Switches

W. Bolton, "Mechatronics --- Electronic control systems in mechanical and electrical engineering," 5th edition, Pearson Education Limited 2012, Chap 9

J. Edward Carryer, R. Matthew Ohline, Thomas W. Kenny, "Introduction to Mechatronic Design," Prentice Hall 2011

線上學習網站：https://www.electronics-tutorials.ws

PowerPoint 中部分圖片擷取和修改自教科書和網路圖片

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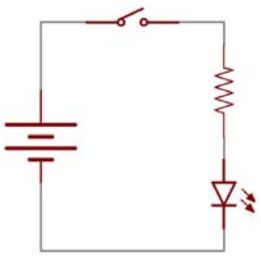
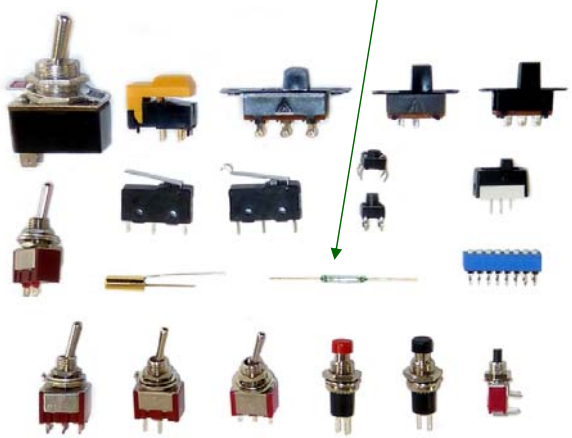
Switch -1

- Definition
  - A component which controls the open-ness or closed-ness of an electric circuit



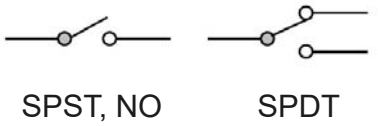
Reed switch: open or close when exposed to the presence of a magnetic field

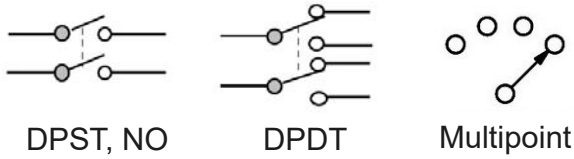


Dip switch

Switch -2

- Terminologies
  - Pole（軸）& throw（切）
    - SPST – Single pole, double throw（單軸單切）
    - SPDT – Single pole, double throw（單軸雙切）
    - DPST – Single pole, double throw（雙軸單切）
    - DPDT – Single pole, double throw（雙軸雙切）

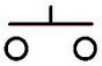


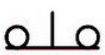


Toggle

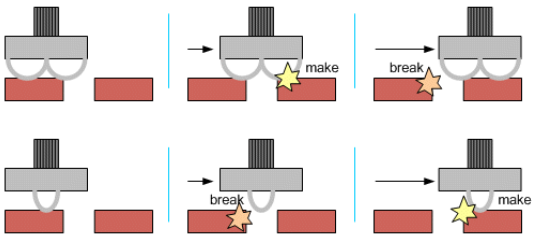
Switch -3

- Terminologies
  - Normally open (NO, 常開) vs. normally closed (NC, 常閉)



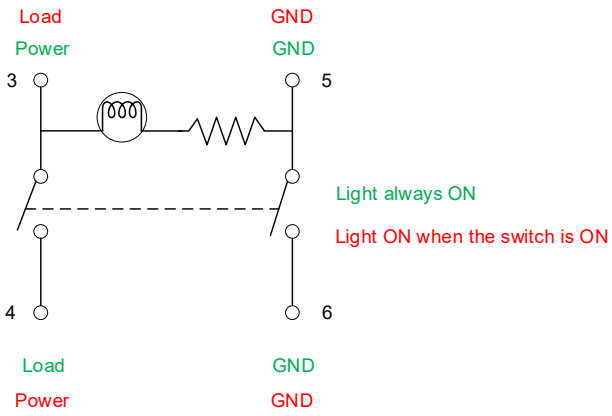


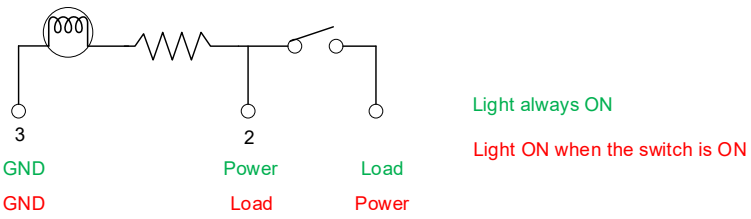
  - Momentary vs. maintained
  - Change over
    - Make-before-break (MBB) – rarely used
    - Break-before-make (BBM)



Switch -4

- Ex: Illuminated switches

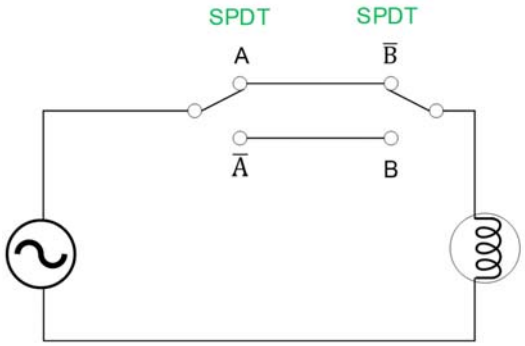




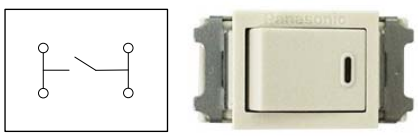
Switch -5

- Ex: Staircase wiring circuit

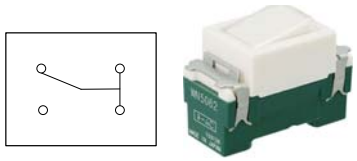
$$T = A\bar{B} + \bar{A}B$$



2-way switch, SPST

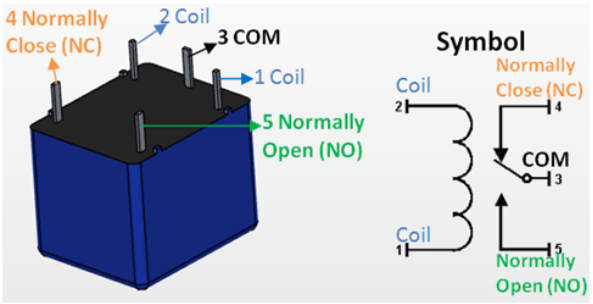


3-way switch, SPDT



Electro-Mechanical Relay -1

- Definition
  - A electrically operated switch in which changing a current in one electric circuit switches a current on or off in another circuit
- Applications
  - Logic switching element (i.e. control relay)
  - Current/Voltage amplifier (i.e. power relay)

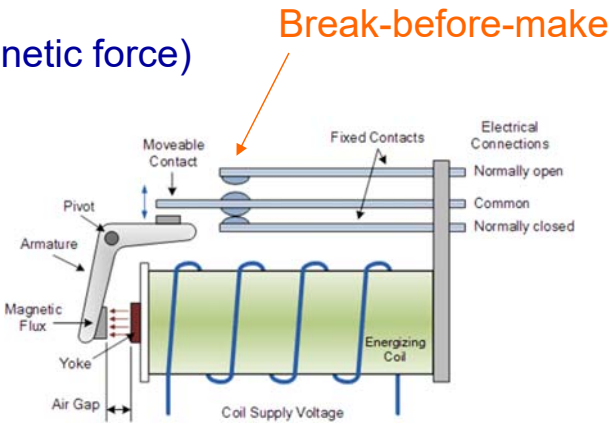


Electro-Mechanical Relay -2

- Advantages
  - Electric isolation between the control signal (coil) and the outputs (contacts)
  - Using a small voltage/current to control large voltages/currents
  - Simultaneously control of many different loads (independent circuits possible)
- Major failure & solutions
  - Failure: Arc generated when the contact is established/broken
  - Solutions: Quick contact/release or arc-suppression circuit

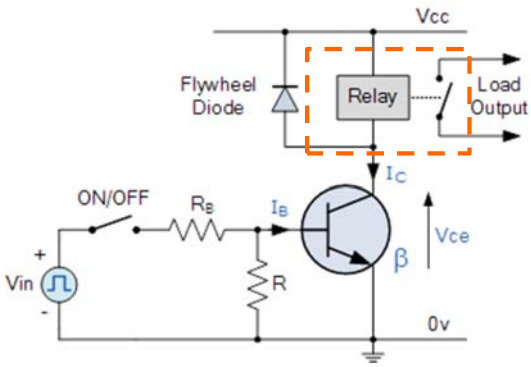
Electro-Mechanical Relay -3

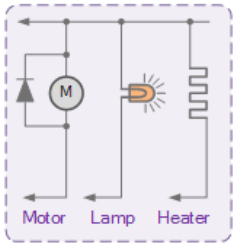
- Specifications
  - Coil voltage: DC 5V, 12V, 24V,…; AC 120V, 240V,…
  - Coil current: 10-200 mA (usually)
  - Contact current rating: ??A
  - Contact arrangement: SPDT, DPDT,…
  - Operating time (i.e. electromagnetic force)
  - Release time (i.e. spring force)
  - Lifetime: ??? cycles



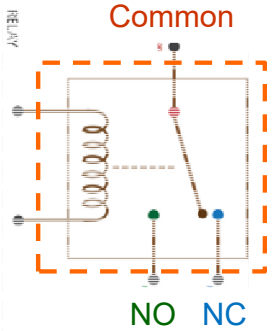
Electro-Mechanical Relay -4

- Ex: Driving a relay using a NPN BJT





Different Collector Loads

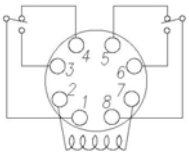


Electro-Mechanical Relay -5

- Ex: A RS Flip-flop circuit

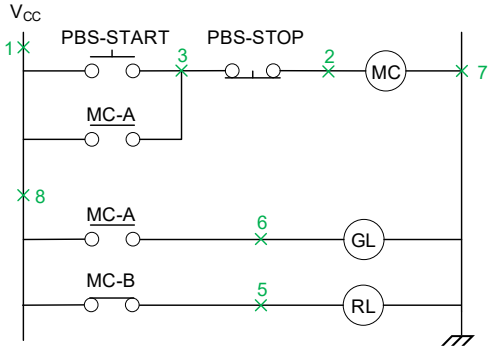
START STOP Push button switches (PBS)

Green Red Lights

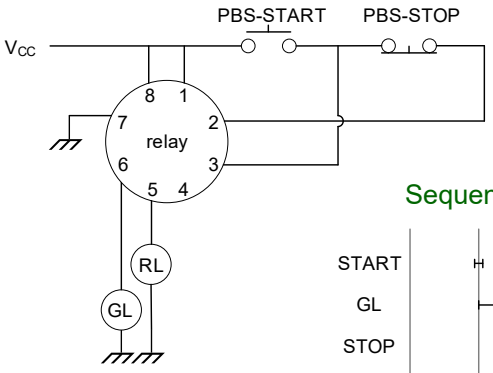


2.7 relay coil
1.8 commons
3.6 N.O. contacts
4.5 N.C. contacts

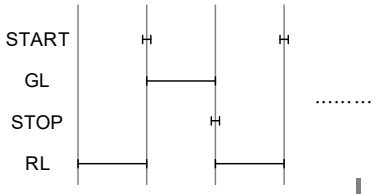
Ladder diagram



Wiring diagram

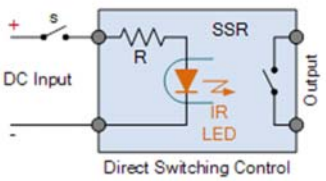


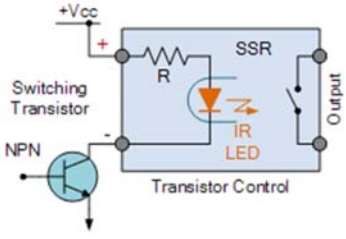
Sequence chart

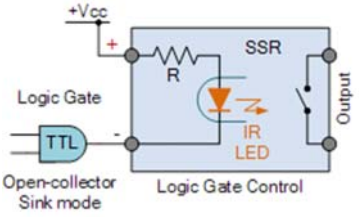


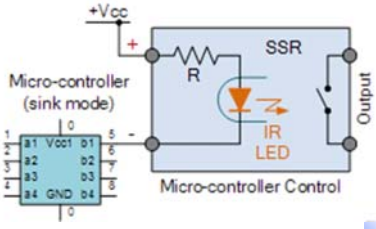
Solid-State Relay -1

- Features
  - Using the electrical and optical properties of solid state semiconductors to perform its input to output isolation and switching functions
  - Unlike EMR, SSR doesn't have moving parts
  - Can switch both AC or DC currents









Solid-State Relay -2

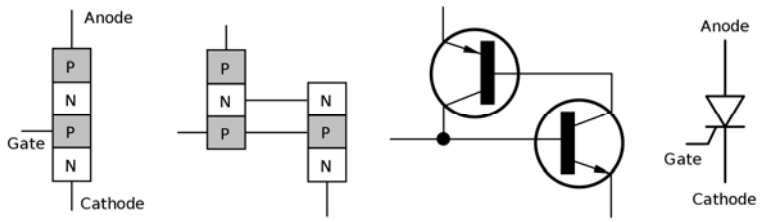
- Solid-state relay vs. mechanical relay
  - Pros
    - Faster response
    - Higher cycle of operation
    - Smaller package
    - Can be powered by low-power electronic circuits (Ex: TTL)
    - Resistant to shock and vibration

Solid-State Relay -3

- Solid-state relay vs. mechanical relay
  - Cons
    - Less tolerance to noise, temperature variation, overload
    - Requiring stable power supply
    - One control switches only one circuit
    - Current leakage in OFF state (several mA)
    - Usually fails in ON state

Solid-State Switches -1

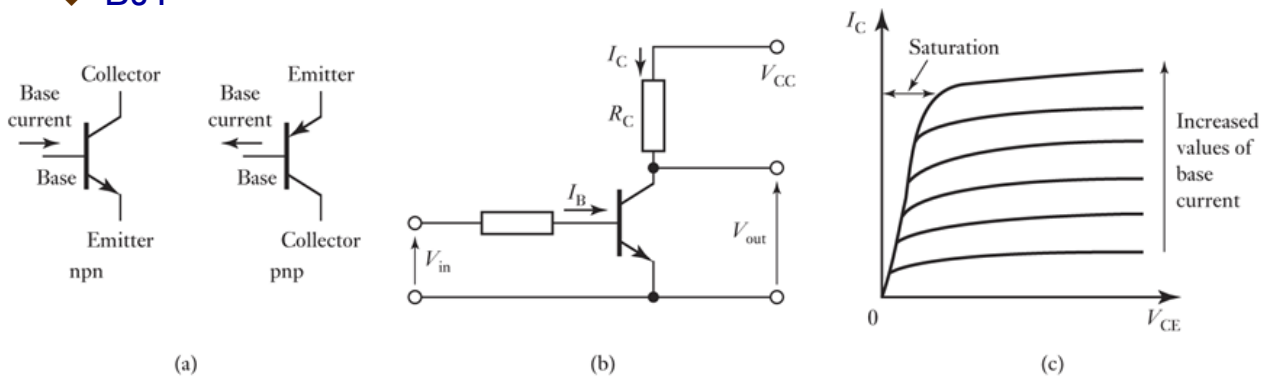
- Devices
  - Diodes
  - Solid-state relay
  - Thyristors（閘流體）or silicon-controlled rectifier (SCR)
    - A device with four layers of P- and N-type materials

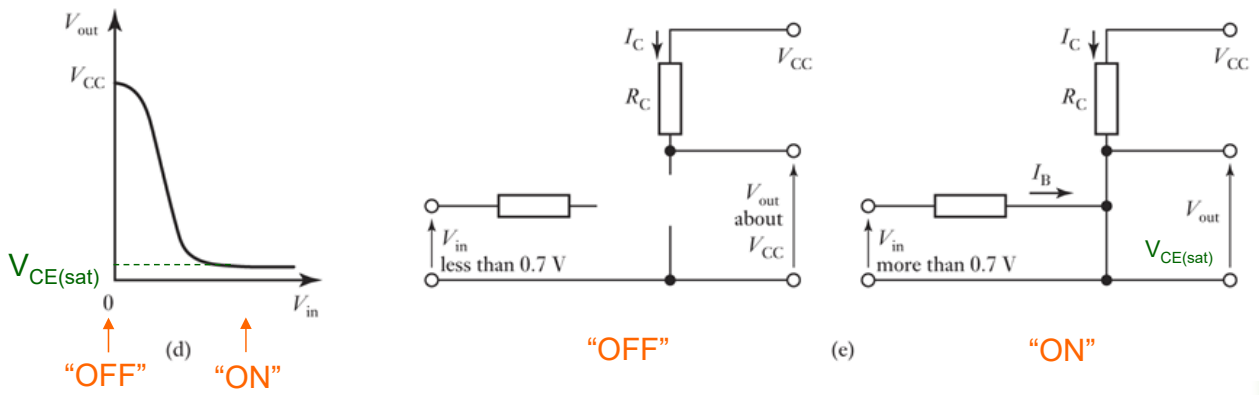


  - Triac or bidirectional triode thyristor

Solid-State Switches -2

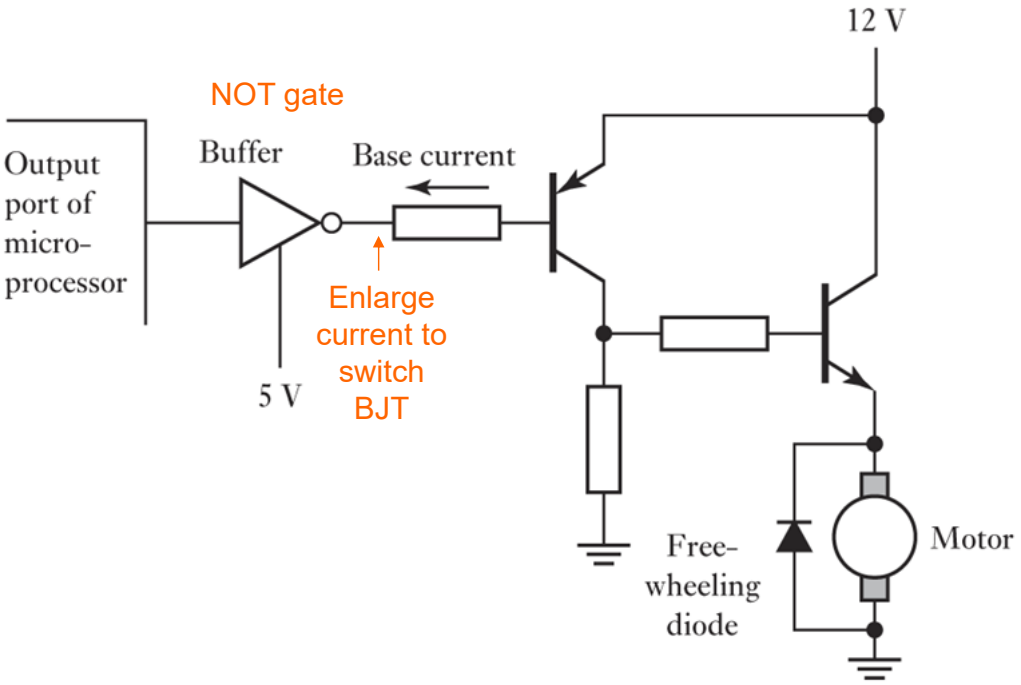
- BJT





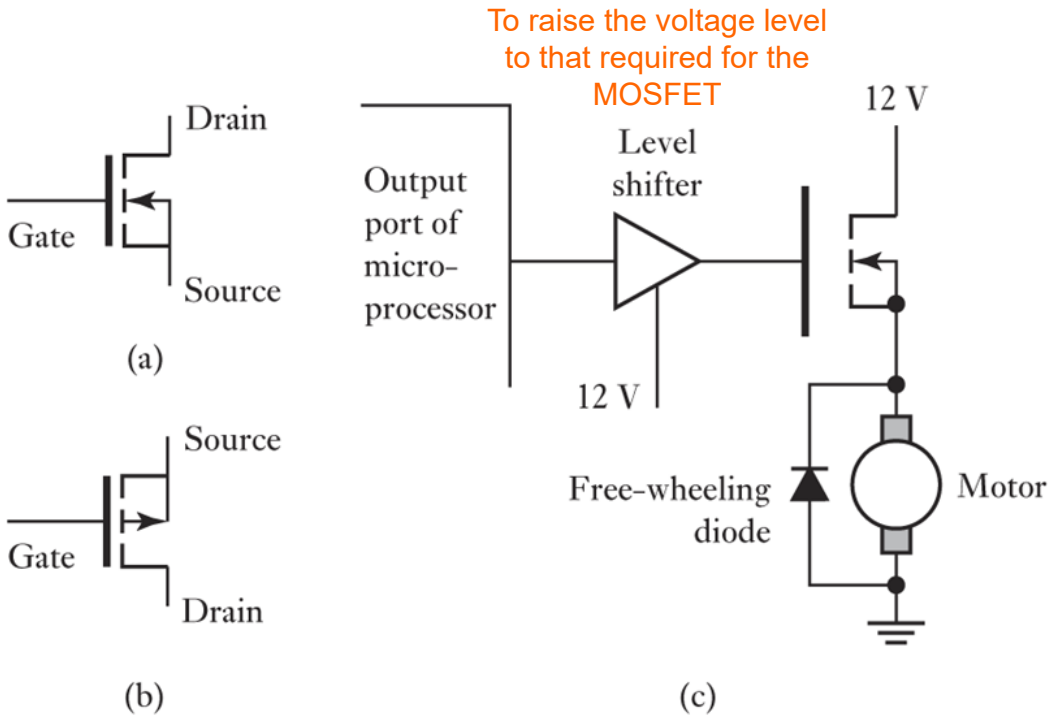
Solid-State Switches -3

- BJT



Solid-State Switches -4

- MOSFET



The End

- Questions?