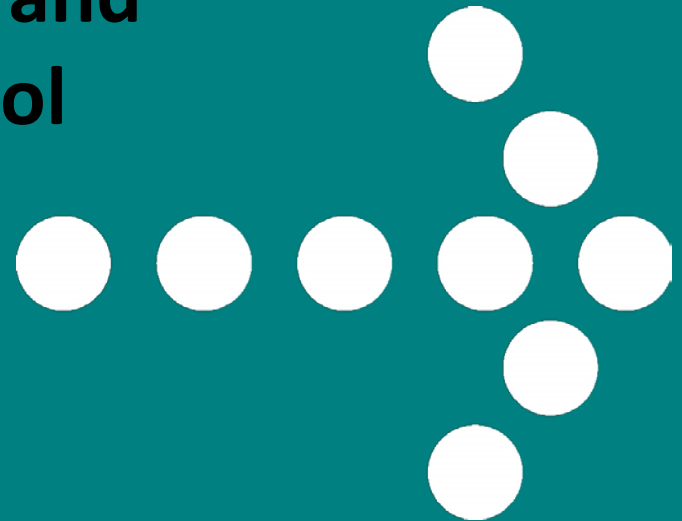


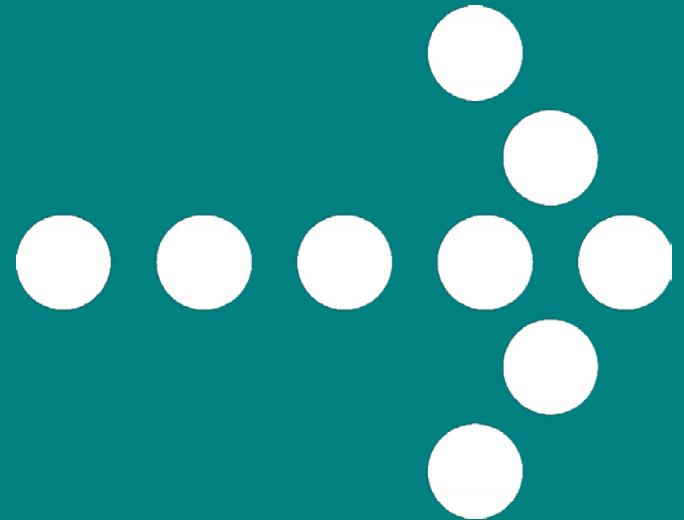
# Power Basics

Understanding thyristors and  
electricity in power control  
applications



# Power basics

## Thyristor basics 2.0





# Thyristor Basics

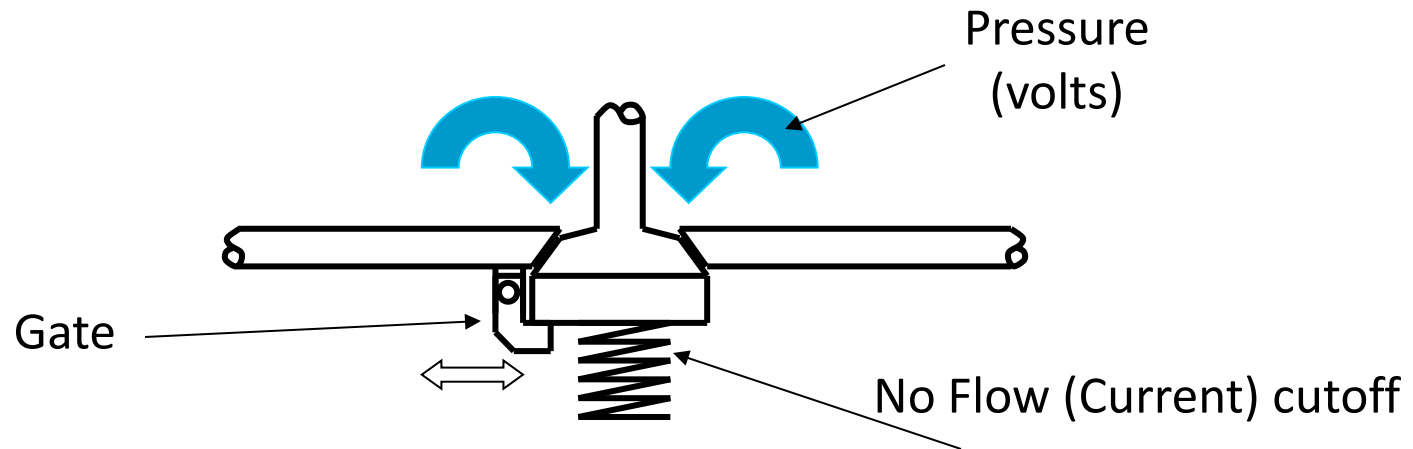
- What is a thyristor? –
  - > Silicon Controlled Rectifier
- How do we use them to control?
- What protection do they need?
- What about Isolation?
- What are the Limitations?



# Advantages / Disadvantages

- Advantages
  - > No electro-mechanical moving parts
  - > Improved electrical characteristics with correct mode
  - > Long term costs
  - > Improved Usage of heater elements
    - Thermoelectric stresses reduced
- Disadvantages
  - > Short term costs
  - > Electrical characteristics

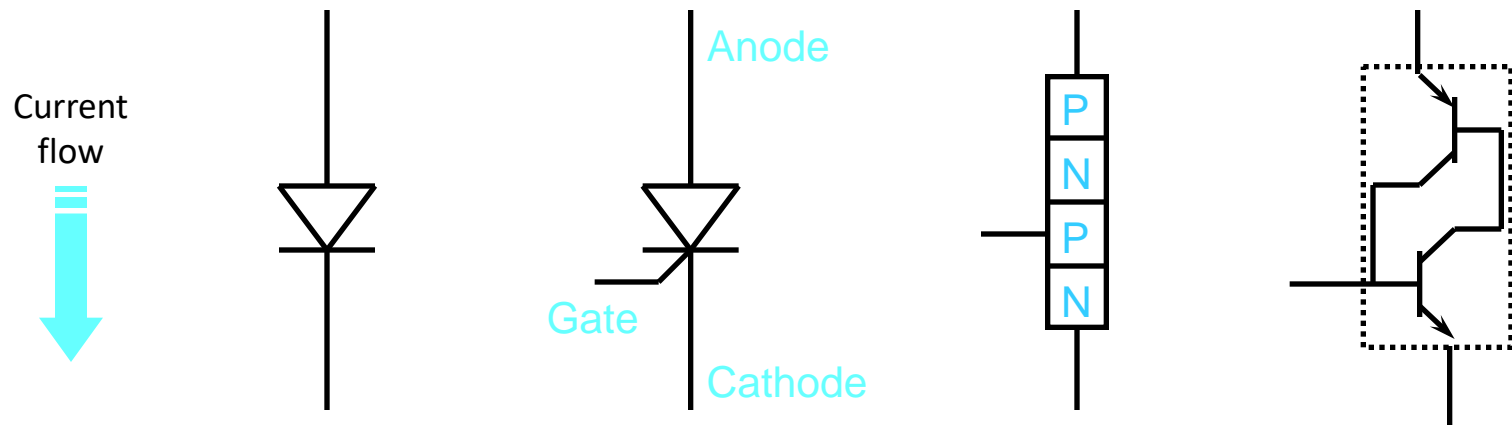
# Device Fundamentals



- 1 - pressure forces the valve open only when gate is open
  - 2 - as long as there is Flow the valve stays open
  - 3 – When the flow stops the valve closes
  - 4 – the gate is re-latched
- > Note that NO flow can or will pass in the reverse direction

# Silicon Controlled Rectifier

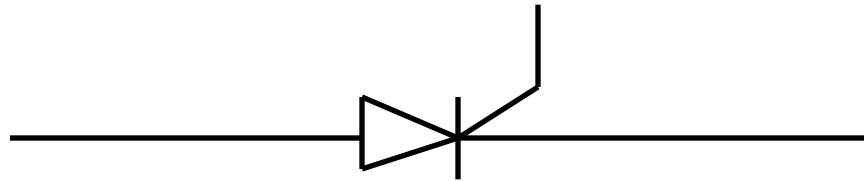
- PNPN Four layer device
- Solid state switch





# Start with a thyristor Device

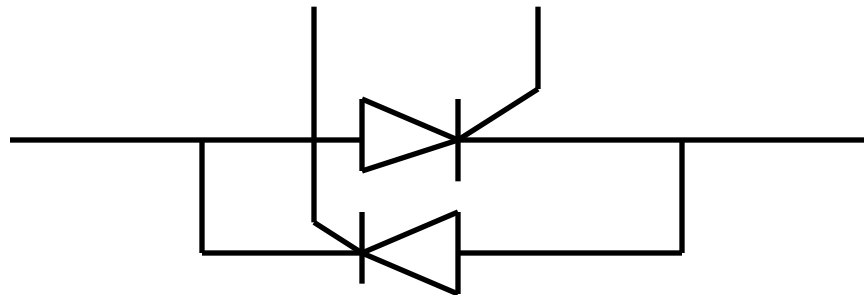
- But this will conduct only one way





## So Add another

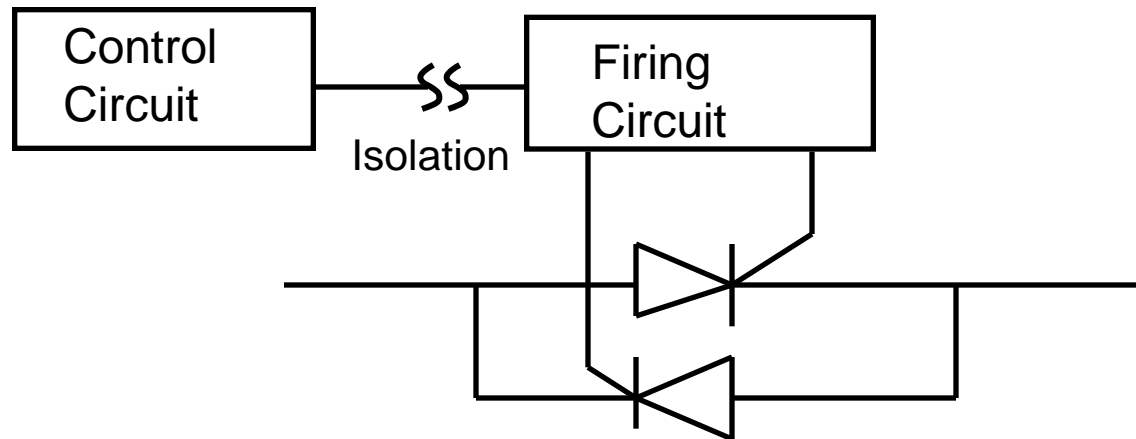
- This is known as an anti-parallel pair





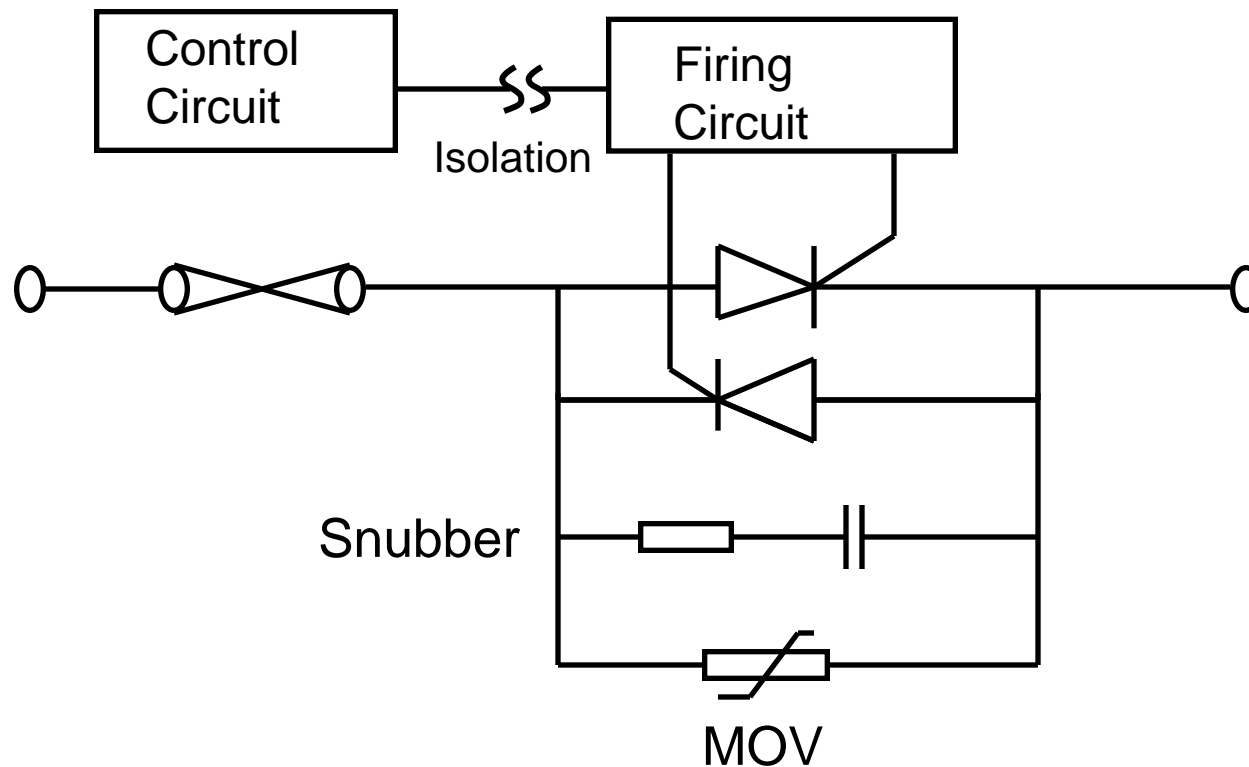
# We need some electronics

- Electronics to provide timed firing pulses



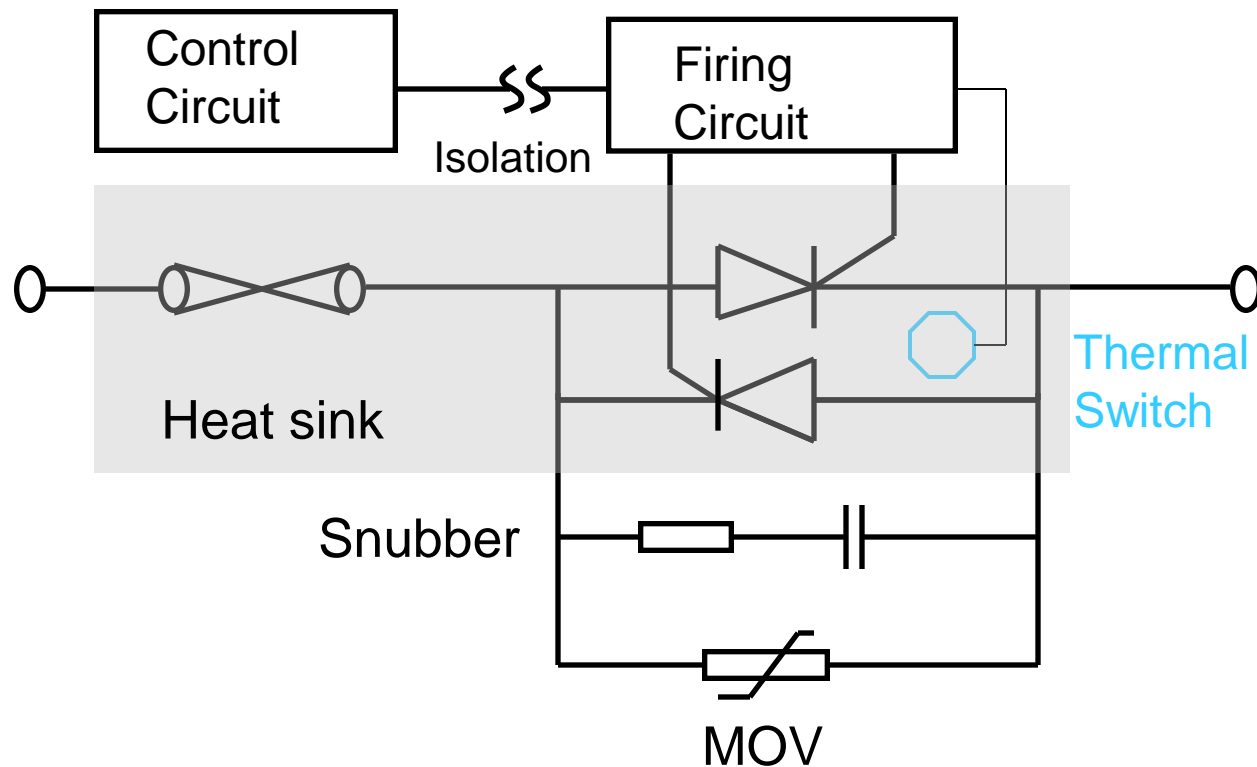
# Now add protective components

- Designed to stop spurious firing and protect the device



# Finally control the heat dissipation

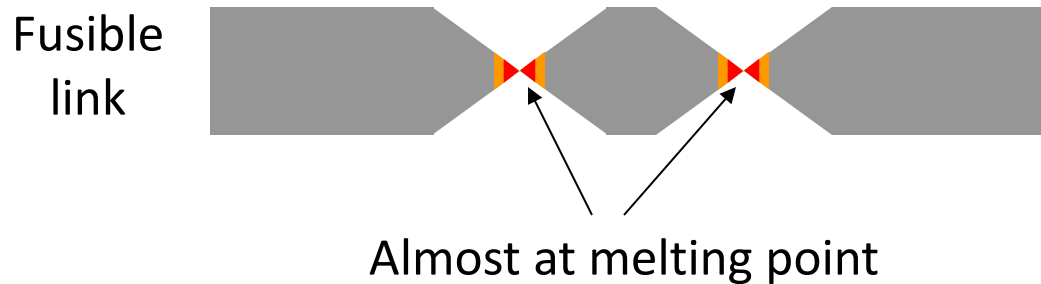
- Fit the device on a heat sink and add a thermal switch





# Protection - Fuses

- Semiconductor Fuse – protects the thyristor
  - > Fast acting to protect against half cycle over currents.



- Circuit protection
  - > A semi conductor fuse does NOT protect wiring...
  - > So a standard HRC fuse or trip is also required!



# Protection

- Inverse parallel pair
  - > Reverse breakdown fatal, but forward blocking less than reverse blocking. Forward breakdown recoverable.
- Snubber
  - > Damps rate of rise due to line transients and due to stored charge in device junction. Passes current when SCR is off.
- MOV Metal Oxide Varistor
  - > Provides protection against excessive voltage transients
  - > due to energy storage in system.
- Thermal Switch
  - > Only on fan cooled units.



# Isolation

- Modules - Heatsink earthed
  - > Products up to 250A???
- Discrete - Heatsink live
  - > Required for for improved thermal efficiency on products above 250A???



# Limitations

- Current
  - > Max surge current determined by chip size
  - > Max running current determined by cooling system
- Voltage
  - > **Peak Inverse Voltage** is  $2 \times \text{supply volts peak (RMS Voltage} \times 1.414)$
  - >  $415\text{V} \times 1.414 \times 2$  gives device rating of 1200V
- Transient
  - > Excessive rate of rise causes false triggering due to parasitic capacitance.
  - > Typical limits: Volts =  $500\text{V}/\mu\text{S}$  Current =  $100\text{A}/\mu\text{S}$
- Temperature
  - > Max junction temperature  $125^{\circ}\text{C}$ . Loss of blocking if exceeded

# Power Basics

End of module 2.0

