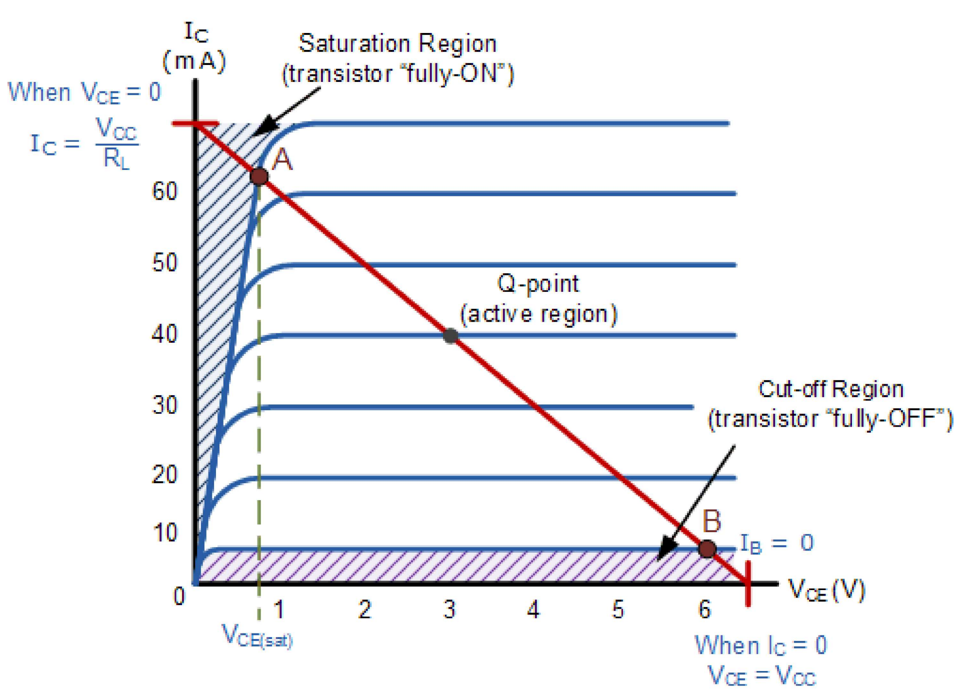


Fig. (2-2) Output characteristic curve of NPN common emitter BJT

2.2 Type of BJT Switching Circuit

2.2.1 Fully driven NPN BJT Switching Circuit

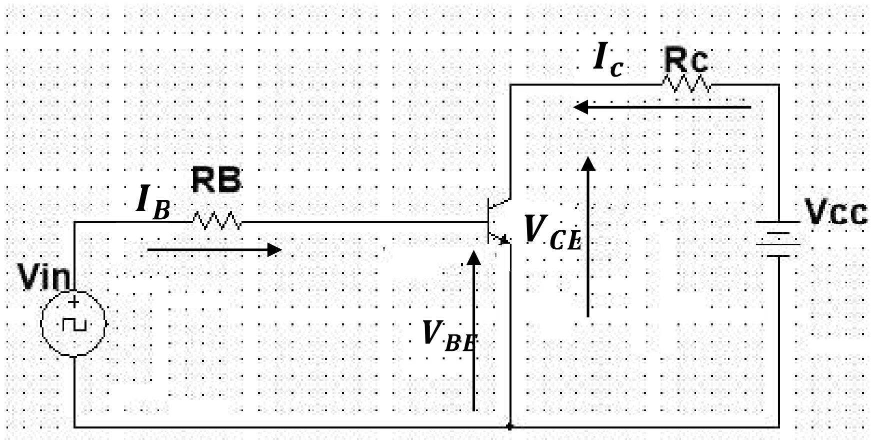


Fig. (2-3) Common emitter BJT fully driven switch

On-state: The BJT operate at the edge of the saturation region it's called point A in Fig.

$V_{CE} = V_{CE(sat)}$

$I_c = I_{sat} = \frac{V_{CC} - V_{CE}}{R_C}$

$I_{Bmin} = \frac{I_{c(sat)}}{B_{dc}}$, $where\ B_{dc} = dc\ current\ gain\ of\ the\ BJT$

Condition of operation

$I_B = 3 \times I_{Bmin}$

$I_{Bmin} = the\ minimum\ base\ current\ at\ which\ I_c has\ maximum\ saturated\ value$

$V_{in} = I_B R_B + V_{BE}$

$V_{BE} = 0.6\ to\ 0.7\ volt$

Off-state: The BJT operate at the edge of the cutoff region its called point B in Fig.

$I_B = 0$

$V_{CE} = V_{CC}$

$I_c = I_{CEO} = leakage\ current$

2.2.2 Over driven NPN BJT Switching Circuit

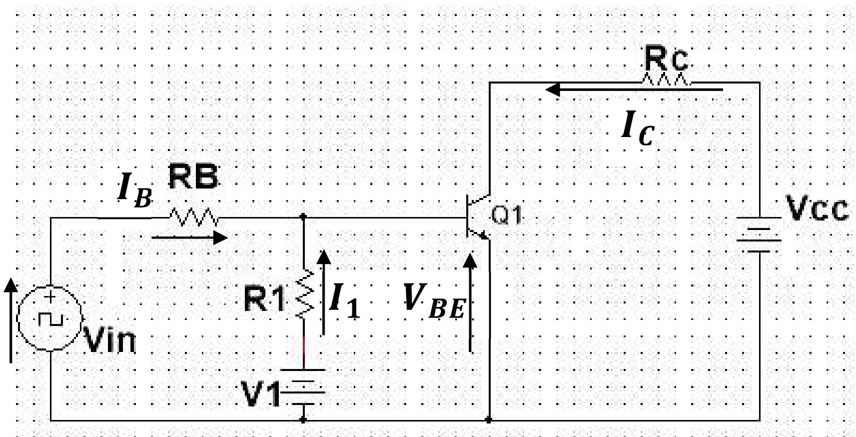


Fig. (2-4) Common emitter BJT Over driven switch

On-state: The BJT operate at the edge of the saturation region its called point Ä in Fig.

$V_{CE} = \mathbf{0}$

$I_c = I_{max} = \frac{V_{cc}}{R_c}$

$I_{Bmin} = \frac{I_{max}}{B_{dc}}$, $where\ B_{dc} = dc\ current\ gain\ of\ the\ BJT$

Condition of operation

$I_B = I_{Bmin}$
$I_1 = 2 \times I_B$
$I_{Bmin} = the\ minimum\ base\ current\ at\ which\ I_c has\ maximum\ saturated\ value$
$V_{in} = I_B R_B + V_{BE}$
$V_1 = I_1 R_1 + V_{BE}$

Off-state: The BJT operate at the edge of the cutoff region its called point B in Fig.

$I_B = 0$

$V_{CE} = V_{CC}$

$I_c = I_{CEO} = leakage\ current$