SWITCHED-MODE POWER SUPPLY

A switched-mode power supply, or SMPS, is an electronic power supply unit (PSU) that incorporates a switching regulator-an internal control circuit that switches the load current rapidly on and off in order to stabilize the output voltage.

Classification

SMPS can be classified into four types according to the input and output waveforms, as follows.

- AC in, DC out: rectifier, off-line converter
- DC in, DC out: voltage converter, or current converter, or DC to DC converter
- AC in, AC out: frequency changer, cycloconverter
- DC in, AC out: inverter

AC and DC are abbreviations for alternating current and direct current.

Uses

Switching regulators are used as replacements for the linear regulators when higher efficiency, smaller size or lighter weights are required.

Switched-mode PSUs in domestic products such as personal computers often have universal inputs, meaning that they can accept power from most mains supplies throughout the world, with frequencies from 50 Hz to 60 Hz and voltages from 100 V to 240 V (although a manual voltage "range" switch may be required). They are, however, more complicated and more expensive. Their switching currents can cause noise problems if not carefully suppressed, and simple designs can have a poor power factor.

Test

In the case of TV sets, for example, one can test the excellent regulation of the power supply by using a variac. For example, in some models made by Philips, the power supply starts when the voltage reaches around 90 volts. From then, one can change the voltage with the variac, and go as low as 40 volts and as high as 260, and the image will show absolutely no alterations.

SMPS compared with linear PSUs

There are two main types of regulated power supplies available: SMPS and Linear. The reasons for choosing one type or the other can be summarized as follows.

- **Size and weight.** Linear power supplies use a transformer operating at the mains frequency of 50/60 Hz.

This component is larger and heavier by several times than the corresponding smaller transformer in an SMPS, which runs at a higher frequency (always above the highest audible frequency, around 50 kHz to 200 kHz)

- **Efficiency.** Linear power supplies regulate their output by using a higher voltage in the initial stages and then expending some of it as heat to improve the power quality. This power loss is a necessary to the circuit, and can be reduced but never eliminated by improving the design, even in theory. SMPSs draw current at full voltage based on a variable duty cycle, and can increase or decrease their power consumption to regulate the load as required. Consequently, a well designed SMPS will be more efficient.
- **Heat output or power dissipation.** An inefficient supply must generate more heat to power the same electrical load. Therefore, a SMPS will produce less heat.
- **Complexity.** Linear PSUs are can be designed and assembled by beginners with a relatively small part count. By contrast, SMPSs are complicated and difficult to design well; they frequently require the use of custom-made transformers and inductors. SMPS behavior may be significantly affected by the layout of components on the circuit board.

- **Radio frequency interference.** The currents in a SMPS are switched at a high frequency. This is due to its internal Armstrong oscillator operating at a high frequency. This high-frequency oscillator can generate undesirable electromagnetic interference. RF shielding is needed to prevent disruptive interference. Linear PSUs, however, generally do not produce interference.
- **Electronic noise at the output terminals.** Inexpensive linear PSUs with poor regulation may experience a small AC voltage "riding on" the DC output at twice mains frequency (100/120 Hz). These "ripples" are usually on the order of millivolts, and can be suppressed with larger filter capacitors or better voltage regulators. This small AC voltage can cause problems in some circuits. Quality linear PSUs will suppress ripples much better. SMPSs do not have "ripples" are more electrically noisy than a good linear PSU.
- **Audio noise.** Linear PSUs typically give off a faint, low frequency hum at mains frequency, but this is seldom audible. (The transformer is responsible.) SMPSs, with their smaller transformers, are not usually audible (unless they have a fan, in the case of most computer SMPSs). A malfunctioning SMPSs may generate high-pitched sounds, since they do in fact generate acoustic noise at the oscillator frequency.

- **Power factor.** The current drawn by a SMPS is non-sinusoidal and out-of-phase with the supply voltage waveform. The most common SMPS designs have a mediocre power factor of about 0.6, and their use in personal computers and compact fluorescent lamps presents a growing problem for power distribution. Power factor correction (PFC) circuits can reduce this problem, and are required in some countries (European in particular) by regulation. Power factor correction is not yet widely required or used in North America. Linear PSUs also do not have unity power factors, but are not as problematic as SMPSs.

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