White Paper

Future visions of the power supply market

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The primary trends present in almost all power supply market segments are: increased efficiency, higher power density and cost reduction. Andrew Skinner, Chief Technology Officer at TDK-Lambda EMEA, looks at how these trends are shaping the future for power supply development.

Thanks to governmental legislation and widespread media pressure, it's fair to say that we are all mindful of how the environment is being affected by the products we use; it's influencing consumer choice and every buying decision we make, whether it's the fuel efficiency of a car or the energy rating of a washing machine.

Similarly power supply efficiency is a key selection criterion and this is supported by legislation such as the Ecodesign Directive 2009/125/EC. Although the scope of the Ecodesign Directive is currently targeted at higher volume consumer related products, many manufacturers of professional electronic products are voluntarily following the same guidelines, which also mandate low power standby operation – similar to the tighter standby power consumption restrictions put on TV and Freeview boxes a few years ago.

Independent of the environmental angle, OEMs are seeking to increase the performance of their end equipment and are consequently looking for power supplies that dissipate less heat and take up less space.

There are several methods to improving efficiency; these include developing new topologies; improved power devices, control ICs and magnetic component designs entering the market; the availability of new materials; and the application of digital control loops. Depending on the type of power supply and its end use, some or all of these methods will be used.

To illustrate this, a low power (150W or less) power supply aimed at high volume, cost sensitive applications would still use a low-cost conventional flyback circuit with one of the newer control ICs that helps simplify compliance to the minimum efficiency standards of the Ecodesign legislation. In contrast, a high power

(>1000W), high density power supply for redundant data centre applications meeting 80 PLUS® efficiency requirements of up to 96% or more, will use most of the methods noted above.

For lower power applications, it's all about high power density with more and more power being claimed on industry standard pc board sizes, such as 2x4-in and 3x5-in; for cost reasons, a flyback circuit is commonly used but this has its limitations in terms of achieving efficiency improvements.

New chips are now available on the market that enable efficiencies of up to 92%, although one must appreciate that at a 92% efficiency level a 200W power supply will still dissipate 27% more excess power than a previous generation 100W product at 88% efficiency. Indeed, many components will be larger for the 200W power supply so, if both are designed to be the same size, then the parts are packed much more tightly and significant thermal challenges arise.

Reducing the value and size of electrolytic output capacitors is a common way to save space and cost. However, the risk is that since flyback circuits generate high ripple current the life of the capacitor can be shortened significantly unless close attention is paid to the design. Customers are becoming increasingly aware of the difference between MTBF and design life, and are now asking power supply manufacturers how a power supply will perform over the expected life of the host equipment.

For medium and high power applications, the use of a digital control loop will play a major part in continued efficiency improvement. By simplifying interleaved power factor correction and enabling real-time efficiency improvement through dynamic operating algorithms, these power supplies can respond continuously to line and load conditions to ensure maximum efficiency at all times; this is commonly referred to as Intelligent Embedded Power.

Certain complex topologies that were previously difficult or almost impossible to control using analogue techniques become viable with a digital approach to deliver additional efficiency gains. DSPs are now coming onto the market at attractive price points with sufficient functionality for power supply use - as a result, digitally controlled power conversion will become increasingly common. The added advantage of an on board DSP or microcontroller is that it is easier to implement a higher level of external monitoring and control whenever the end application demands it.

A growing proportion of the market is requiring additional system monitoring and control features beyond those required of a basic power supply – especially for use in large complex installations such as data centres, as well as remote and Smart Grid related installations. For mainstream applications in the foreseeable future, digital power conversion will be a means to create power supplies with higher density and efficiency – but those offering self-monitoring and diagnostics will be attractive to customers whose products are deployed in mission critical applications.

The impact of digital control and enhanced efficiency means that convection cooled medium to high power products are becoming more viable from a cost and size perspective. Whilst a convection cooled power supply will never be the same size as a fan cooled product (in the foreseeable future), many customer end products can accommodate a reasonably sized power supply and the attractions of a product that does not have fan noise or the risk of pollution ingress are substantial.

New power devices using Silicon Carbide (SiC) and Gallium Nitride (GaN) will be increasingly common in AC-DC power supplies. SiC diodes are already in common usage in high efficiency products and this will expand as component prices fall further – driven by increasing volumes and device manufacturers moving to larger wafer sizes. GaN wafer costs are expected to be significantly lower than SiC.

The first SiC FETs we see on the market are 1200V devices targeted mainly at inverters and motor applications for renewable energy. At the moment, the use of a 1200V SiC FET is likely to be too expensive for most commercial AC-DC power supply applications, even though the efficiency improvement gains can be attractive. For conventional switched mode power supplies, 600-800V devices are sufficient, and it is expected that devices targeting industrial power supplies in sub 1000V class will first come from GaN.

Although GaN devices suitable for low voltage DC-DC converters are now available, it is likely to be 2014 or 2015 before devices suitable for the primary-side of AC-DC power supplies become commercially available and, in the early years, adoption is likely to be limited to higher end products targeting maximum efficiency.

Magnetics will continue to see improvement – new ferrite materials will help to reduce core sizes and reduce losses further and squeezing out more efficiency gains means that magnetics designs will be more complex in some products to minimise core and winding losses albeit at a higher cost. Cost-effective use of ceramics will also become more common, particularly where adequate thermal design is a major constraint

The physical parameters of the power supply will continue to dominate most applications for the foreseeable future with the key driver being high efficiency, which in turn allows compactness and lower heat dissipation. The most successful companies are likely to be those that are actively developing advanced technologies, especially digital power conversion, often in collaboration with Universities.

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About TDK Corporation

TDK Corporation is a leading electronics company based in Tokyo, Japan. It was established in 1935 to commercialize ferrite, a key material in electronic and magnetic products. TDK's portfolio includes electronic components, modules and systems marketed under the product brands TDK and EPCOS, power supplies, magnetic application products as well as energy devices, flash memory application devices, and others. TDK focuses on demanding markets in the areas of information and communication technology and consumer, automotive and industrial electronics. The company has a network of design and manufacturing locations and sales offices in Asia, Europe, and in North and South America. In fiscal 2013, TDK posted total sales of USD 9.1 billion and employed about 80,000 people worldwide.

About TDK-Lambda Corporation

TDK-Lambda Corporation, a group company of TDK Corporation, is a leading global power supply company providing highly reliable power supplies for industrial equipment worldwide. TDK-Lambda Corporation meets the various needs of customers with our entire range of activities, from research and development through to manufacturing, sales, and service with bases in five key areas, covering Japan, Europe, America, China, and Asia. For more details, please pay a visit to http://www.nl.tdk-lambda.com

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