INVERTERS

The DC to AC converters are called Inverters. The AC output voltage can be fixed at a fixed frequency or at variable frequency.

The conversion can be achieved by controlled switching devices like BJT, MOSFETs, IGBTs, thyristors (Silicon Controlled Rectifiers) etc.

The ideal output voltage waveforms of an ideal inverter should be sinusoidal. The output voltage waveforms of practical inverters are however non sinusoidal and contain certain harmonics.

The output frequency of an inverter is determined by the rate at which the semiconductor devices are switched on and off.

The DC power input to the inverter may be battery, fuel cell, solar cell or any other DC source. But in most industrial applications, it is fed by a rectifier.

Industrial Applications of Inverters

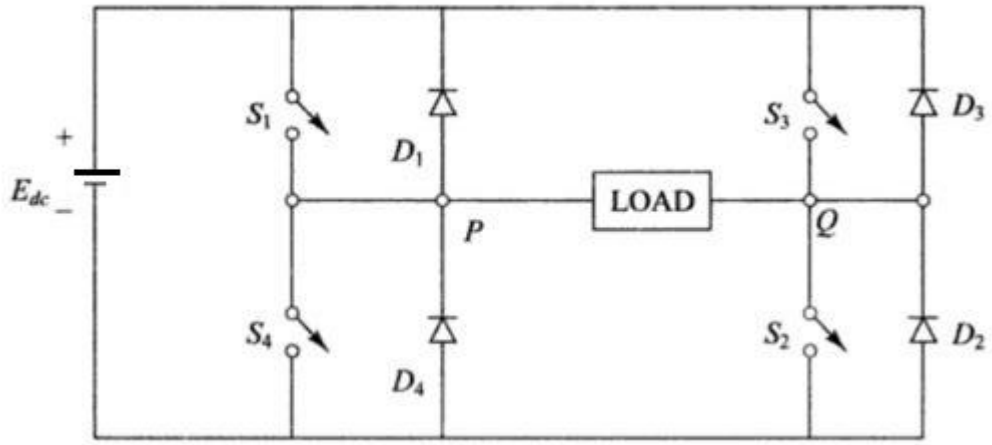
- Variable speed AC drives
- Induction heating
- Uninterrupted power supplies (UPS)
- High voltage DC transmission lines
- Battery vehicle drives
- Regulated voltage and frequency power supplies

Single phase Full Bridge Voltage Source Inverters

Figure shows the configuration of single phase full bridge inverter. The inverter used two pairs of controlled switches (S_1S_2 and S_3S_4).

Operation with Resistive load

Voltage waveforms are shown in figure. The bridge inverter operates in two modes in one cycle of the output.

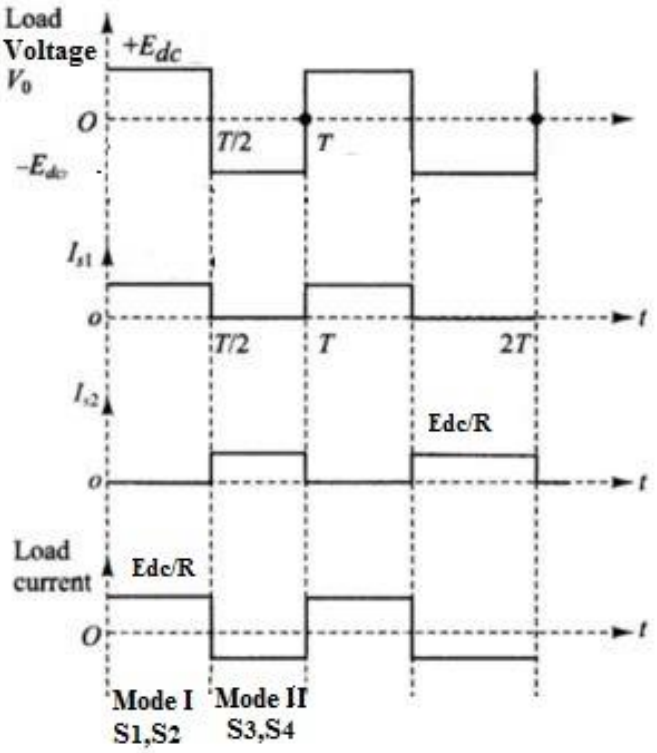


Mode I: ($0 \leq t \leq T/2$)

Switches S_1 and S_2 conducts simultaneously. The load voltage is $+E_{dc}$ and load current flows from P to Q. At t=T/2, S_1 and S_2 are turned off and S_3 and S_4 are turned on.

Mode II: ($T/2 \leq t \leq T$)

At t=T/2, switches S_3 and S_4 conducts simultaneously. The load voltage is $-E_{dc}$ and load current flows from Q to P. At t=T, S_3 and S_4 are turned off and S_1 and S_2 are turned on again.

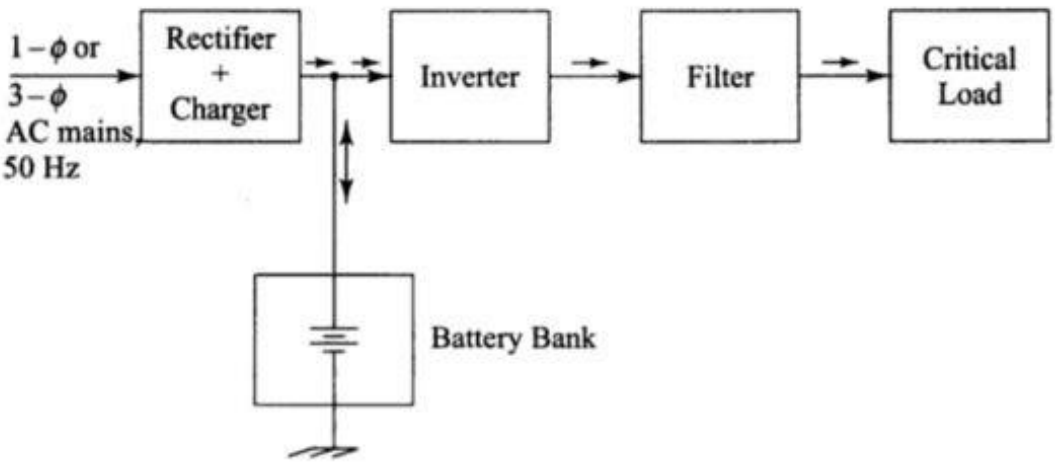


UNINTERRUPTED POWER SUPPLY (UPS)

The function of a UPS is to provide uninterrupted supply of power to the AC load. It is a power conditioner which:

(i) Provides good quality power to the load at all conditions of supply power.
(ii) Regulates the load voltage when the mains voltage fluctuates
(iii) Provides complete isolation between the load and the mains
(iv) Suppresses the line transient (voltage spikes) and minimizes EMI (RFI) problems
(v) Provides constant voltage and constant frequency supply to the critical load.

Figure shows the block diagram of a typical UPS system. A rectifier converts a single phase or three phase AC voltage to DC, which supplies power to the inverter as well as the battery bank (to charge it). The inverter gets a DC input voltage from the rectifier when the AC mains is ON and from the battery when AC mains is OFF. Inverter converts this DC voltage into AC voltage and through a suitable filter, applies it to the load. A static switch will connect or disconnect the battery from the input of the inverter depending on the status of Ac mains.



Applications

Used in applications such as medical intensive care systems, chemical plant process control, safety monitors or major computer installations where temporary loss of supply could have severe consequences.

UPS configurations

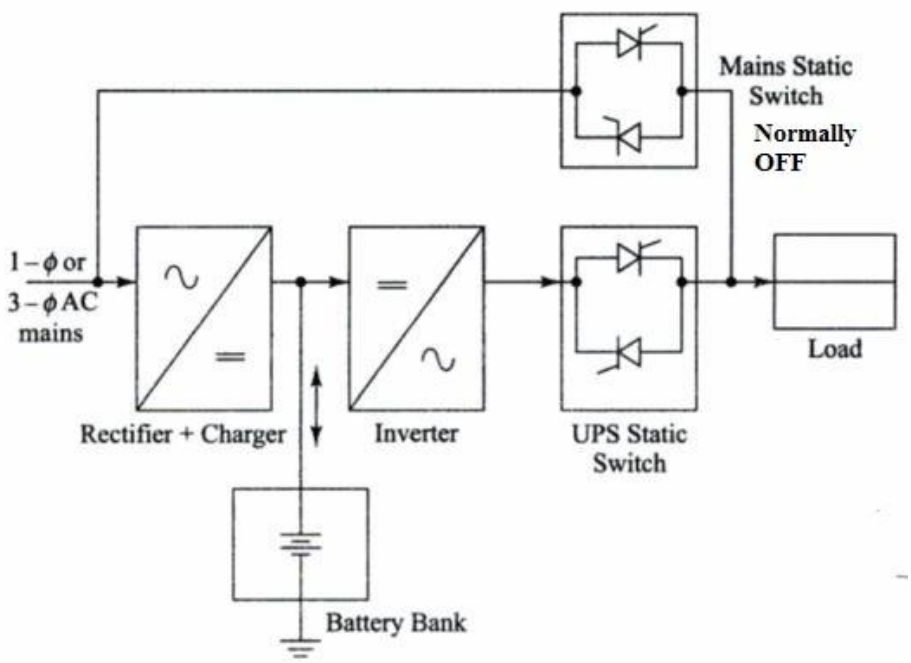
Depending on the arrangements of basic blocks, UPS systems are mainly classified as

(i) On-line or inverter preferred UPS

(ii) Off-line or line preferred UPS

On-line UPS

In this load is always connected to the inverter through the UPS static switch which is normally ON.



When the AC mains is ON, the rectifier circuit will supply power to the inverter as well as to the battery. Therefore it acts as a rectifier cum charger. The inverter output is connected to the load via UPS static switch. Battery will be charged in this mode.

If the supply power fails suddenly, the rectifier output will be zero and hence the battery bank will supply power to the inverter without any interruption and delay.

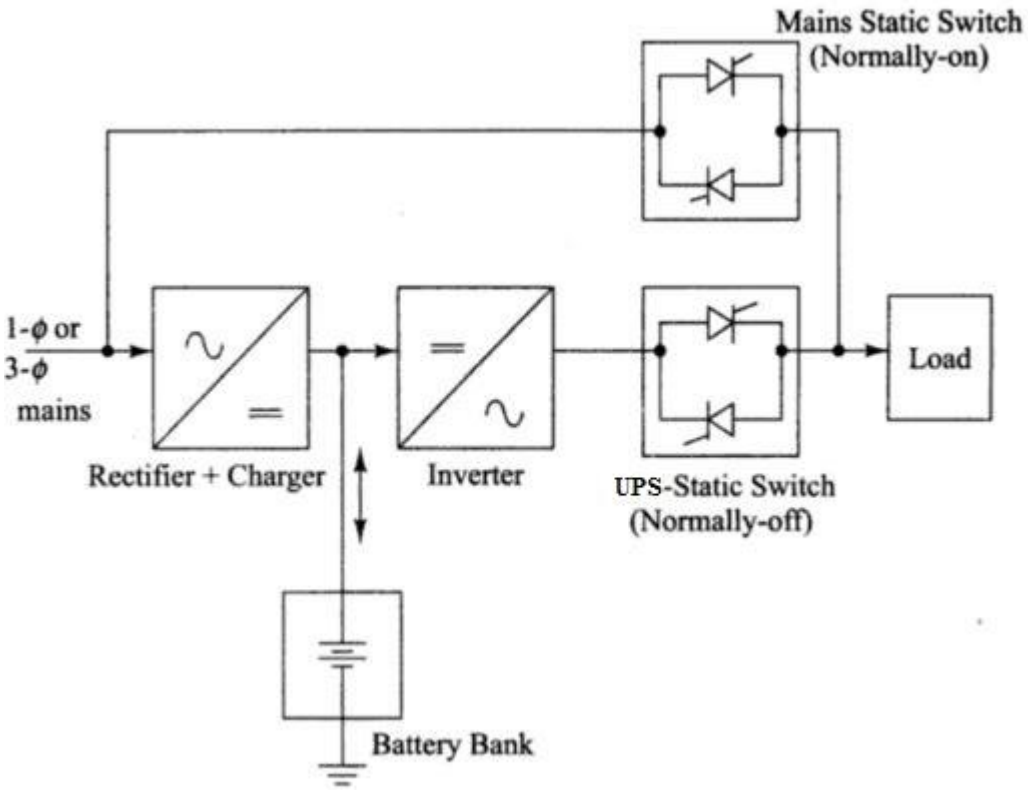
After restoration of line supply, the charger supplies the inverter and recharges battery.

In case the UPS fails, then the normally OFF, main static switch is turned on which automatically transfers the AC line to the load in less than a quarter of cycle period.

This type of UPS is more popular as it can provide full isolation of critical load from AC line and also provides power conditioning. Changeover time is very less and there is no interruption during transfer from battery to line and vice versa. Also the system protects the critical load against surges, spikes,, line noise, frequency and voltage variations, brown out and outages. These are not available in offline systems.

Off-line UPS

The main difference between off-line and on-line UPS is that the mains static switch here is normally ON. It connects the AC mains directly to load when the mains is ON. UPS static switch is normally OFF. It is turned ON only when the mains fails.



The rectifier/charger has only to charge the battery. Under the mains failure, the static switch operates to disconnect the load from the mains and connect to the UPS output. The battery will supply power to the load via the inverter. The total time taken to sense the power failure and make a changeover from the mains to UPS is about a quarter cycle period.

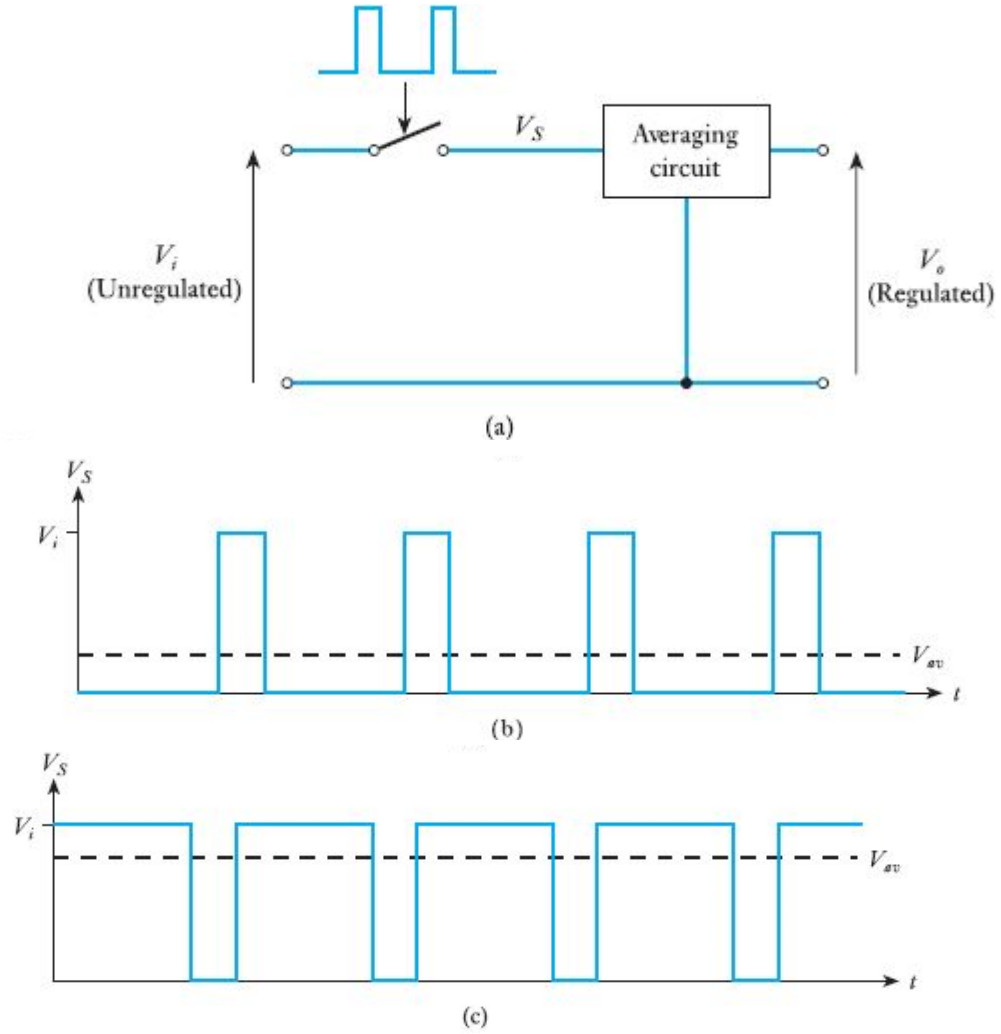
Here there is no isolation between load and the mains and hence this UPS is not recommended for highly critical loads.

SWITCH MODE POWER SUPPLY (SMPS)

In low to medium power range, say, from 50W, a DC source of supply is often required which contains negligible ripple. For this application switch-mode power supplies are used.

A power supply that makes use of a switching regulator is often referred to as a switch-mode power supply. Switching regulators can be used to replace conventional regulators. This reduces the power consumed in the regulator and may cut its size and weight.

The basic configuration of switching regulator is shown in figure (a). The unregulated voltage is connected to a switch that is opened and closed at a rate of about 20 kHz (or more). While the frequency remains constant, the duty cycle (that is, the ratio of the on time to the off time) is varied. If the switch is closed for a relatively short period during each cycle, the average value of the output will be low, as shown in figure (b). However, if the switch is closed for a larger proportion of each cycle, the average value will be higher, as in figure (c). By varying the duty cycle of the switching waveform, the average value of the output voltage can be varied from zero up to the input voltage.



A great advantage of switching regulators is that their power dissipation is very low. When an ideal switch is off, the *current* through it is zero, but when it is on, the *voltage* across it is zero. Therefore, in either state, the power dissipated in the switch is zero. Transistors are not ideal switches, but both bipolar transistors and MOSFETs have very good switching characteristics.

The general block diagram of an SMPS is given below.