



**Ministry of Higher Education
University of Al-Maarif
Medical Instruments Engineering Techniques Department**



Power Electronic

*For
Students of Third class*

**Lecture ONE
Introduction to power electronic**

**By
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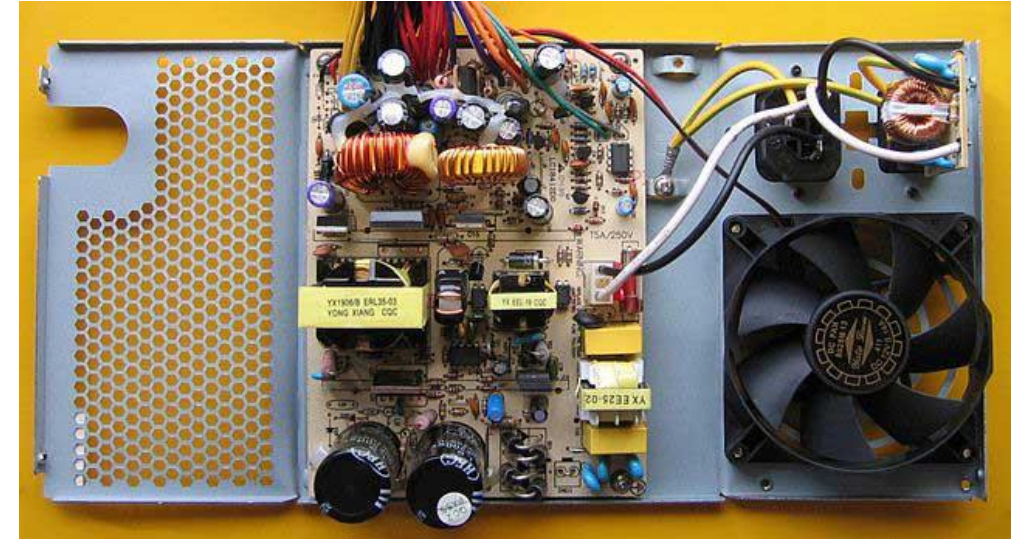
Department of Medical Instrumentation Engineering Techniques
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What is the Power Electronic ?

1. Power electronics combine **power**, **electronics**, and **control**.
2. Application of solid-state electronics for the **control** and **conversion** of electric power.
3. The focus in power electronics is on **conversion**, **efficiency** of **conversion** and **control** of energy.
4. Power electronics is based primarily on the **switching** of the power semiconductor devices.

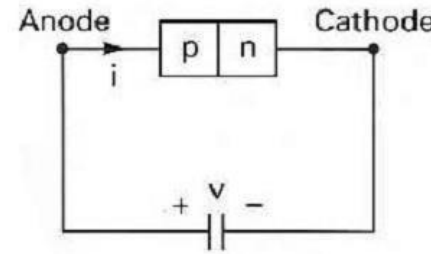
Power Semiconductor Devices:

1. Power Diodes
2. Power Bipolar Junction Transistors (BJTs)
3. Thyristors
4. Power MOSFETS
5. Insulated-Gate Bipolar Transistors (IGBTs) Static Induction transistors (SITs)

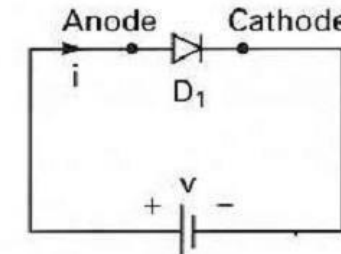


Power Diode

1. A power diode is designed for **high forward current** and **high reverse breakdown voltage**.
2. The area of pn junction in power diodes is much larger than in a signal diode because it is designed for **large current flow**.
3. The frequency response (or switching speed) is low compared to signal diodes.



(a) pn-junction



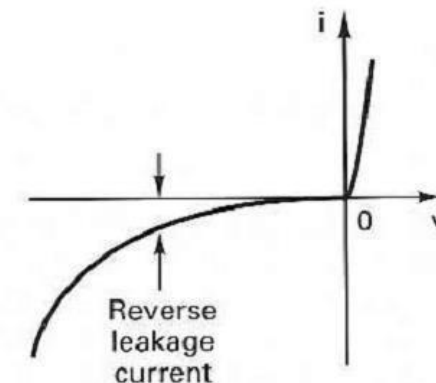
(b) Diode symbol

pn Junction and diode symbol

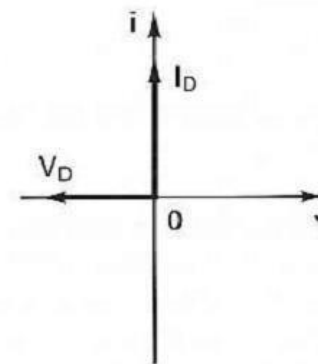
Types of Power Diode

1. General-purpose diodes: up to 3000V, 3500A
2. High speed (or fast-recovery) diodes: up to 3000V, 1000A reverse recovery time varies between 0.1 and 5 μ s.
3. Schottky

v-i characteristics of diode






(a) Practical



(b) Ideal

Comparison Between Power Diode Types

| Type | Standard or General-Purpose Diodes | Fast-Recovery Diodes | Schottky Diodes |
|-----------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Reverse recovery time | relatively high reverse recovery time, 25 μ s | low recovery time, normally less than 5 μ s | the charge storage problem of a pn junction can be eliminated or minimized, |
| Application | used in low-speed application | used in dc-dc and dc-ac converters | ideal for high-current and low-voltage dc power supplies |
| Current rating | from less than 1A to several thousands amperes | from less than 1A to hundreds of amperes | from 1A to 300A |
| Voltage rating | from 50V to around 5kV | from 50V to around 3kV | maximum allowable voltage is generally limited to 100V |
| General shape |  |  |  |

Types of power electronic circuits

1- diode rectifiers : **Un**controlled rectifiers

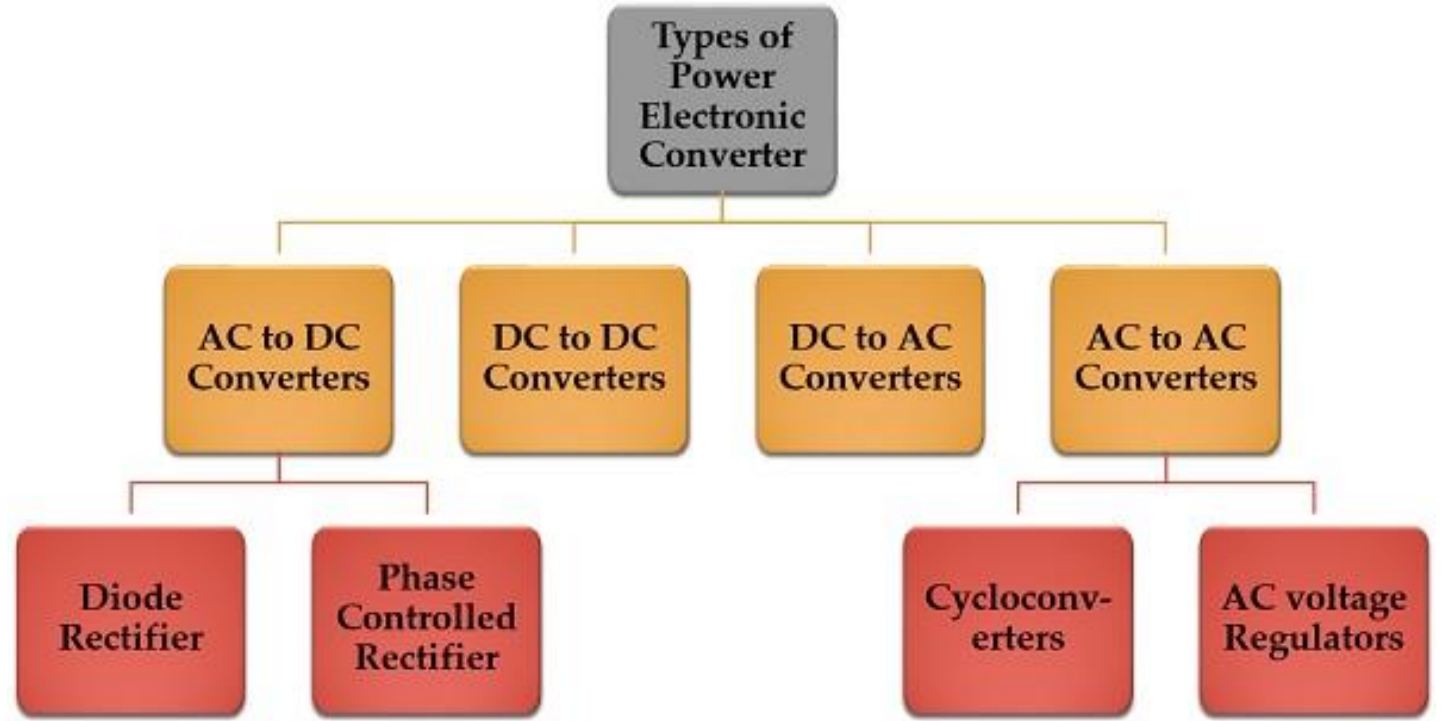
2- ac-dc converters: controlled rectifiers

3- ac-ac converter: ac voltage controllers

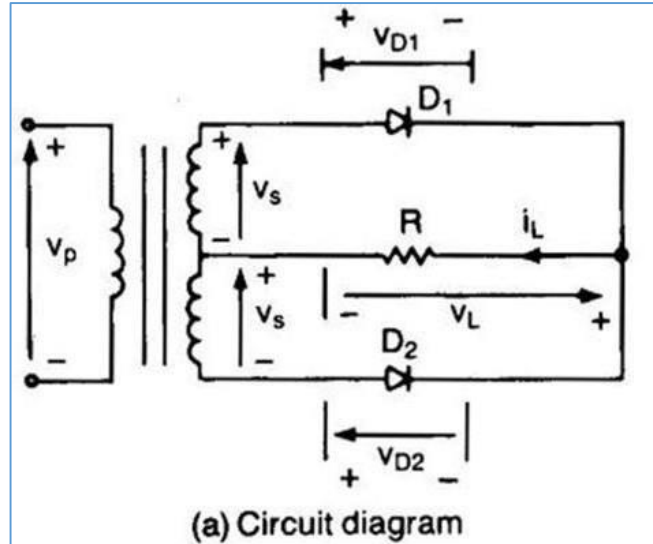
4- dc-dc converter: dc choppers

5- dc-ac converter: inverters

6- static switches:

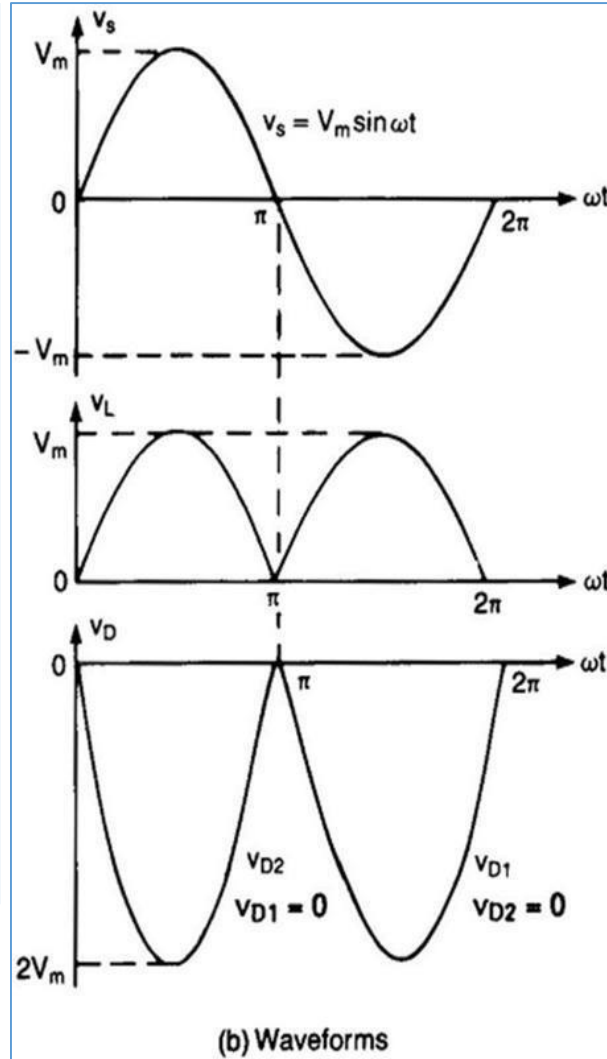


Single phase full wave rectifier circuit With center-tapped transformer:

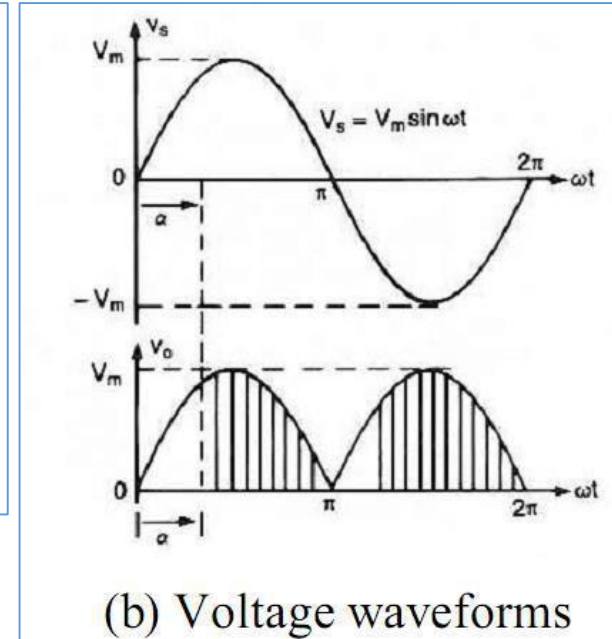
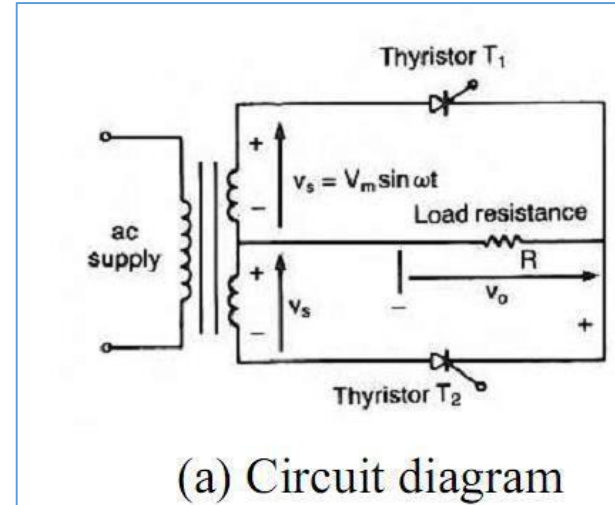


$$V_{dc} = \frac{2}{T} \int_0^{T/2} V_m \sin \omega t \, dt$$

$$= \frac{2V_m}{\pi} = 0.6366 V_m$$



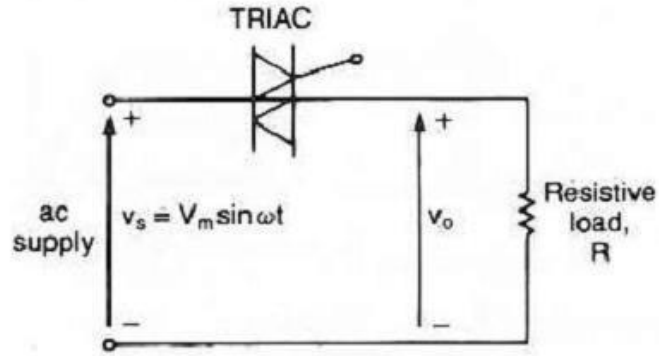
Single phase ac-dc converter:



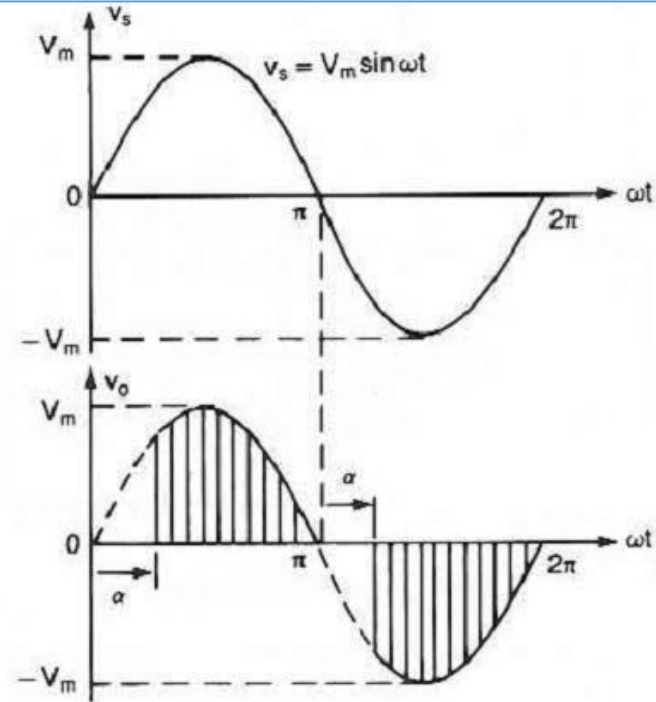
Application

1. DC motor drives
2. Regulated dc power supplies
3. High voltage dc transmission
4. Wind generator converters

Single phase ac-ac converter:



(a) Circuit diagram

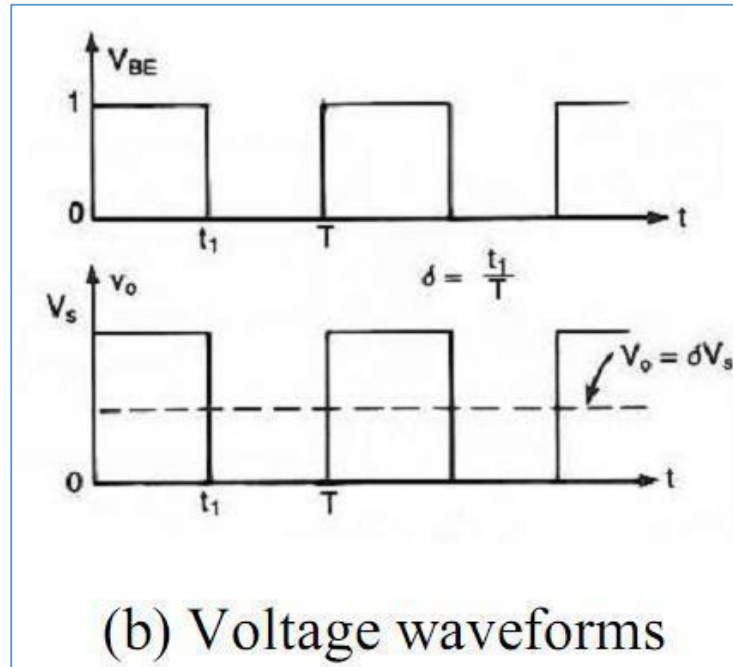
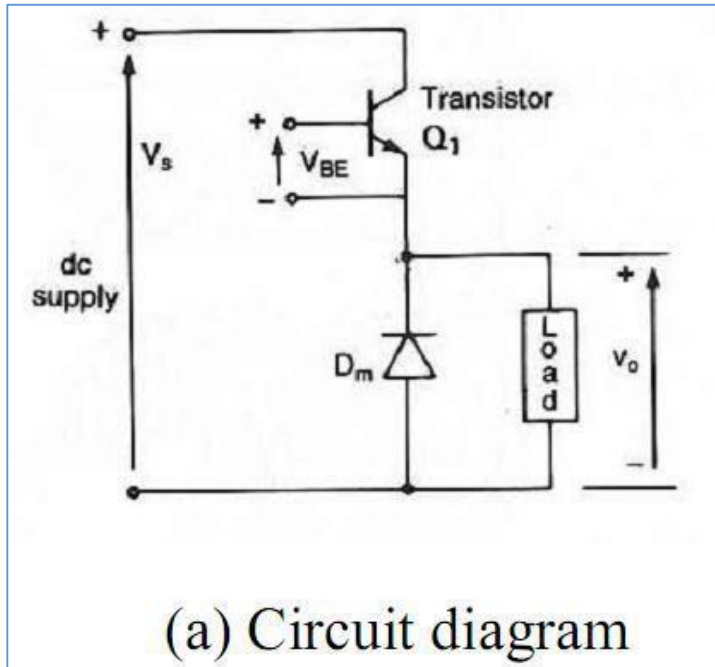


(b) Voltage waveforms

Application

1. Light dimmers
2. Voltage regulators
3. VAR regulators
4. AC motor speed controls
5. Electronic tap changers
6. Solid-state relays

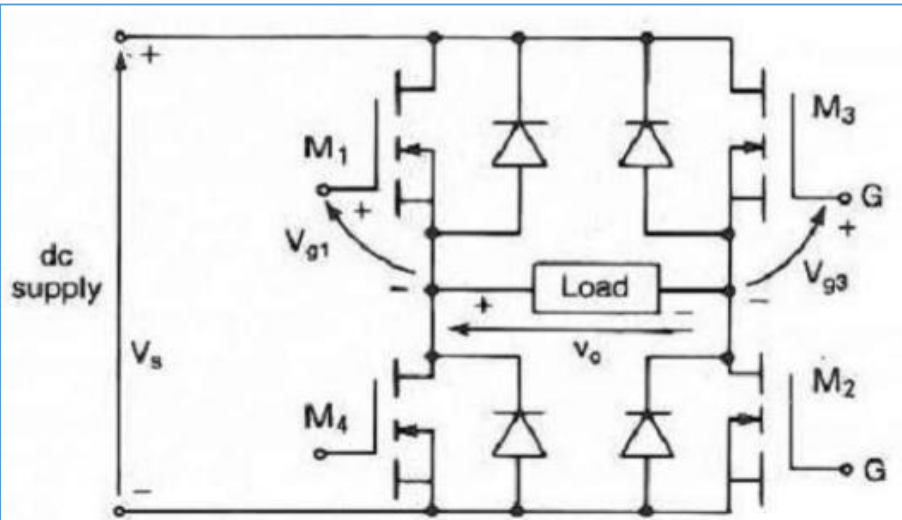
dc-dc converter:



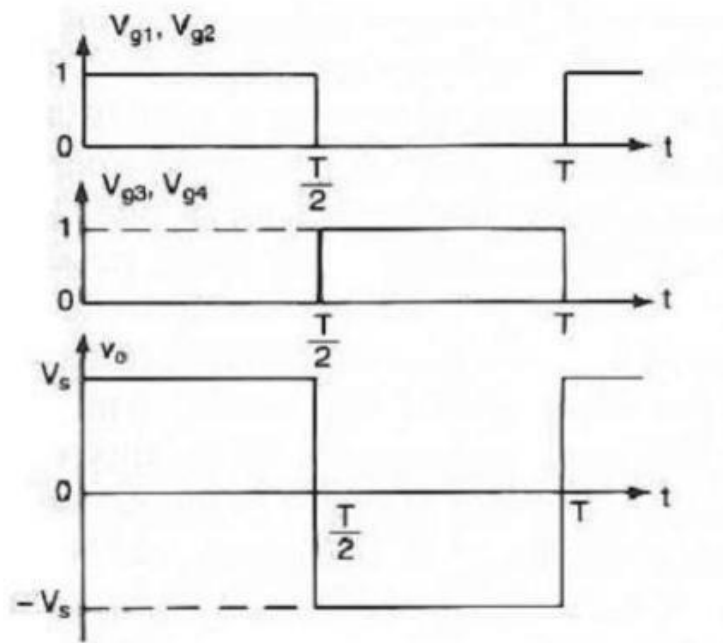
Application

1. Electric transportation
2. High performance regulated power supplies
3. Electronic ballasts
4. DC motor drive systems

dc-ac converter:



(a) Circuit diagram



(b) Voltage waveforms

Application

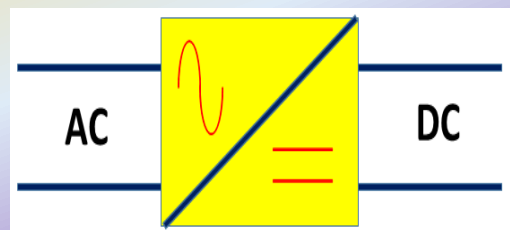
1. Aircraft and space power supplies
2. Uninterruptible power supplies
3. Variable-frequency ac motor drives
4. Aircraft variable-speed constant frequency supplies
5. Induction heating supplies

Summary

ac-dc converters: controlled rectifiers

Application

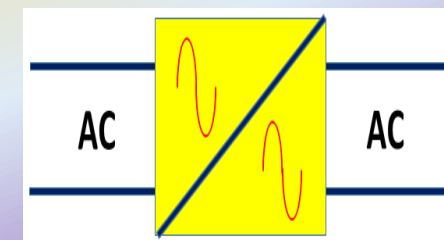
- dc motor drives
- regulated power supplies
- high voltage dc transmission
- wind generator converters



ac-ac converter: ac voltage controllers

Application

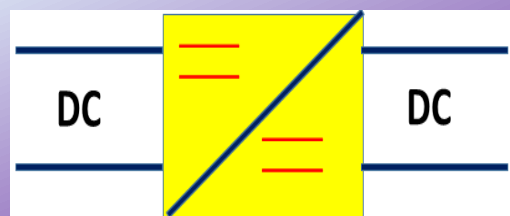
- Light dimmers
- Voltage regulators
- VAR regulators
- AC motor speed controls
- Electronic tap changers
- Solid-state relays



dc-dc converter: dc choppers

Application

- Electric transportation
- High-performance regulated power supplies
- Electronic ballasts
- DC motor systems



dc-ac converter: inverters

Application

- Aircraft and space power supplies
- Uninterruptible power supplies
- Variable-frequency ac motor drives
- Aircraft variable-speed constant frequency supplies
- Induction heating supplies
- Solar energy

