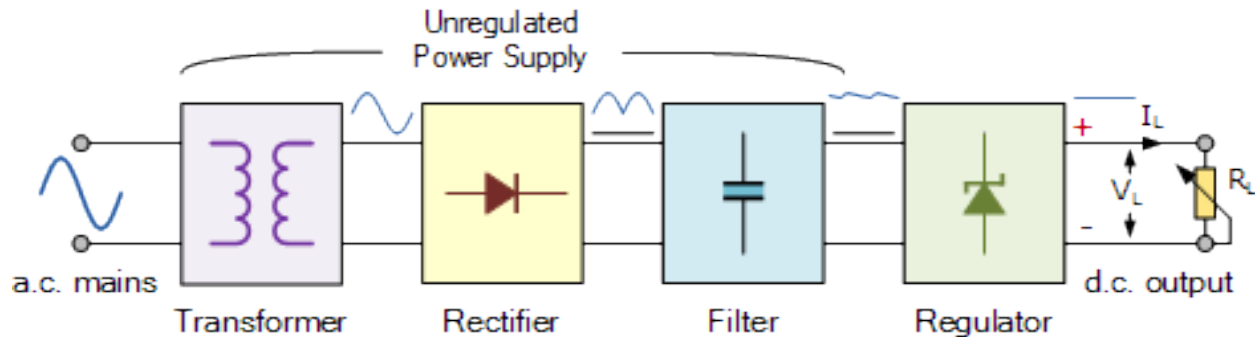


Switch Mode Power Supply (SMPS)

Typical DC Power Supply



These typical power supply designs contain a large mains transformer (which also provides isolation between the input and output) and a series regulator circuit. The regulator circuit could consist of a single zener diode or a three-terminal linear series regulator to produce the required output voltage. The advantage of a linear regulator is that the power supply circuit only needs an input capacitor, output capacitor and some feedback resistors to set the output voltage.

Linear voltage regulators produce a regulated DC output by placing a continuously conducting transistor in series between the input and the output operating it in its linear region (hence the name) of its current-voltage (i-v) characteristics.

What is switch mode power supply?

A switch mode power supply is a power converter that utilizes switching devices such as MOSFETs that continuously turn on and off at high frequency; and energy storage devices such as the capacitors and inductors to supply power during the non-conduction state of the switching device.

The supplies have higher efficiencies of up to 90%, are small in size and widely used in computers and other sensitive electronic equipment.

The basic switch mode power supplies (SMPS) are categorized based on supply input and output voltage. The main four groups are:

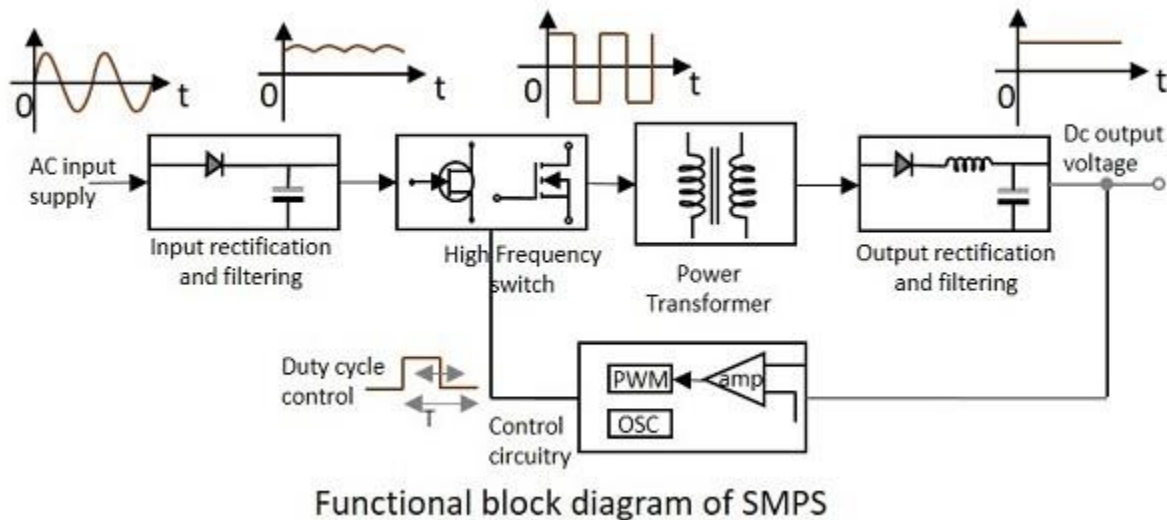
- AC to DC – Off-line DC power supply
- DC to DC – Converter
- DC to AC – Inverter
- AC to AC – Cycloconverter or frequency changer

A basic isolated AC to DC switched-mode power supply consists of:

- Input rectifier and filter

- Inverter consisting of switching devices such as MOSFETs
- Transformer
- Output rectifier and filter
- Feedback and control circuit

The architecture of a typical switched-mode power supply



Rectification

The filtered AC input voltage passes through a bridge rectifier arrangement to create a pulsating DC voltage. A smoothing 'bulk' capacitor removes line ripple from the rectified voltage and provides a voltage hold-up function.

Switching function

Comprising the switching power semiconductors, the transformer, and the driver IC, together they create a high alternating voltage for the transformer. The turns-ratio of the transformer permits a step-up or step-down of voltage, as well as serving to provide an isolation barrier.

Switching frequencies can vary from 25kHz up to 500 kHz or more. The frequency and/or the duty cycle of the PWM signal can vary depending on the load imposed on the output.

During the design of the switching function, adherence to EMI best practice is essential to minimize the conducted and radiated EMI to meet regulatory standards.

DC output and line voltage regulation

The secondary output from the transformer passes through a rectifier to the load. Smoothing capacitors and filtering components also form part of this function. The output voltage also feeds

a comparator amplifier which compares the output against a reference voltage to provide tight voltage regulation.

An opto-isolator provides a galvanic safety barrier for feedback to the primary PWM drive circuit, adjusting the drive accordingly to correct any output voltage deviations.

Most switched-mode power supplies available today are highly efficient, from 85 % up to 95 % being the norm. Most waste heat generated by losses within the power supply is dissipated by conduction. However, depending on used technologies, particularly for high output power supplies delivering upwards of 150 watts, the need for forced-air cooling may be necessary.

Switch mode power supply advantages / disadvantages

The use of any technology is often a careful balance of several advantages and disadvantages. This is true for switch mode power supplies which offer some distinct advantages, but also have their drawbacks.

SMPS advantages

- **High efficiency:** The switching action means the series regulator element is either on or off and therefore little energy is dissipated as heat and very high efficiency levels can be achieved.
- **Compact:** As a result of the high efficiency and low levels of heat dissipation, the switch mode power supplies can be made more compact.
- **Costs:** one of the points that makes switch mode power supplies very attractive is the cost. The higher efficiency and the switching nature of the design means that the heat that needs to be reduced is lower than that of linear supplies and this reduces costs. Long with this, the switching nature of the supply means that many of the components are lower cost.
- **Flexible technology:** Switch mode power supply technology can be used to provide high efficiency voltage conversions in voltage step up or "Boost" applications or step down "Buck" applications.

SMPS Disadvantages

- **Noise:** The transient spikes that occur from the switching action on switch mode power supplies are one of the largest problems. The spikes can migrate into all areas of the circuits that the SMPSs power if the spikes are not properly filtered. Additionally the spikes or transients can cause electromagnetic or RF interference which can affect other nearby items of electronic equipment, particularly if they receive radio signals.
- **External components:** While it is possible to design a switch mode regulator using a single integrated circuit, external components are typically required. The most obvious is the reservoir capacitor, but filter components are also needed. In some designs the series switch element may be incorporated within the integrated circuit, but where any current is consumed, the series switch will be an external component. These components all require space, and add to the cost.

- ***Expert design required:*** It is often possible to put together a switch mode power supply that works. To ensure that it performs to the required specification can be more difficult. Ensuring the ripple and interference levels are maintained can be particularly tricky.
- ***Filtering:*** Careful consideration of the filtering for an SMPS because poor design can lead to high levels of noise and spikes on the output.

On balance, switch mode power supplies are ideal for a host of applications from computers to chargers, and laboratory equipment to many items of domestic electronic gadgetry. Cost, size and efficiency are key factors in ensuring that they are the mainstay technology of very many applications.