Power Supplies: Switchmode vs. Linear

A power supply is designated either a "switchmode" (or "switcher") or a "linear" based on the method of voltage regulation used. Linear regulation technology has been in use for decades and is based on dissipative regulation. Essentially, unwanted voltage is thrown away by the regulation device (generally a transistor) as heat. This method is relatively crude and can best be compared to using a rheostat to adjust a voltage level

Switchmode power supplies use a switching device as the regulator. Regulation is achieved by varying the duty cycle or repetition rate of the switch. This approach is attractive because a perfect switch is either fully on or fully off. Thus it does not dissipate heat due to resistance between the fully on and fully off states. This means the overall efficiency is much higher than the dissipative linear regulation method. Even without the existence of a perfect electronic switch, switchmode regulation is considerably more efficient than linear regulation. Generally more costly, switchmode power supplies are expected to justify their cost based on performance, reliability, and size when compared with similarly rated linear power supplies. The main advantage of switchmode power supplies is the higher efficiency and thus lower heat dissipation. Coupled with the smaller size per watt, switchmode supplies are ideal for applications where panel density is high. For example, when a power supply, PLC, relays, terminals, and signal conditioners have to be housed in a compact enclosure, there may not be sufficient space available for a linear supply and, even if there was, the heat dissipation would likely cause problems.

Some analog signal conditioner users feel that linear supplies are more desirable because of the lower output ripple. The concern is that the higher ripple of a switchmode supply will interfere with the analog signals (the ripple may appear on the analog signal and make accurate measurements difficult or impossible). In reality, this should not be a concern with isolated analog signal conditioners where an internal DC/DC converter produces two isolated supplies at voltages lower than the external supply voltage.

In fact, most analog signal conditioners contain filtering as a minimum, and commonly DC/DC converters, in the supply circuitry, which eliminates the input, ripple. Since switchmode power supply ripple is typically at a frequency between 50khz and 200khz it is easily eliminated by a small value capacitor. It requires much larger capacitors to eliminate a 50Hz or 60Hz ripple. In short, switchmode power supplies are suitable for powering analog circuitry.

Feature	Switchmode	Linear
Efficiency	65% to 85% typical	25% to 50% typical
Temperature Rise	20ºC to 40ºC typical	50ºC to 100ºC typical
Ripple	20-50 mV peak-to-peak typical	5 mV peak-to-peak can be easily achieved
Overall Regulation	0.3% typical	0.1% typical
Weight	30W per pound is common	10 to 15 W per pound is common
Volume	1-2 cubic inch per watt typical	2-3 cubic inch per watt typical
Isolation from line transients	Very good, often as high as 60db	Poor
RFI/EMI	Shielding and suppression required	Less likely to be a concern
Magnetic	High frequency operation eliminates need for bulky 50/60Hz magnetics	Requires bulky magnetics, especially for higher ratings
Reliability	Enhanced by cooler operation	Higher operating temperatures may degrade reliability
Cost	Although generally more expensive the difference narrows for higher ratings	Generally less expensive for lower ratings