# Series Resistors

Applied Mechatronics

First Grade Level

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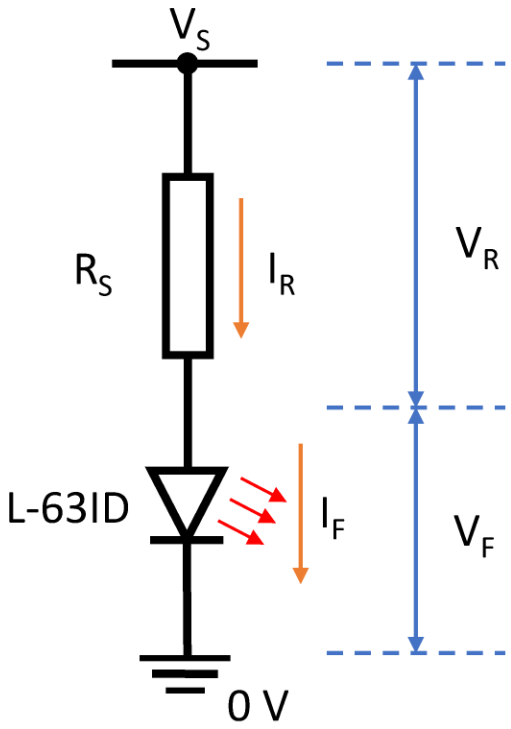
# Series Resistors (1)

- 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 V
  - From datasheet for LED L-63ID
    - Typical forward voltage $V_F$ = 1.9 V
    - Typical forward current $I_F$ = 10 mA
    - Maximum forward current $I_F$ = 30 mA

# Series Resistors (2)

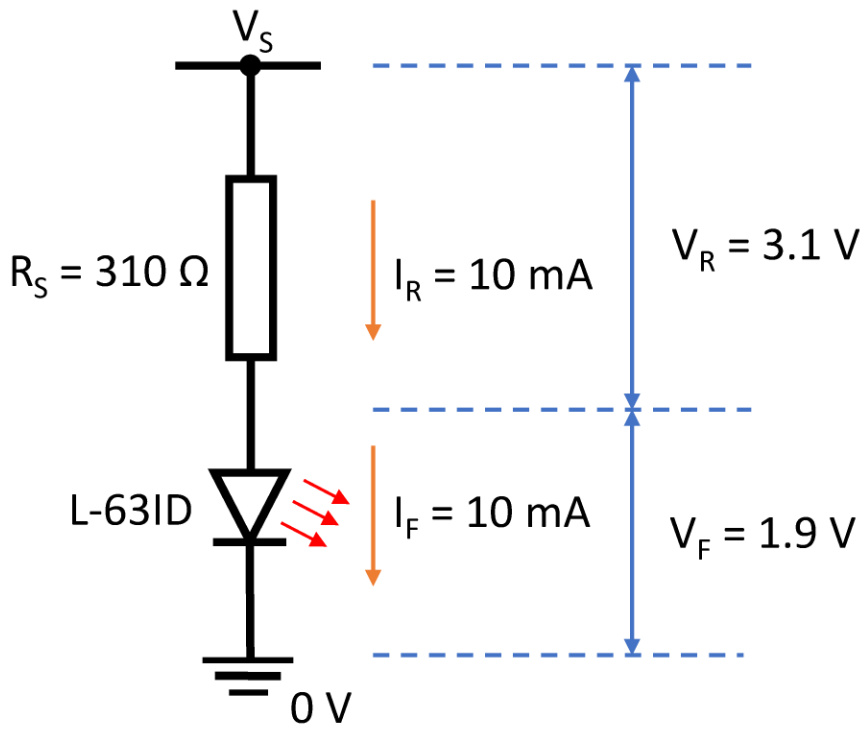
- Derivation of the formula of the Series Resistor
  - Given values
    - $I_F$, $V_F$, $V_S$
  - Required values
    - $R_S$
  - Relations
    - $I_R = I_F$
    - $V_S = V_R + V_F$
    - $R_S = V_R / I_R$
  - Formula
    - $R_S = \frac{V_S - V_F}{I_F}$



# Series Resistors (3)

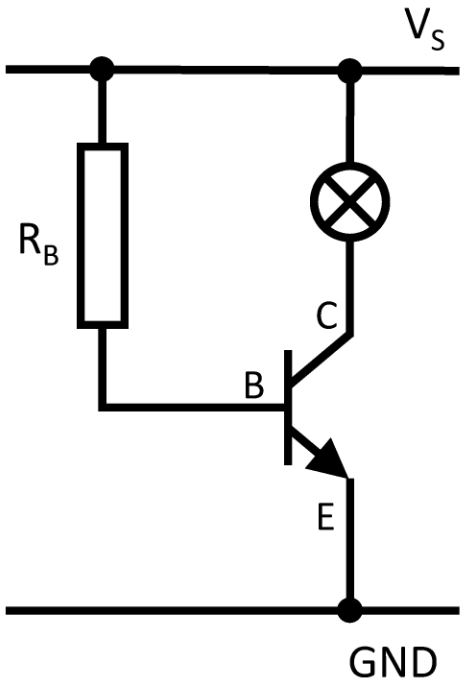
- Calculation of the Series Resistor
  - Given values
    - $V_S$ = 5 V
    - $V_F$ = 1.9 V
    - $I_F$ = 10 mA
  - Solution
    - $R_S = \frac{V_S - V_F}{I_F}$
    - $R_S = \frac{5\ V - 1.9\ V}{10\ mA} = \frac{3.1\ V}{0.01\ A}$
    - $R_S = 310\ \Omega \rightarrow 330\ \Omega$

E12 Series of Resistors



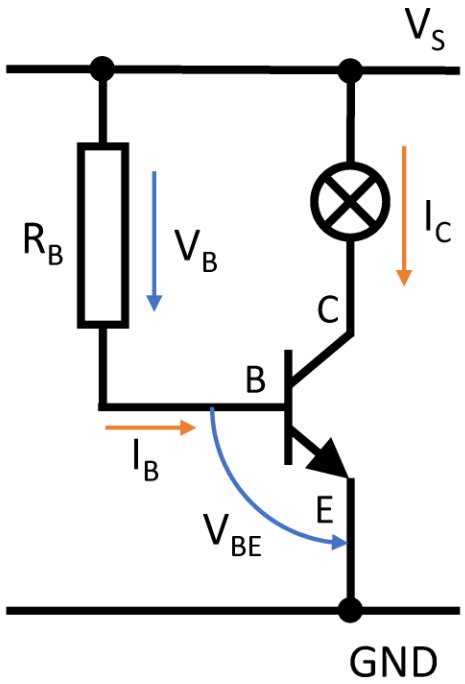
# Series Resistors (4)

- Example Base Resistor
  - Supply voltage $V_S$ = 5 V
  - Load current $I_L$ = 350 mA
  - From datasheet for BC377-40
    - DC Current Gain $h_{FE}$ = 250
    - Saturation Voltage $V_{BE}$ = 0.7 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

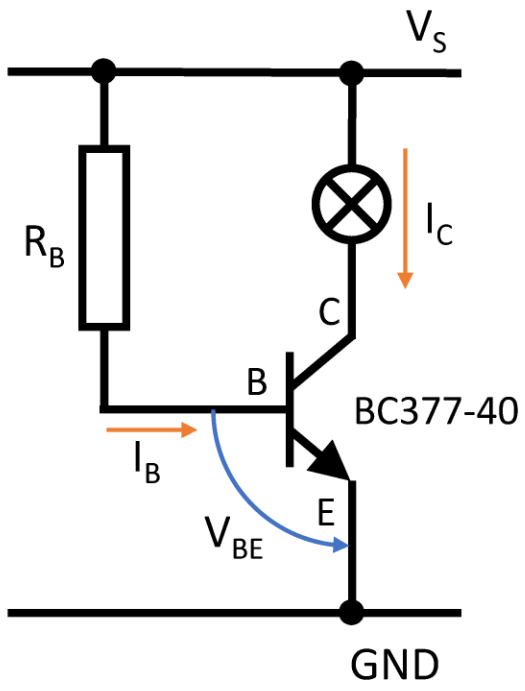
$R_B$: Base Resistor

$V_B$: Base Resistor Voltage

# Series Resistors (6)

- Calculation of the Series Resistor
  - Given values
    - $V_S$ = 5 V
    - $I_C$ = 350 mA
    - $h_{FE}$ = 250
    - $V_{BE}$ = 0.7 V
  - Solution
    - $I_B = \frac{I_C}{h_{FE}} = 1.4\ mA$
    - $R_B = \frac{V_S - V_{BE}}{I_B}$

      $= 3071\ \Omega \rightarrow 2.7\ k\Omega$




E12 Series