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INSPIRING INNOVATIONS

Switch-mode versus linear power supplies

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Introduction

While linear power supplies (LPS) and switch-mode power supplies (SMPS) offer a similar function; the automation industry has widely adopted SMPS over the past few decades. SMPS can help realize benefits such as better efficiency, smaller footprint, better power regulation, and generally more competitive lifetime cost.

An overview of power supply technologies

When discussing power conversion in a control cabinet, there are two predominant power supply technologies: linear power supplies (LPS) and switch-mode power supplies (SMPS). Both types of power supplies are based on the same fundamental technology, but vary on some of their internal components. These differences alter how they perform under given circumstances.

For a very basic level comparison, the differences can be imagined as two cars from different eras. While the older one, LPS, offers a simple design and low component count, the other, SMPS, offers newer technology, better efficiency, feature sets, and a more compact design, all at the cost of having slightly more complex internals.

Looking at the components

For LPS, the power conversion process starts with input capacitors and the high-input voltage being stepped down to a lower, more manageable voltage. After the power is stepped down, it is converted to DC via rectification, and then is sent to the regulation circuit. The regulation circuit typically uses components such as transistors, resistors, and operational amplifiers to ensure that a certain voltage is met if the input varies too much. If an LPS allows the voltage level to be set, it may use variable resistors as well to help with these changes. The power then passes to a capacitor again to help with any minor issues in ripple or filtration.

An SMPS has similar components to an LPS, where a capacitor helps with input filtration and a transformer for voltage step-down. Additional over-current, short-circuit, or overvoltage components may be added to protect the power supply. After the rectification to a DC voltage, however, the SMPS begins to vary more from an LPS. The additions to this regulation circuit typically consist of an oscillator and an RLC circuit containing a diode, capacitor, and inductor.

While these additions may sound very complex, the additional components still regulate power, but just take a different approach. With the oscillator, this helps with the need of having a larger transformer in the power supply and chops the wave up before sending the power to a regulation/rectification circuit. Additionally, adding these components helps with minor load buffering in a power blip and helps avoid poor power factor. On the output of an SMPS, there is again a capacitor to help with the filtration of the power.

Though SMPSs have additional components, they tend to be physically smaller and have higher electrical efficiency. An SMPS uses printed circuit boards (PCBs) in combination with lighter, smaller components, relative to an LPS, which allows an SMPS to have a generally smaller enclosure and thus, a smaller profile.

Part of the reason why an SMPS can use these smaller components is because it accepts a narrow band of voltage on the input. As a result, the components can be sized for a narrower range of operation. If the input strays outside of this range, the SMPS will switch off to protect the components and will not turn back on until the voltage is back within the appropriate range.

Compared to the operational components of an LPS, this also allows for greater efficiency and lower heat dissipation. With the generally larger components, particularly transformers, of an LPS, they do not operate as efficiently and will generate

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more heat as a result. In some applications, the larger size of components and the simpler design of an LPS may be helpful when maintaining the internal components of the power supply; however, this is uncommon in the industrial automation industry.

The effects of abnormal inputs

These two different types of power supplies also react differently to abnormal inputs, which may affect the output of the power supply and, therefore, the downstream components. In situations where the input may not be as stable, the technology in an LPS may not react as quickly as the components in an SMPS. This slower reaction time can lead to higher fluctuations at the output voltage, as the power supply responds to the change in voltage or other alterations of the input. However, this quicker response to voltage fluctuations comes at the cost of the output of an SMPS being more prone to electromagnetic noise due to the oscillator circuit. For some sensitive applications, it may be critical to minimize this noise, so an LPS may be a better fit in these situations.

Many modern applications use an SMPS as opposed to an LPS for their power conversion needs. Modern computers, chips, and complex equipment need a very specific input to function properly and to minimize unexpected downtime. These same pieces of equipment also tend to be very sensitive to temperature changes because they produce high amounts of heat. Combining the needs of this technology with the needs of many customers to minimize the physical space of a control cabinet, the correct choice for power conversion quickly becomes an SMPS, due to generally better price points, better efficiency, smaller footprint, and better power regulation.

In addition to the basic needs, the system may need complex additional features. An SMPS offers easier integration of complex systems, such as power supply monitoring, or simpler additions, such as system protection, due to the easier design modification of a printed circuit board.

Conclusion

There are many different technologies used for power conversion, but the most common are linear power supplies and switch-mode power supplies. Both technologies offer different feature sets, but the industrial automation market tends to predominantly require the SMPS feature set.

	Conversion	Protection	Response time	Heat dissipation	Efficiency	Weight	Footprint
LPS	Simple	Simple	Slower	Higher	Lower	Higher	Higher
SMPS	Complex	Advanced	Quicker	Lower	Higher	Lower	Lower

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