

Switched Mode Power Supplies

by Dr.Ing. Heinz Schmidt-Walter

Switched mode power supplies (SMPS) are used in nearly all electronic systems. Every television set and computer is powered by an SMPS as are many state-of-the-art industrial equipment. Battery powered equipment also uses SMPSs to provide a constant internal supply operating voltage independent of the state of charge of the battery. SMPSs are also used to achieve a higher supply voltage compared to the powering battery voltage. This is normally the requirement for tape recorders, CD players, note books mobile phones and cameras.

SMPS have remarkable advantages in compared to linear regulated power supplies. Theoretically SMPS work loss-free and in practice efficiencies of about 70% to 95% are achieved, this results in low temperature operation and consequently high reliability. The other major advantage is that SMPS operate at a high frequency which results in small low weight components. Compared to linear power supplies SMPS are therefore inherently more efficient, smaller, lighter and cheaper to manufacture.

In general all SMPS operate by the same principle whereby packets of energy are taken from an input voltage by an electronic switch (transistor) which switches at a high frequency. Switching frequencies are normally in the range of 20kHz to 300kHz, depending on the required performance. The conditions between turn-on and turn-off time of the switch determines the average energy flow. A low pass filter is placed at the output of all SMPSs to smooth the discontinuous energy flow. The high efficiency of SMPSs is a direct result of the theoretically loss free switching component and low pass filter.

There are a number of different types of switch SMPSs which are described below.

SMPSs can be configured as **secondary** or as **primary switched power supplies**. Secondary switched power supplies have no isolation between input and output. They are used in applications where isolation in respect to the mains already exists or where isolation is not required, for example in battery supplied devices. Primary switched power supplies offer an isolation between input and output, their switching transistors operate on the primary side of a transformer. The energy is be transferred to the secondary side at a high frequency via a high frequency transformer. The transformer can be relatively small, because of its high operating frequency.

There are three basic SMPS configurations which are: **flyback**, **forward** and **resonant-converters**. Flyback converters transfer their energy during the off-time of the transistors. Forward converters transfer their energy during the on-time of the transistors. Resonant converters use a resonant circuit for switching the transistors when they are at the zero current or zero voltage point, this reduces the stress on the switching transistors.

A **power factor pre-regulator** is also a SMPS and is used to ensure that the mains current is substantially sinusoidal.