

# Series Resistors

Electrical Engineering

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# Series Resistors (1)

- Current Limiting Resistors
  - Devices can break if current is too high
  - Series resistors limit the current
  - They protect the device from damage
- Example LED
  - Supply voltage  $V_S = 5\text{ V}$
  - From datasheet for LED L-63ID
    - Typical forward voltage  $V_F = 1.9\text{ V}$
    - Typical forward current  $I_F = 10\text{ mA}$
    - Maximum forward current  $I_F = 30\text{ mA}$

# Series Resistors (2)

- Derivation of the formula of the Series Resistor

- Given values

- $I_F$ ,  $V_F$ ,  $V_S$

- Required values

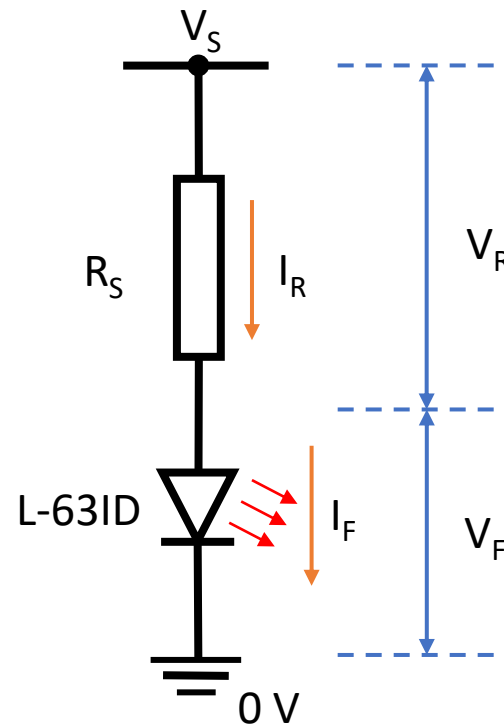
- $R_S$

- Relations

- $I_R = I_F$
- $V_S = V_R + V_F$
- $R_S = V_R / I_R$

- Formula

- $$R_S = \frac{V_S - V_F}{I_F}$$



# Series Resistors (3)

- Calculation of the Series Resistor

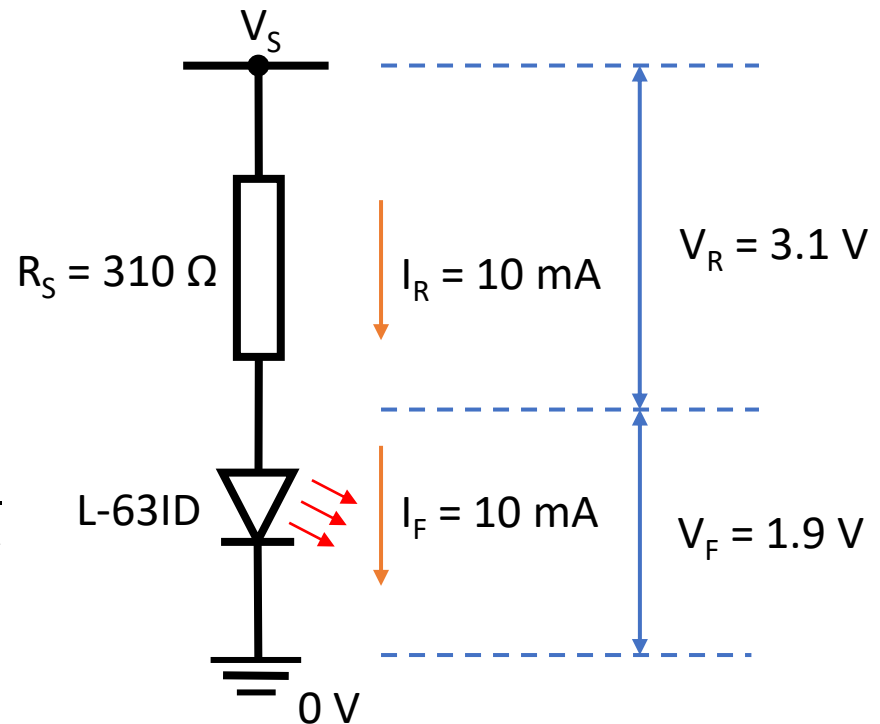
- Given values

- $V_S = 5\text{ V}$
    - $V_F = 1.9\text{ V}$
    - $I_F = 10\text{ mA}$

- Solution

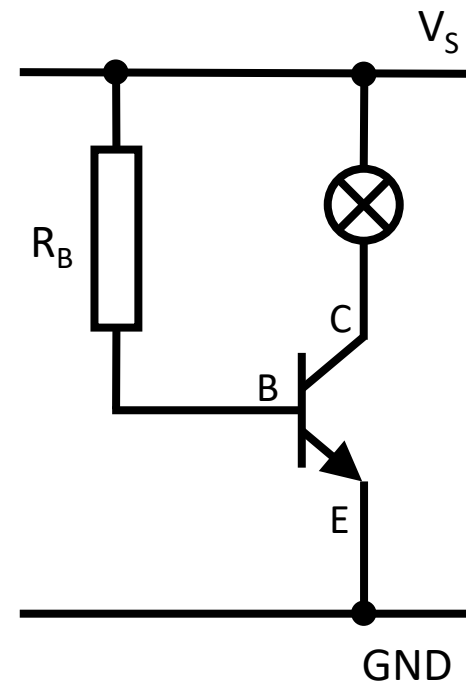
- $R_S = \frac{V_S - V_F}{I_F}$
    - $R_S = \frac{5\text{ V} - 1.9\text{ V}}{10\text{ mA}} = \frac{3.1\text{ V}}{0.01\text{ A}}$
    - $R_S = 310\ \Omega \rightarrow 330\ \Omega$

E12 Series of Resistors



# Series Resistors (4)

- Example Base Resistor
  - Supply voltage  $V_S = 5\text{ V}$
  - Load current  $I_L = 350\text{ mA}$ 
    - $I_L = I_C$  (collector current)
  - From datasheet for BC337-40
    - DC Current Gain  $h_{FE} = 250$
    - Saturation Voltage  $V_{BE} = 0.7\text{ V}$



# Series Resistors (5)

- Derivation of the formula of the Series Resistor

- Given values

- $h_{FE}, I_C, V_{BE}, V_S$

- Required values

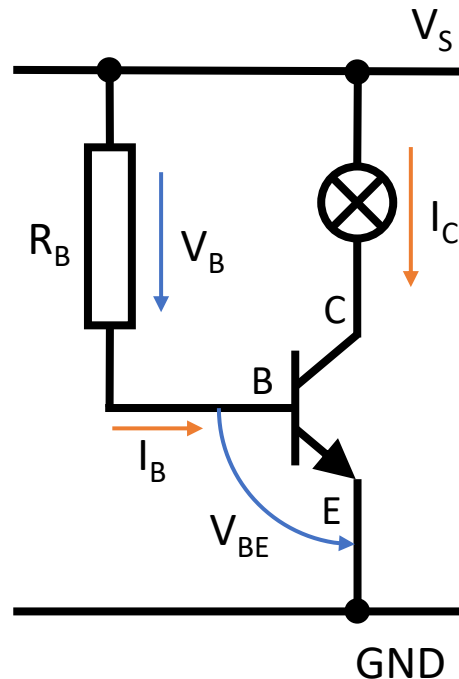
- $I_B, R_B$

- Relations

- $I_C = h_{FE} \cdot I_B$
- $V_S = V_B + V_{BE}$
- $R_B = V_B / I_B$

- Formula

- $$R_B = \frac{V_S - V_{BE}}{I_C / h_{FE}} = h_{FE} \cdot \frac{V_S - V_{BE}}{I_C} = \frac{V_S - V_{BE}}{I_B}$$



$I_C$ : Collector Current = Load Current

$I_B$ : Base Current

$R_B$ : Base Resistor

$V_B$ : Base Resistor Voltage

# Series Resistors (6)

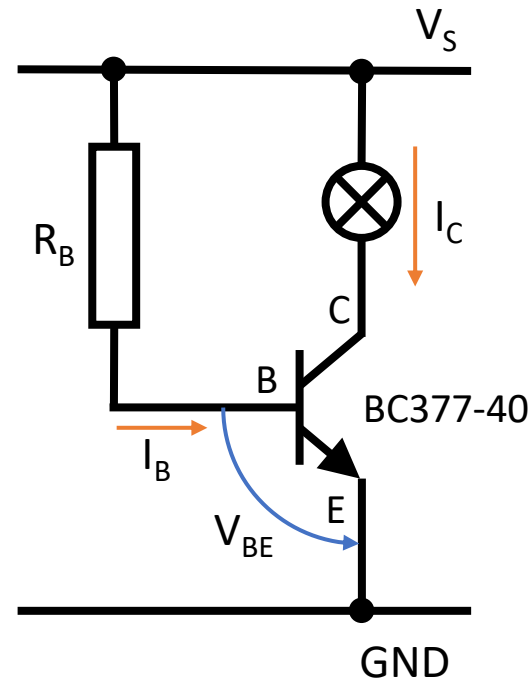
- Calculation of the Series Resistor

- Given values

- $V_S = 5\text{ V}$
    - $I_C = 350\text{ mA}$
    - $h_{FE} = 250$
    - $V_{BE} = 0.7\text{ V}$

- Solution

- $I_B = \frac{I_C}{h_{FE}} = 1.4\text{ mA}$
    - $R_B = \frac{V_S - V_{BE}}{I_B}$   
 $= 3071\ \Omega \rightarrow 2.7\text{ k}\Omega$



E12 Series