

LECTURE. 1: INTRODUCTION

1.1 Power Electronics Fundamentals

Power electronics relates power semiconductor devices circuitry, its design and role includes the techniques of converting and processing high power electrical energy. The role of power electronics is shown in Fig.1.

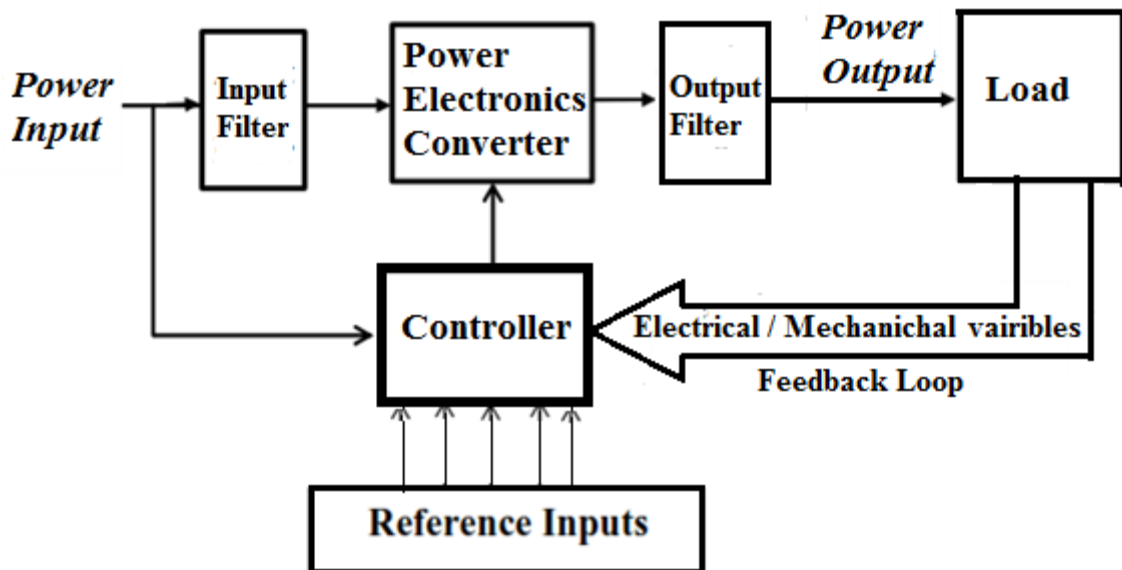


Fig. 1 The role of power electronics

Power semiconductor devices are used, such as power diodes, thyristors and power transistors. These power semiconductor devices are so important in modern power control. They are used in switching applications where they compete with “mechanically-operated” or “electrically-operated” switches and they give the following advantages:-

1. Faster in operation by a factor of at least a hundred times.
2. Need no routine maintenance.
3. Do not stick, bounce or wear.
4. Give no sparking on break.
5. Have a very long life expectancy when used properly .
6. Are physically small.
7. Are relatively cheap.

1.2.Goal of power electronic systems

The main goal of electronic power conversion systems is to convert electrical energy from one form to another, from the source to load using power semiconductor device with:

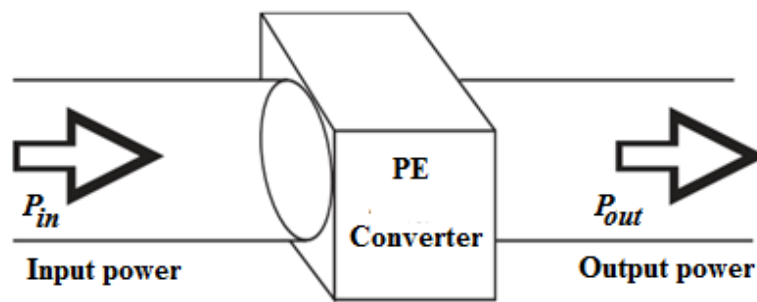
- »High efficiency
- »High availability
- »High reliability
- »Small size
- »Light weight and
- »Low cost



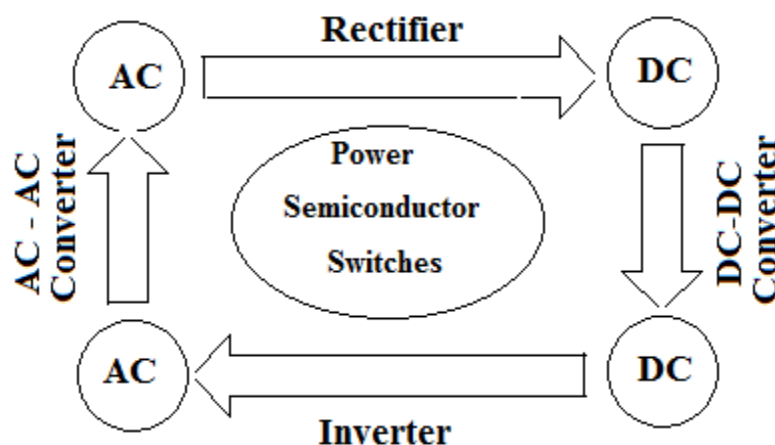
In addition to the simple on-off applications of power semiconductor devices their speed of operation and life expectancy, which are independent of the number of switching actions, make them possible to arrange for smooth control of the mean power from zero to maximum in most applications.

1.3 Power Electronics Applications

The main fields of applications are in Energy Processing and Drive Technology. Power semiconductor devices are interconnected in a variety of ways to form power control units, see Fig.2 (a). These units can be classified in a variety of ways, one of the simplest being to classify them according to their input/output requirements, thus, referring to Fig.1.2 (b).



(a)



(b)

Fig.1.2 Power or energy processing through power electronics converters.

(A) **Rectifiers** — circuits for changing ac voltage to dc voltage or transfer of power from an alternating current (ac) supply to direct current (dc) form. These circuits can be of two main types:

- AC - DC (uncontrolled)
- AC - DC (controlled)

(B) **DC - DC Converters** — Circuits which change a fixed d.c. voltage into a variable dc supply, i.e., transfer of power from a direct current supply directly into a direct current load of different voltage level. These types of converters are usually called DC choppers.

(C) **Inverters** — Circuits for changing a d.c. voltage to an alternating one or transfer of power from a direct current supply to alternating current form. This type of converter is usually called DC – AC converter or inverter.

(D) **AC-AC Converters** - Circuits which change a fixed a.c. voltage into a variable a.c. supply, i.e., transfer of power from an alternating current supply directly into an alternating current load of different voltage level at fixed frequency or variable frequency. These converters are usually of two types:

(i) AC choppers: change the a.c. supply voltage magnitude only keeping the frequency unchanged.

(ii) Cycloconverters or matrix converters: change the a.c. supply directly to a variable a.c. supply both in magnitude and frequency (also called frequency changers).

1.4 Major Power Electronics Applications

The development of power semiconductors with very high voltage and current ratings has enabled the use of power electronic converters for many applications, such as,

- ***Residential***

Lighting, Space heating, Air conditioning, Cooking, Refrigeration, Power supplies for consumer products and Computers.

- ***Transportation***

Electric trains, Trams, Hybrid electric and all-electric vehicles also utilize controlled power electronic converters for interfacing the battery and motor/generator, Battery chargers, Subways, Conveyor systems, and Rapid transit systems.

- ***Commercial***

Heating, ventilating, and air-conditioning (HVAC) , Refrigeration , Lighting Computers & office equipment, Uninterruptible power supplies (UPS) and Elevators.

- ***Utility Systems***

High-voltage DC transmission (HVDC) , Static VAR compensation, Renewable energy sources (wind, PV, fuel cells), Boiler feed systems , and Energy storage.

- ***Industrial***

Lighting, Pumps, Compressors, AC & DC motor drives, paper industries , steel industries, Gas analysers , Electro plating , Induction heating ,Machine tools, Arc and induction furnaces, Welding, Blowers and fans, Robotic applications, and Process plants.

- ***Aerospace***

Satellite power systems, Aircraft power systems, and Aircraft controls.

- ***Communications and Telecommunications***

Battery chargers, UPS systems, Satellite antenna drive systems in ground station, High power transmitters and receivers, and Power supplies.