

Power Electronics

Chapter 1

Introduction

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Fall 2015

Outline

- I. What is power electronics?
- II. The history
- III. Applications

I. What is power electronics?

- 1) Definition
- 2) Position and significance in the human society

1) Definition

⊕ **Power Electronics:**

is the electronics applied to conversion and control of electric power.

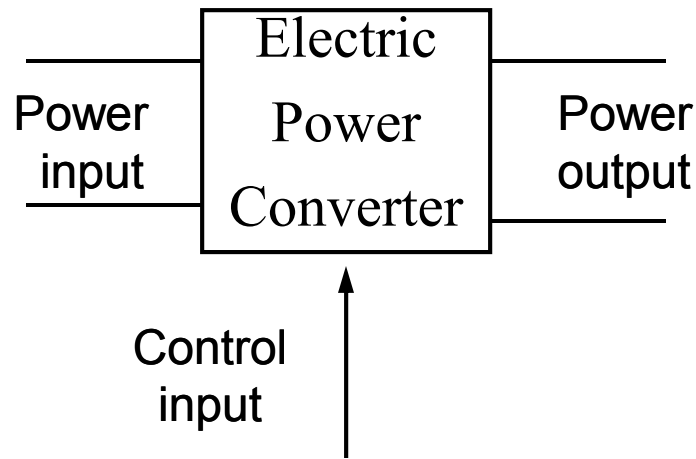
Range of power scale :

milliwatts(mW) → megawatts(MW) → gigawatts(GW)

⊕ **A more exact explanation:**

The primary task of power electronics is to process and control the flow of electric energy by supplying voltages and currents in a form that is optimally suited for user loads.

Conversion of electric power



✚ Other names for electric power converter:

- Power converter
- Converter
- Switching converter
- Power electronic circuit
- Power electronic converter

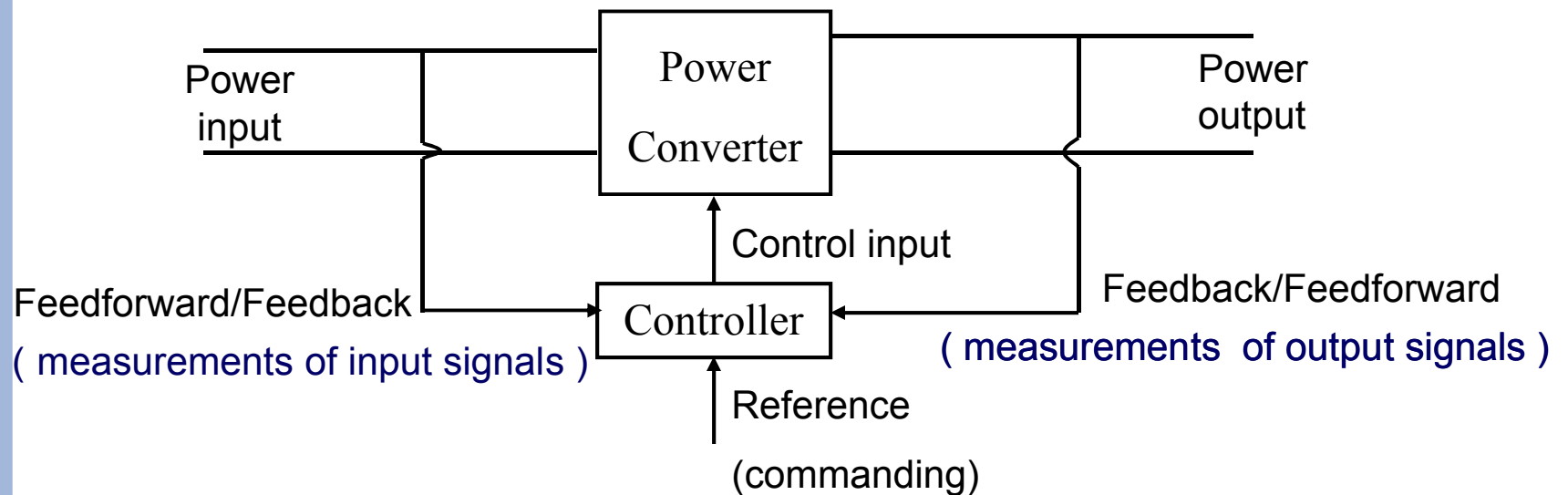
Two types of electric power	Changeable properties in conversion
DC(Direct Current)	Magnitude
AC (Alternating Current)	Frequency, magnitude, number of phases

Classification of power converters

Power input \ Power output	DC	AC
	DC	AC
AC	AC to DC converter (Rectifier)	AC to AC converter (Fixed frequency : AC controller Variable frequency: Cycloconverter or frequency converter)
DC	DC to DC converter (Chopper)	DC to AC converter (Inverter)

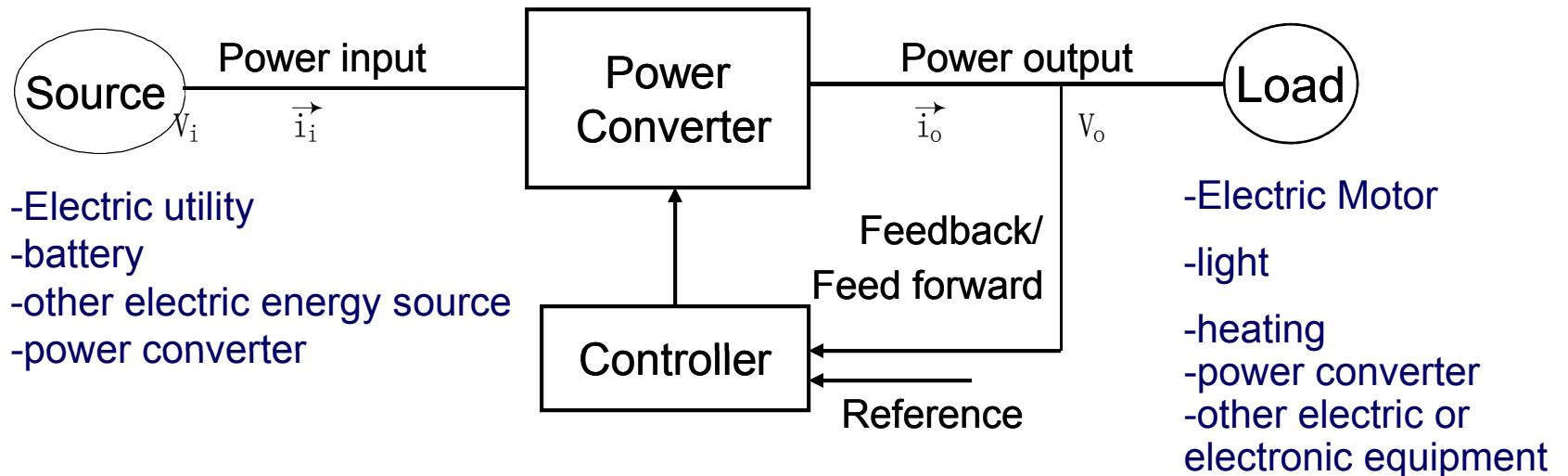
Power electronic system

Generic structure of a power electronic system



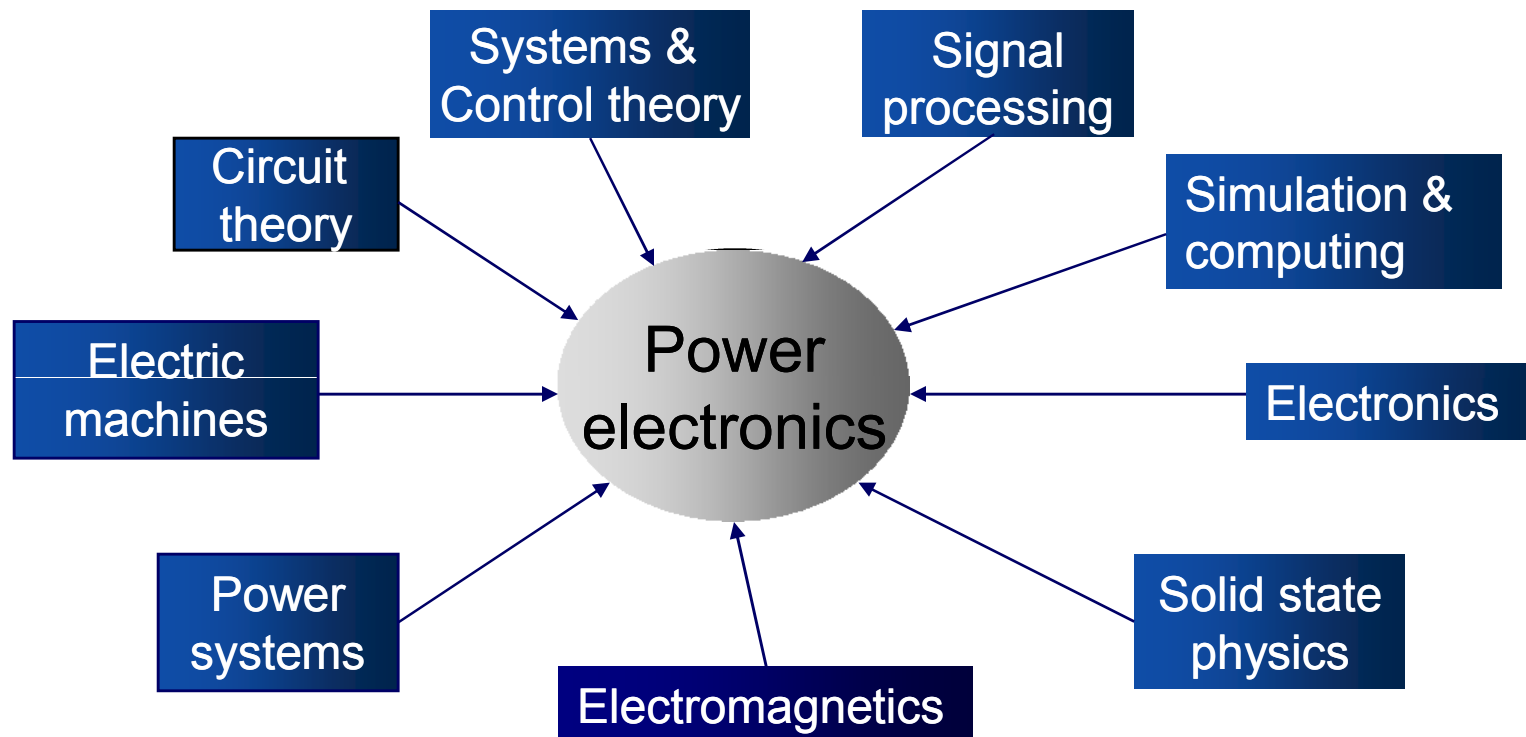
- ⊕ Control is invariably required.
- ⊕ Power converter along with its controller including the corresponding measurement and interface circuits, is also called power electronic system.

Typical power sources and loads for a power electronic system



- ✦ The task of power electronics has been recently extended to also ensuring the currents and power consumed by power converters and loads to meet the requirement of electric energy sources.

Relation with multiple disciplines

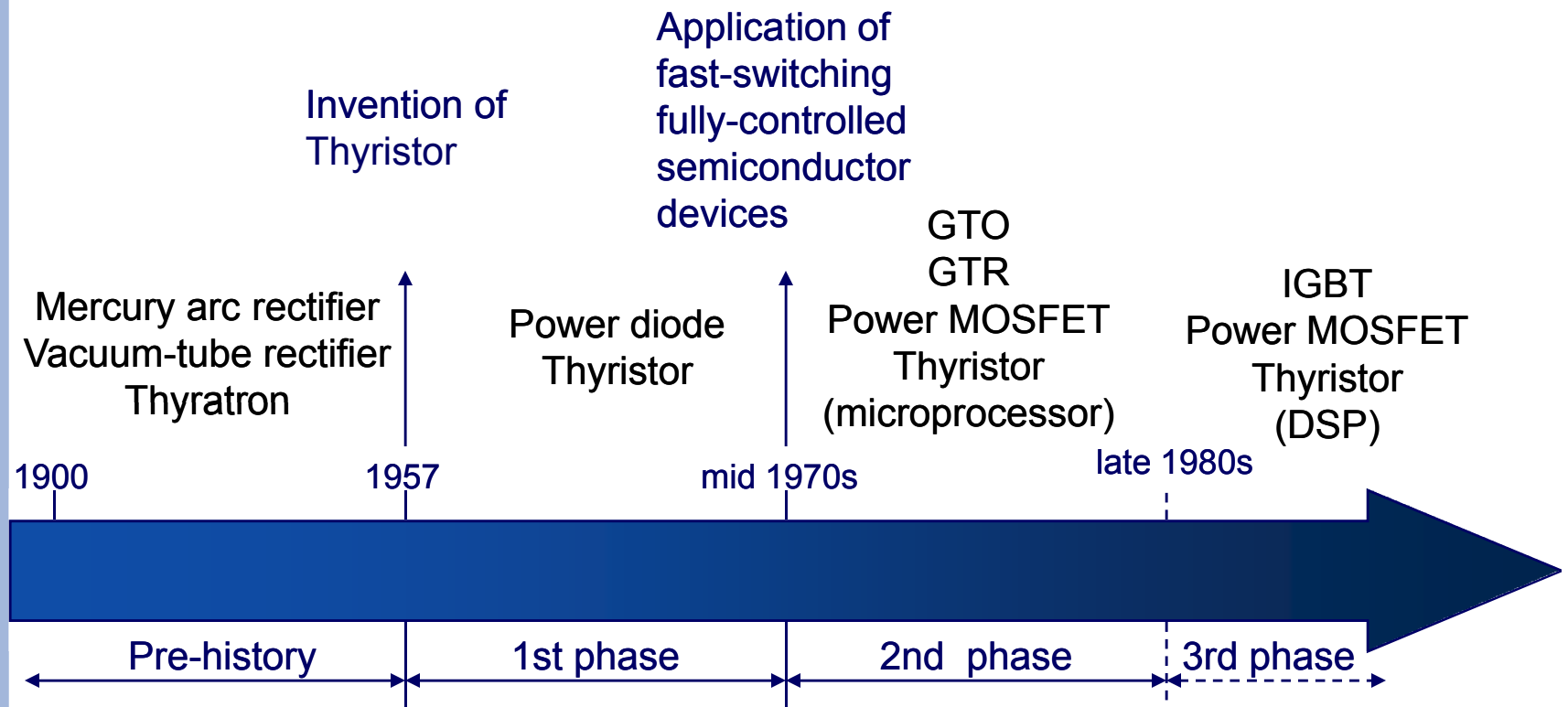


- ⊕ Power electronics is currently the most active discipline in electric power engineering worldwide.

2) 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.

II. The history



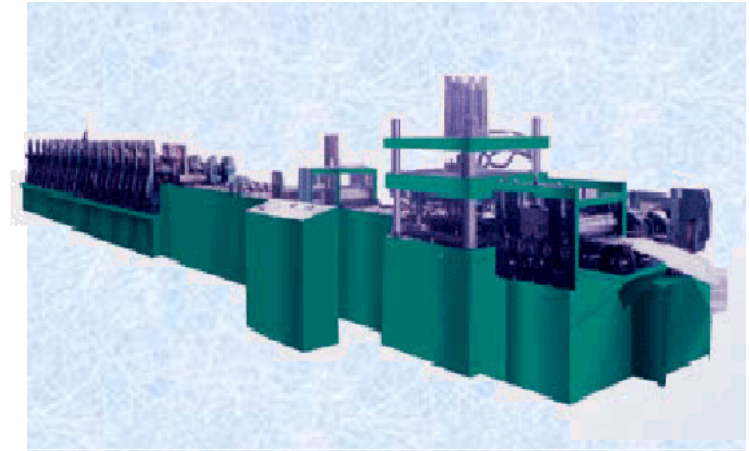
- ⊕ The thread of the power electronics history precisely follows and matches the break-through and evolution of power electronic devices

III. Applications

- ⊕ Industrial
- ⊕ Transportation
- ⊕ Utility systems
- ⊕ Power supplies for all kinds of electronic equipment
- ⊕ Residential and home appliances
- ⊕ Space technology
- ⊕ Other applications

Industrial applications

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



Transportation applications

- ⊕ Trains & locomotives
- ⊕ Subways
- ⊕ Trolley buses
- ⊕ 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
- ⊕ Electronic instruments
- ⊕ Portable or mobile electronics



Residential and home appliances

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



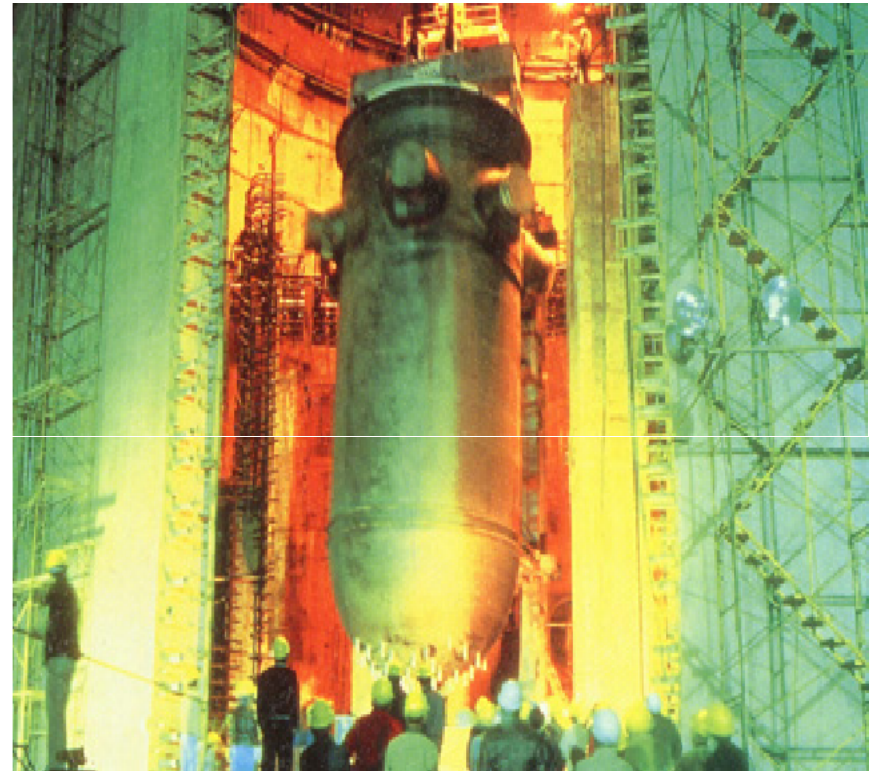
Applications in space technology

- ✦ 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

Major issues in power electronics

- # How to meet the requirement of the load or gain better control of the load
- # How to improve the efficiency
 - for reliable operation of power semiconductor devices
 - for energy saving
- # How to realize power conversion with less volume, less weight, and less cost
- # How to reduce negative influence to other equipment in the electric power system and to the electromagnetic environment