5. SWITCHED MODE POWER SUPPLY

5.1. Introduction

A power supply is an important element of any type of electronic circuit. It provides the supply for the proper operation of the circuit. The successful operation of the circuit depends on the proper functioning of the power supply. Most of the electronic circuits require a smooth D.C. voltage as that of batteries. The power supply in a circuit tries to provide such a constant voltage. The regulator in a power supply is an important unit which keeps the output D.C. voltage constant under the variable load and variable input conditions.

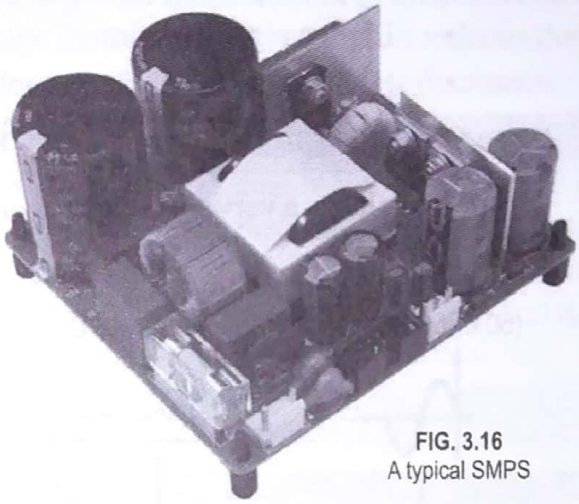

FIG. 3.16
A typical SMPS

Most of the regulators used in conventional power supplies are series voltage regulators which are called linear regulators. In such regulators, the series pass transistor is a control element which conducts in series with the load. As load or input changes, the current through the transistor is adjusted so as to keep the output constant. Thus the series pass transistor is conducting all the time as long as the load is drawing the current. Due to this the linear regulator power supplies have number of limitations.

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Switching regulators are used as replacements for linear regulators when higher efficiency, smaller size or lighter weight are required. They are, however, more complicated; their switching currents can cause electrical noise problems if not carefully suppressed, and simple designs may have a poor power factor.

5.2. Need for Switched Mode Power Supply

A linear regulator power supply has following limitations:

1. The required input step down transformer is bulky and expensive.
2. Due to low line frequency (50 Hz), large values of filter capacitors are required.
3. The efficiency is very low.
4. Input must be greater than the output voltage
5. As large is the difference between input and output voltage, more is the power dissipation in the series pass transistor.
6. For higher input voltages, efficiency decreases.
7. The need for dual supply is not economical and feasible to achieve with the help of linear regulators.

Thus in modern days, to overcome all these limitations Switched Mode Power Supplies (SMPS) are needed.

The Switch Mode Regulators (SMPS) are used in modern digital equipment, telephone ex-change, PCs, robotics, etc. to overcome the shortcomings of linear voltage regulators. These systems require

- Very compact supplies
- Light weight supplies
- Highly energy efficient supplies

5.3. Basic Block Diagram of a Switched Mode Power Supply

Figure 3.17 shows a very simple arrangement of a switch mode power supply (SMPS).

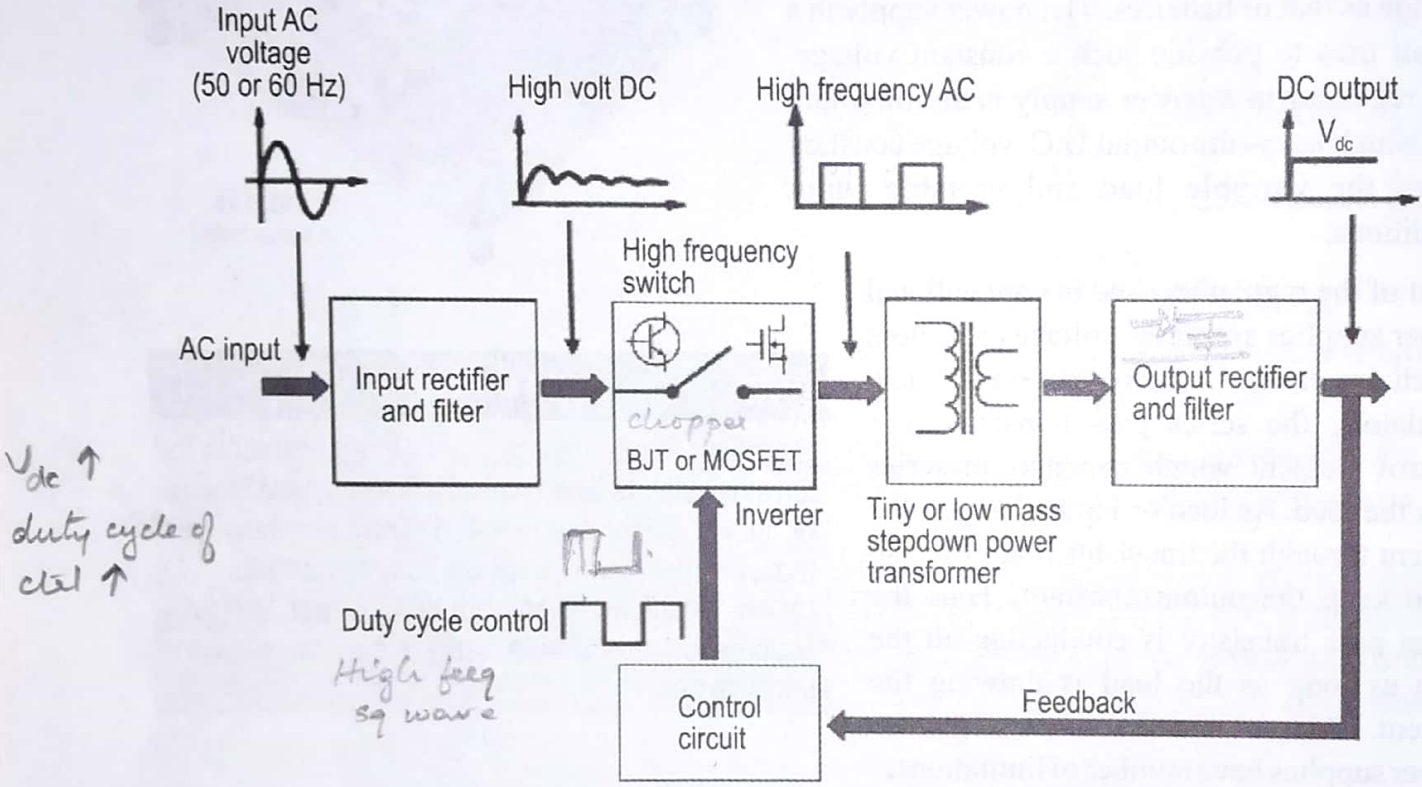


FIG. 3.17
Block diagram of a basic switched mode power supply

In this system the 50Hz input (AC mains) voltage is rectified and filtered. Then this filtered dc voltage is chopped (switched) at a very high frequency by a switch. Fast switching semiconductor devices such as MOSFET or IGBT or BJT are used as high frequency switches. The chopped (switched) voltage is applied to the primary of a transformer and then stepped down to the required level through the secondary winding of transformer. The output of the transformer is again rectified and filtered to get the required dc voltage. The output voltage is sensed by a control circuit that supplies a correction signal to the driver circuit to vary the ON/OFF time of the switch and compensate for any change at the output.

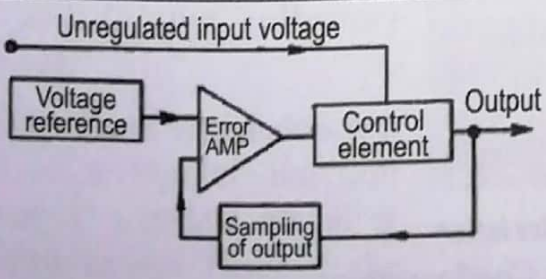
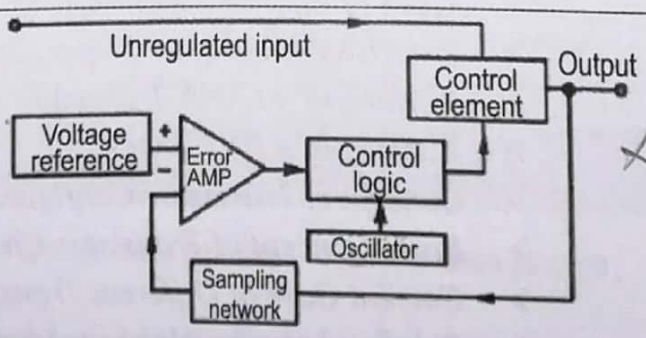
The switching pulses have fixed frequency (20 to 200 kHz) and variable duty cycle (Duty cycle of a square wave is the ratio of time during which the output voltage is high to the total time period). Thus a voltage pulse train of suitable magnitude and duty cycle appears at the transformer secondary. This voltage pulse train is rectified and then smoothed by the output filter, which is

either a capacitor /inductor arrangement. Regulation of the output is done by the control/feedback circuit.

Output voltage is proportional to the duty cycle. If the output voltage decreases, feedback circuit raises the duty cycle. Then the switching device remains ON for more amount of time and hence output voltage increases. Similarly if the output voltage increases feedback circuit reduces duty cycle. This makes the switching device OFF for more time and hence output voltage decreases.

The power-switching device in switch mode power supply is always operated in a switched mode. In other words, it is operated either in the cut-off or in the saturation region and hence, it is more efficient than the linear supply. The transformer size more or less determines the overall size of the unit and is drastically reduced due to energy conversion at high frequency. If the input of the SMPS is dc source like a battery, solar cell, etc., then the input rectifier is not at all needed and the power supply becomes a dc to dc switching power supply (dc to dc converter).

5.4. Comparison between the Linear Power Supply and Switched Mode Power Supply

Sl. No.	Linear Power Supply	Switched Mode Power Supply
1.	Series pass transistor used in the linear regulator acts in the active region.	Series pass transistor used in SMPS acts in either cut off or saturation region.
2.	Series pass transistor does not act as switch.	Series pass transistor act as switch.
3.	Step down transformer is bulky and expensive.	Small or tiny mass power transformer is used.
4.	Weight is high.	Light in weight.
5.	No switching loss	High switching loss
6.	Response to load variations is fast	Response to load variations is slow
7.	I/O isolation not possible	I/O isolation possible
8.	Efficiency is low	Efficiency is high
9.	Simple to design	Complex to design
10.	Less ripple	More ripple
11.	 Basic working principle	 Basic working principle **[KTU JAN 2016]**