

## UNIT-5

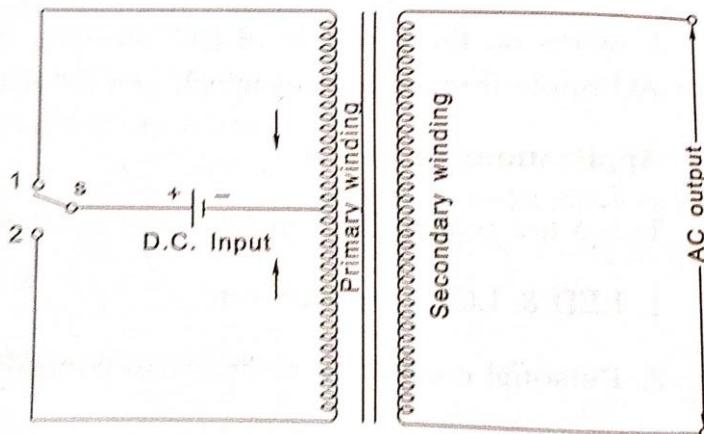
### INVERTERS, SMPS, UPS & PLCS

#### 1. What is the need of Inverters.

It is an electronic device that converts DC to AC. It is used in Uninterruptible Power Supply (UPS) to convert DC current in storage batteries to AC power supply in the absence of AC main supply. Automatic startup once electricity is switched off. Now a days, most of the devices are operated with the AC power due to its flexibility in transfer/and also having the facility of step up (or) step down the voltage levels easily with the use of transformer, Where-as it is not easy in D.C and hence we do not use D.C systems. But the problem is that electricity can not be stored in AC form. Hence it has to be converted in to DC for storage.

#### 2. State the principle of operation of inverters

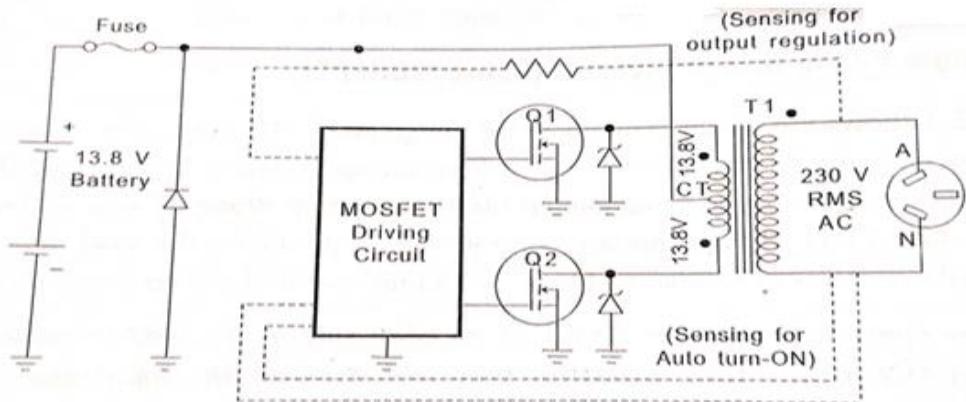
If S is connected alternately to positions 1 and 2 at a rapid speed and if S is not kept closed to any of the two positions (1 and 2) for too long, then an alternating voltage will appear across the primary winding. This can be explained by the direction of the current flow in the primary winding . Although the voltage applied is DC in nature, the direction of current flow in the primary winding when S is connected to position 1, is from top to bottom whereas when S is connected at position 2, the current flows from bottom to top. This change in the direction of current flow in the primary winding gives rise to an alternating voltage in it. The frequency of this alternating voltage will depend on how rapidly the switch (S) positions are interchanged. This alternating voltage in the primary winding will induce an alternating emf in the secondary winding which will act as the AC output.



#### 3. Explain the working of MOSFET based inverter circuit.

In this the DC source from the battery is converted in to AC source by using a pair of power MOSFETs (Q1 and Q2) acting as very efficient electronic switches. The positive 13.8 V DC from the battery is connected to the centre-tap of the transformer primary, while each MOSFET is connected between one end of the primary and earth (battery negative). So, by switching on Q1, the battery current flows through the top half of the primary and to earth via Q1. Conversely, by switching on Q2 instead, the current flows oppositely through the lower half of the primary and to earth. Therefore, by switching on the two MOSFETs alternately, the current flows first in one half of the primary and then in the other, producing an alternating magnetic flux in the transformer secondary. As the secondary has about 24 times the number of turns in the primary, the induced AC voltage is much higher around 650 V peak-to-peak.

Here MOSFETs are used as electronic switches to convert the DC into AC because MOSFETs make the most efficient high-current switches. When they are OFF, they form a virtually open circuit and yet when they are ON, they are very close to a short circuit (only a few milli ohms). So, very little power is wasted as heat.



#### 4. List the applications of Inverters.

1. Domestic appliances
2. Solar power generation systems
3. HVDC power transmission system
4. Industrial heating systems
5. E-battery vehicles
6. Dielectric heating
7. Uninterruptible power supplies
8. Variable speed AC motor drives.

#### 5. State the need for PLC.

- To get the automation in the process.
- Controlling of equipments with just one click.
- Arranging so many controllers as per our requirements.
- To make the efficient use of digital electronics and control system.
- Real time application of microcontrollers, microprocessor and input-output modules.
- In the industries, PLC may help to get the reduction in manpower and wastage of raw materials.

#### 6. State the need of industrial automation.

**Automation:** Automation is basically the conversion of human made manual operations (or) functions into automatic operations done by the technical equipments (or) devices.

**Need of Industrial Automation :** In these modern days as the day to day is in progress there is high demand for high quality products with economic price in the market. To meet this challenges the number of industries are implementing new manufacturing techniques with the use of automated devices instead of increasing the human resources. Hence, now a days the industrial automation systems are very much needed to meet the demand at the market and also to produce the products at economic price by reducing the various costs and expenses.

#### 7. List the applications of SMPS

- LED & LCD television sets
- Personal computers and desktops
- Battery charges in case of cell phones
- LED lighting system
- Space stations
- Automobile vehicles

## 8. List the applications of UPS

- Computer operating systems
- Operation theatres in hospitals
- Movie theatres
- Fish aquarium pumps
- TV & LCD systems
- Domestic appliances
- Agricultural pump sets
- Railway signal systems
- Commercial shopping complexes.

## 9. List the applications of PLC

- Electrical power generation.
- Oil refining.
- Chemical industry.
- Steel mills.
- Plastic industry.
- Cement plants.
- Fertilizer plants.
- Pump and paper mills.
- Auto mobile industry.
- Food and beverage processing industry.

## 10. Explain the PLC system with block diagram

It mainly consists of three units, namely

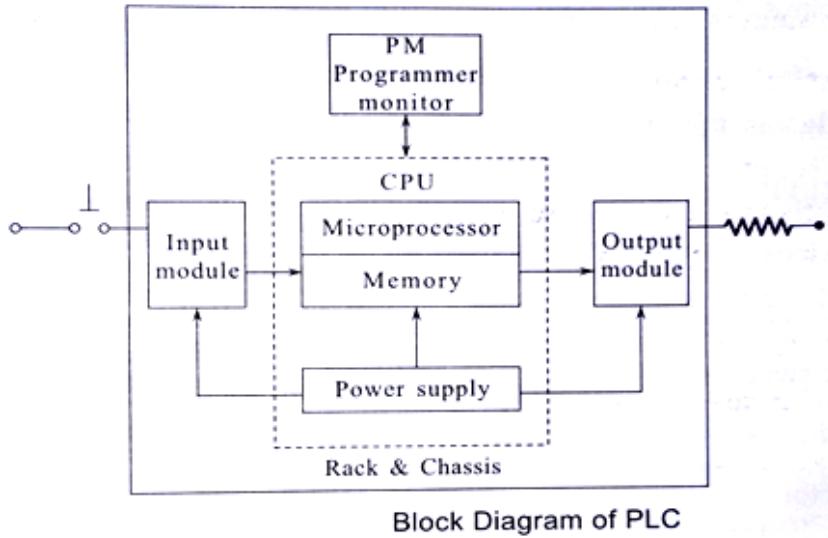
- (i) Central processing unit (CPU).
- (ii) Programmer/Monitor devices.
- (iii) Input/output (I/O) modules.

**(i) Central Processing Unit (CPU):** The "brain" of the system, which has three subparts

- Microprocessor: The computer center that carries out mathematic and logic operations.
- Memory: The area of the CPU in which data and information is stored and retrieved. Holds the system software and user program.
- Power Supply: The electrical supply that converts alternating current (AC) line voltage to various operational DC values. In the process, the power supply filters and regulates the DC voltages to ensure proper computer operation.

**(ii) Programmer/Monitor:** The programmer/monitor is a device used to communicate with the circuits of the PLC. Hand-held terminals, industrial terminals, and the personal computer devices. In a hand-held unit, input takes place through a membrane keypad and the display is usually a Liquid-Crystal Display (LCD). With the industrial terminal or personal computer, more complex, typewriter-type keyboards and Cathode Ray Tubes (CRTs) are employed.

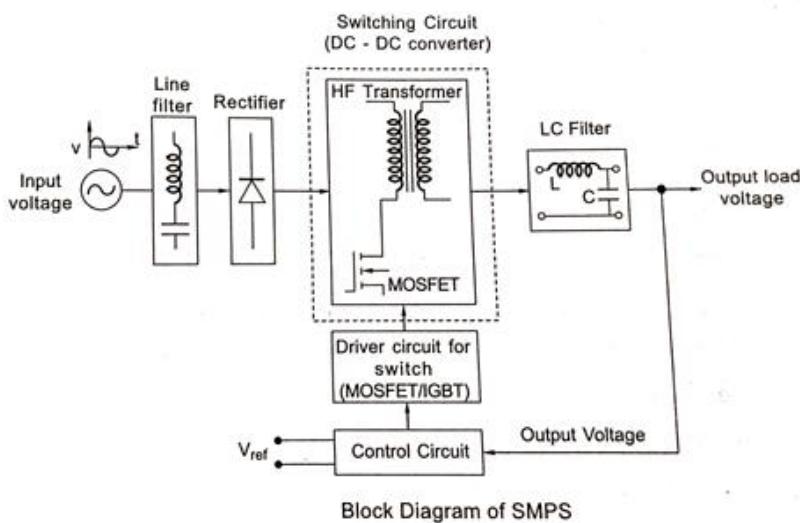
**(iii) I/O Modules:** The input module has terminals into which outside process electrical signals, generated by sensors or transducers, are entered. The output module has terminals to which output signals are sent to activate relays, solenoids, various solid state switching devices, motors, and displays.



Block Diagram of PLC

### 11. Explain the working of SMPS with block diagram.

- In order to get ripple free d.c output voltage, the size of filter circuit elements required are very large.
- Hence, it becomes inefficient in practical usage. This disadvantage is overcome by using SMPS.
- SMPS works on the principle of D.C chopper. By operating ON/OFF switch very rapidly, ac ripple frequency rises which can be easily filtered by using L and C filter circuits.
- Fig. shows the block diagram of SMPS. It consists of line filters, Rectifier, choppers, LC filter, control circuit and driver circuit.
- The input to the switching device is unregulated dc, which may be available from AC - DC rectifier and filter circuit.
- This d.c voltage is chopped at high frequency in order to withstand the fluctuations in the input voltage (or) the load conditions. It is also used to step-up (or) step down the output voltage in comparison with the input voltage level.
- The output voltage is fed to the chopper circuit using a control circuit & driver circuit.
- The main function of control circuit is to sense the output load voltage and to decide about the duty ratio of MOSFET. The driver circuit will functions as a switching device.
- By adjusting the duty ratio of chopper, the output voltage is maintained constant and it is then filtered by using LC filter supply the ripple free output voltage to the load.

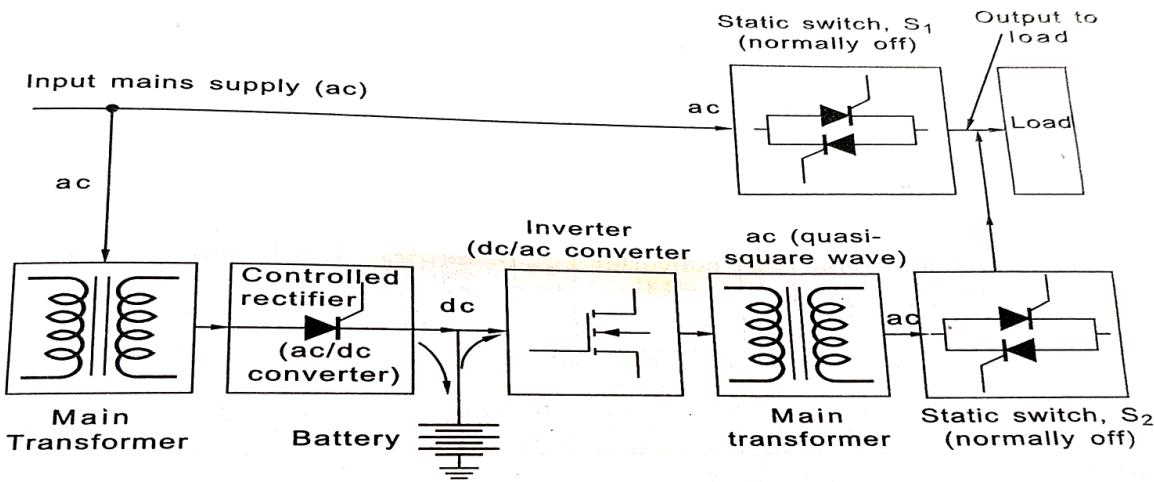


Block Diagram of SMPS

## 12. Explain the working of off-Line UPS

It consists of independent battery charging circuit, load circuit which is supplied through static transfer switched (S1) during main power ON and through battery, inverter, static switch S<sub>2</sub> during power failure.

During normal mode the battery is charged through AC-DC converter and a charge controller and the load supplied through static switch S<sub>1</sub>. During power failure, static switch (S<sub>2</sub>) operates and battery supplies power to the load through inverter. Normally, single-pulse, quasi square wave AC voltage is generated by an inverter of off-line UPS.



The change-over of the supply from S<sub>1</sub> to S<sub>2</sub> is completed within 1/4 cycles so that the operation of the load is not disturbed.

## 13. Explain the working of on-Line UPS

Fig. shows the block diagram of On-line preferred UPS, during main supply is available, the main power supply is fed to the load through converter, inverter, static switch S<sub>1</sub> and PCU, as well as the same supply is utilised for charging the battery through converter. When the main power supply fails, the battery instantly supplies the power to the load through inverter, static switch S<sub>1</sub> and PCU. Hence, power supply to the load continues without any interruption. In this method, in the event of failure of inverter, the main can be diverted to the load through the static switch (S<sub>2</sub>) and its direction is represented by dotted line.

