Power Converters
Introduction and Scope

Lecture-1

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Main Areas in Electronics

Signal Electronics

- Electronic circuits process signals
- Electronic circuits contain electronic-devices
- Dominant application of Electronics is to process information.
- The biggest user of semiconductor Electronic devices is the computer industry.
- Next user is the consumer electronics.
- The primary function is to process information.

Main Areas in Electronics

Power Electronics

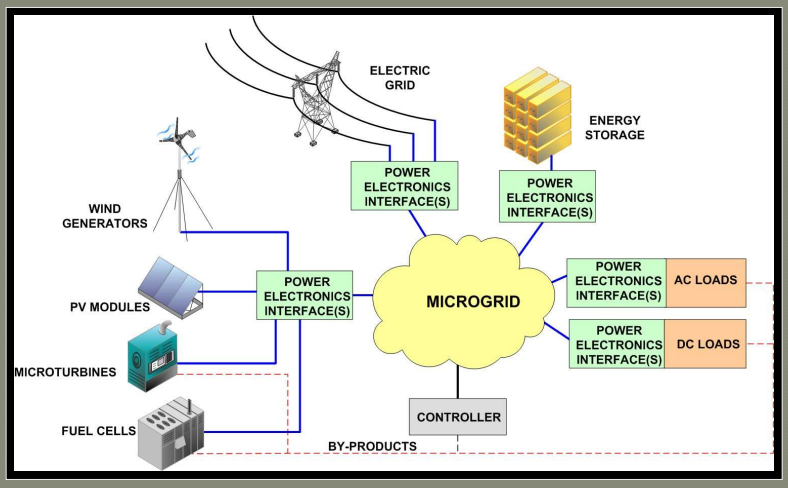
- Process electric power.
- Uses power devices handling large power.
- Electric Power Processing is "Power Conditioning".
- Power devices operated in switch-mode for higher efficiencies.

Scope of Power Converters

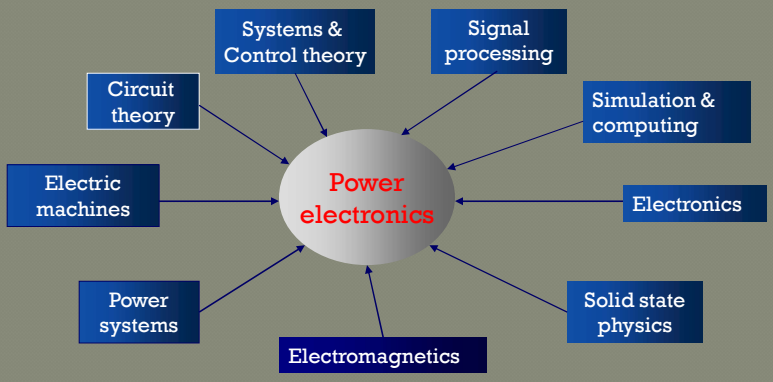
- All electronic systems are operated by power from a wall plug or battery
- It is needed to convert electrical energy from the form supplied by the source to the form required by the load.
- In some cases the power circuit converts electric energy to the form required by the electromechanical system, such as an electric motor.

Power Converters in Micro-grid

• Power electronic converters provide the necessary adaptation functions to integrate all different micro-grid components into a common system.



Relation with multiple disciplines

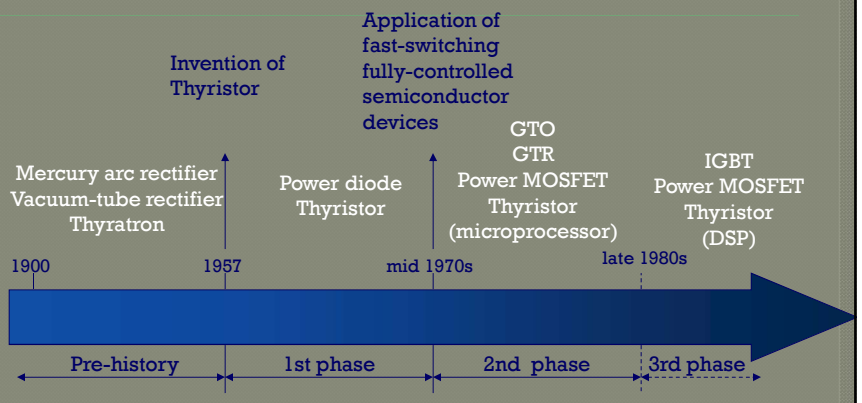


- Power electronics is currently the most active discipline in electric power engineering worldwide.

Position and significance in the human society

- Electric power is used in almost every aspect and everywhere of modern human society.
- Electric power is the major form of energy source used in modern human society.
- The objective of power electronics is exactly about how to use electric power, and how to use it effectively and efficiently, and how to improve the quality and utilization of electric power.
- Power electronics and information electronics make two poles of modern technology and human society—— information electronics is the brain, and power electronics is the muscle.

The history



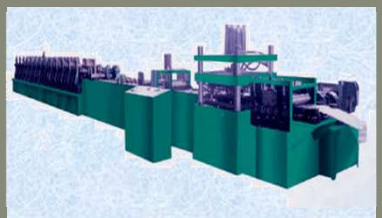
- The thread of the power electronics history precisely follows and matches the break-through and evolution of power electronic devices

Applications

- Industrial
- Transportation
- Utility systems
- Power supplies
- Residential and home appliances
- Space technology
- Other applications

Industrial applications

- Motor drives
- Electrolysis
- Electroplating
- Induction heating
- Welding
- Arc furnaces and ovens
- Lighting



Transportation applications

- Trains & locomotives
- Subways
- Trolley buses
- Magnetic levitation
- Electric vehicles
- Automotive electronics
- Ship power systems
- Aircraft power systems



Utility systems applications

- High-voltage dc transmission(HVDC)
- Flexible ac transmission(FACTS)
- Static var compensation & harmonics suppression: TCR, TSC, SVG, APF
- Custom power & power quality control
- Supplemental energy sources : wind, photovoltaic, fuel cells
- Energy storage systems


Power supplies for electronic equipment

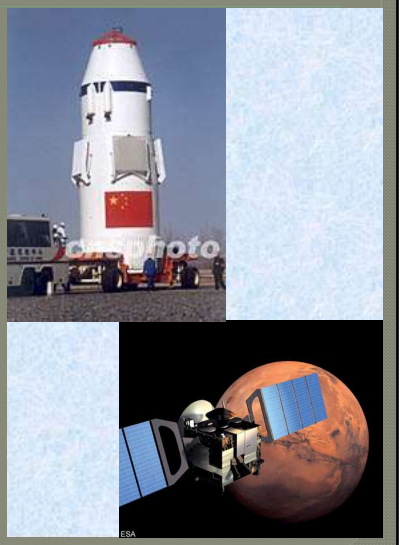
- Telecommunications
- Computers
- Office equipment
- Instruments
- Mobile electronics

Residential and home appliances

- Lighting
- Heating
- Air conditioning
- Refrigeration & freezers
- Cooking
- Cleaning
- Entertaining

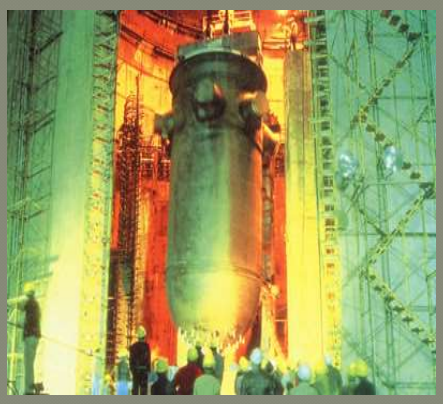
Applications in space technology

- Spaceship power systems
- Satellite power systems
- Space vehicle power systems



Other applications

- Nuclear reactor control
- Power systems for particle accelerators
- Environmental engineering



Trends

- It is estimated that in developed countries now 60% of the electric energy goes through some kind of power electronics converters before it is finally used.

- Power electronics has been making major contributions to:

  --better performance of power supplies and better control of electric equipment

  --energy saving

  --environment protection
  - reduction of energy consumption leads to less pollution
  - reduction of pollution produced by power converters
  - direct applications to environment protection technology

Power Conditioners

- Power Converters
  - AC/DC converters
  - DC/DC converters
  - DC/AC converters
  - AC/AC converters

AC to DC Converters

- Uncontrolled AC to DC converters- Rectifiers
- Semi-Controlled AC to DC converters
- Fully controlled AC to DC converters
- Three-Phase, 6-step AC to DC converters
- 12-step and 24-step AC to DC converters
- Pulse Width Modulation AC to DC converters

DC to DC converters

- **Linear**
  - *Series type*
  - *Shunt type*
- **Switch mode**
  - *Non Isolated converters*
    - Buck converters
    - Boost converters
    - Polarity inverting Converters
  - *Isolated converters*
    - Forward converters
    - Fly back converters

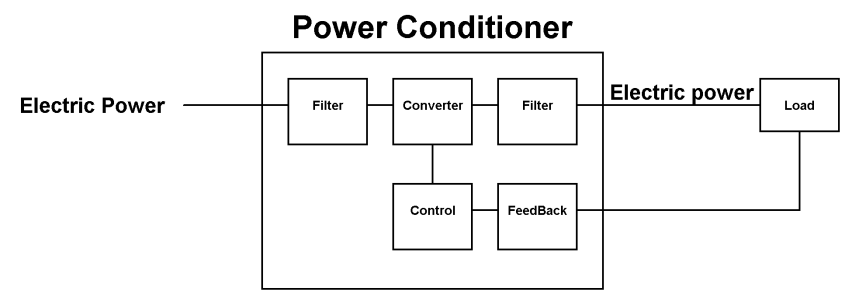
DC to AC converters

- Square wave DC to AC converter
- Quasi-Square wave DC to AC converters
- Multi-step DC to AC converters
- Pulse Width Modulation DC to AC converters
  - *Natural Sampling PWM*
  - *Regular Sampling PWM*
  - *Selective Harmonic Reduction PWM*

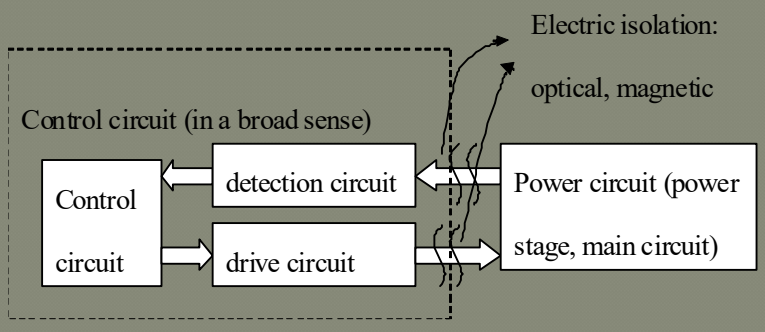
AC to AC converters

- Input is AC with fixed voltage and frequency
- Output is AC with variable voltage and variable frequency.
- Cycle-Converters
- Matrix Converters

Power Conditioner



Configuration of systems



Protection circuit is also very often used in power electronic system especially for the expensive power semiconductors.

Conclusions

- The scope of power converters design is discussed to process Electric Power under high voltage -high current Scenario.
- All four types of power converters are introduced.
- The use of Power converters are increasing and main concern is the power quality.
- The research in this area is mainly addressing these power quality issues

Thank you

For your attention