Transistors

Networks and Embedded Software

Module 3.1.2

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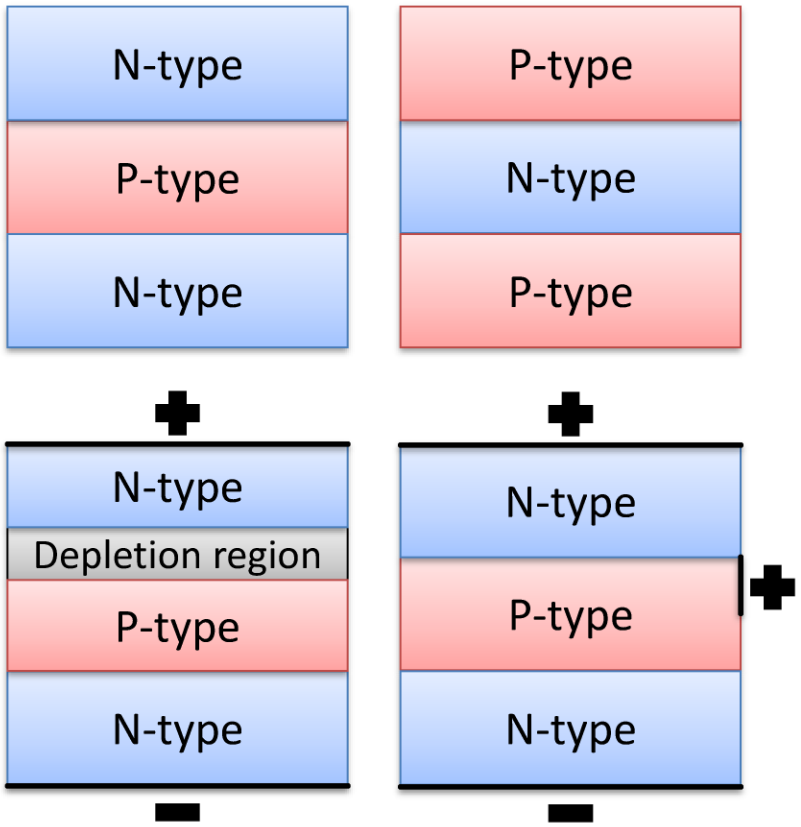
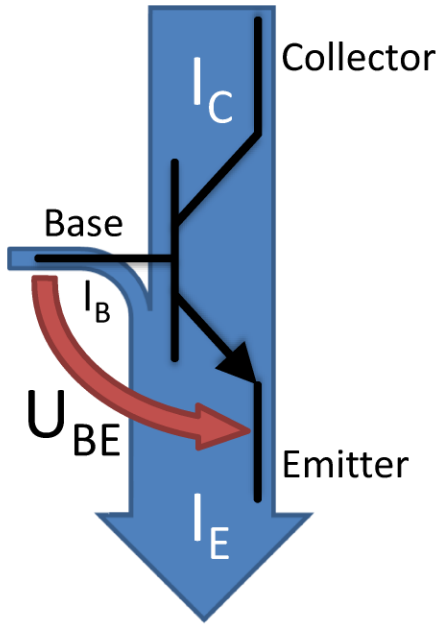
Transistors

- Structure
  - Bipolar junction transistor (BJT)
  - Two p-n junctions
    - NPN transistor
    - PNP transistor
  - Third connection
    - Insulator
    - Conductor



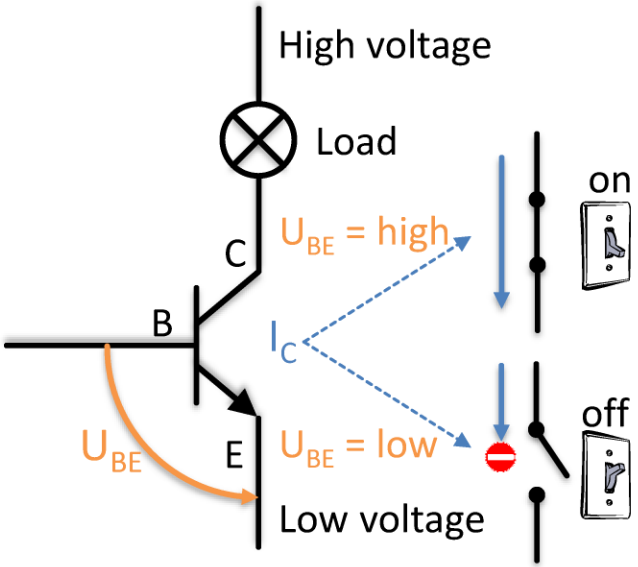
NPN Transistors (1)

- Characteristics
  - Collector current flows if base current flows
  - Base current flows into base
  - Positive voltage drop between base and emitter necessary



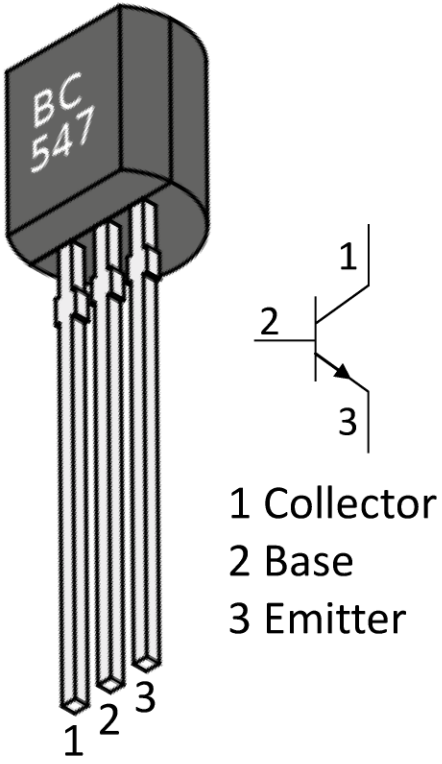
NPN Transistors (2)

- Application: switch
  - Load in collector branch
  - Controlled by base
  - Switch is
    - On if U_{BE} is positive
    - Off if U_{BE} is zero
  - Active high
    - On if U_{BE} is high
    - Off if U_{BE} is low



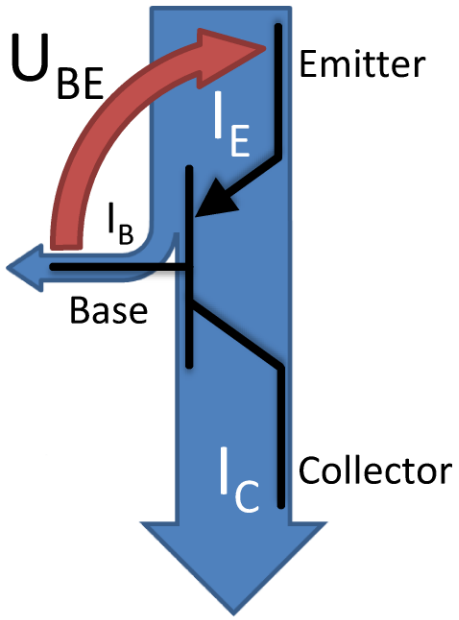
NPN Transistors (3)

- Example: BC547
  - Maximum collector current
    - I_C = 100 mA
  - Base saturation voltage
    - U_{BE} = 0.7 V
  - DC current gain
    - $h_{FE} = \frac{I_C}{I_B}$
    - $h_{FE} \approx 250$



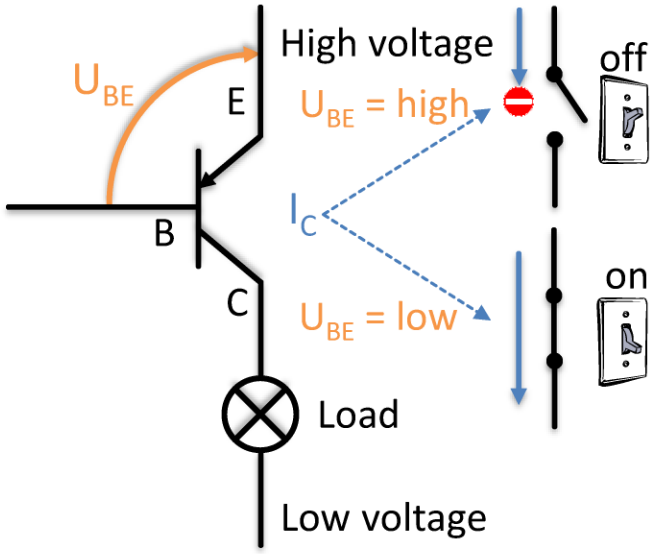
PNP Transistors (1)

- Characteristics
  - Collector current flows if base current flows
  - Base current flows out of base
  - Negative voltage drop between base and emitter necessary



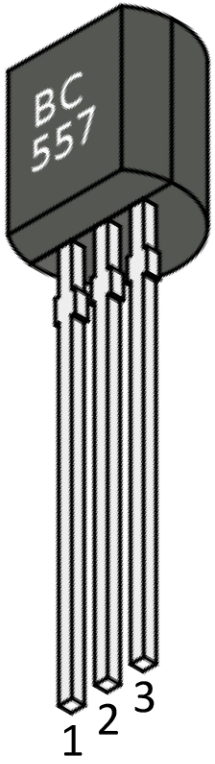
PNP Transistors (2)

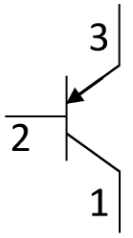
- Application: switch
  - Load in collector branch
  - Controlled by base
  - Switch is
    - On if U_{BE} is negative
    - Off if U_{BE} is zero
  - Active low
    - On if U_{BE} is low
    - Off if U_{BE} is high



PNP Transistors (3)

- Example: BC557
  - Maximum collector current
    - I_C = -100 mA
  - Base saturation voltage
    - U_{BE} = -0.7 V
  - DC current gain
    - $h_{FE} = \frac{I_c}{I_B}$
    - $h_{FE} \approx 250$

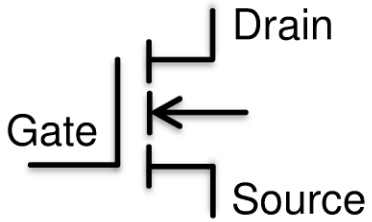




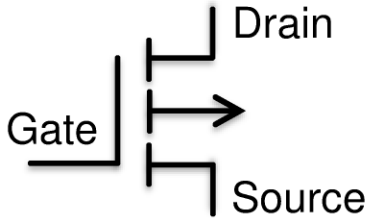
1 Collector
2 Base
3 Emitter

MOSFET (1)

- Metal-Oxide-Semiconductor
  - Composition
- Field-Effect Transistor
  - Operating mode
  - Controlled by voltage
    - No current necessary
    - Energy efficient



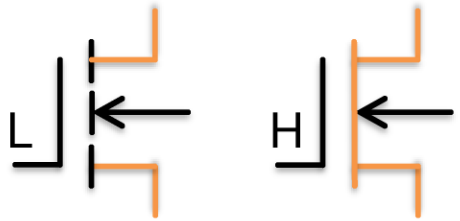
N-channel, enhancement mode



P-channel, enhancement mode

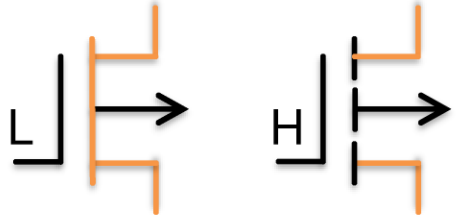
MOSFET (2)

- Application: switch
  - N-Channel
    - Drain current
      - On if gate high
      - Off if gate low
    - Active high



off on

  - P-Channel
    - Drain current
      - On if gate low
      - Off if gate high
    - Active low

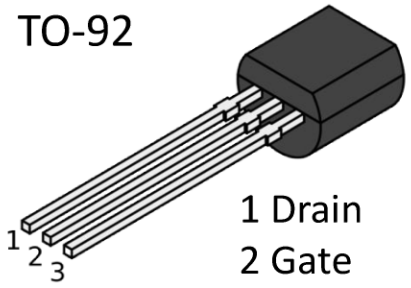


on off

MOSFET (3)

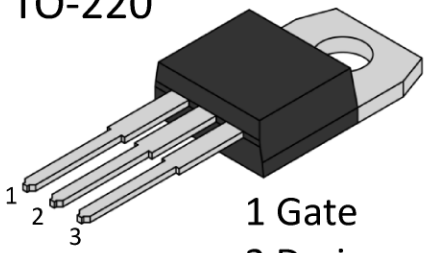
- Examples
  - 2N7000
    - N-Channel MOSFET
    - Max drain current I_D = 0.2 A
  - BS250
    - P-Channel MOSFET
  - IRF510
    - N-Channel Power MOSFET
    - Max drain current I_D = 5.6 A

TO-92



1 Drain
2 Gate
3 Source

TO-220



1 Gate
2 Drain
3 Source

MOSFET (4)

- Comparison
  - NPN / N-Channel
  - PNP / P-Channel