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THE GROWING IMPORTANCE OF POWER-SUPPLY EFFICIENCIES

Many factors are driving designers to improve power-supply efficiency, from the green movement to simple dollars and cents.

ECONOMIC AND ENVIRONMENTAL factors are playing an ever-increasing part in the drive to improve efficiencies and reduce pollution from electronic equipment. Simply put, power-supply efficiency is measured by comparing the ac power going into the power supply to the dc power coming out of the supply.

For example, imagine a power supply that uses 100 W of ac power to provide 90 W of dc output power. The supply's efficiency would be calculated by dividing 90 W by 100 W, which equals 90% efficiency. When comparing a 75% to a 90% efficient power supply, the savings in electricity usage and wasted energy, in the form of heat, is quite significant.

The most recent advance in power supplies to improve efficiencies implements digital-control technologies. Many power-supply manufacturers have introduced new digitally controlled power supplies for various applications. With microcontroller-based digital control, power supplies can be smaller and much more efficient, consistent with the trend toward greener and earth-friendlier products.

In addition, these digitally controlled power supplies can be built to medical, industrial, and commercial design specs where space is limited, providing a smaller and cooler operating end product. Many of these new designs include integrated magnetics in which multiple transformer and inductor windings are wound on the same magnetic core for efficiencies of 90% or better. The digital-control portion of these power supplies uses small microcontrollers that replace bulky and less efficient analog circuits.

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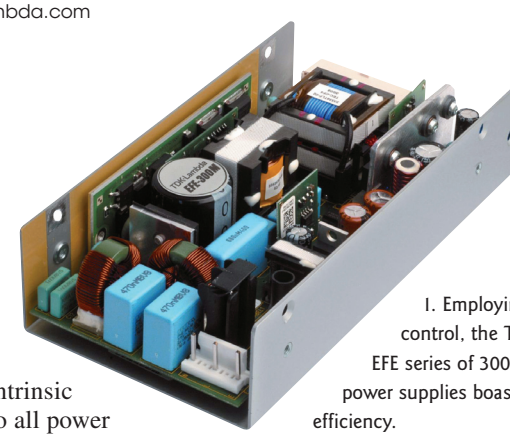
Digital control is needed to regulate the dc outputs and handle housekeeping routines that are intrinsic to all power supplies. In a typical supply, digital control reduces parts count by 25%, size by 45%, and weight by 56%. Typical power densities of up to 16.6 W/in.^{3} are possible at peak load conditions and 12.5 W/in.^{3} under continuous loading.



1. Employing digital control, the TDK-Lambda EFE series of 300- to 400-W power supplies boasts 90% efficiency.

Digital power supplies include active power factor correction, which ensures EN61000-3-2 compliance and operation from a wide input range from 90 to 264 V ac for global applications. Earth leakage current can be less than 300 µA at up to 264-V ac input, complying with most medical safety requirements.

Other electromagnetic compliance (EMC) and efficiency-improving design features include the use of low-loss, silicon-carbide Schottky diodes that ensure conformance with EN55022 Class B EMC. The new digital power supplies can be certified per the IEC/EN/UL 60601-1 standards for medical equipment and to IEC/EN/UL 60950-1 for general purpose (ITE) and industrial applications as well as IEC/EN/UL 61010-1 for laboratory and process control applications.

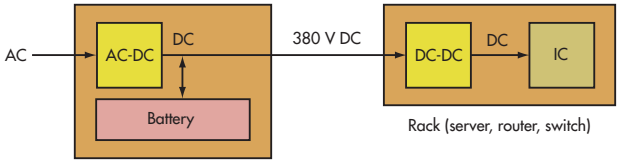
TDK-Lambda's R&D is very focused on developing higher-efficiency power supplies, driven by what it sees as a future market and by our initiatives on environmental consciousness. As just one example, our EFE series power supplies achieve 90% efficiency via digital control *(Fig. 1)*.

STANDARDS & REQUIREMENTS

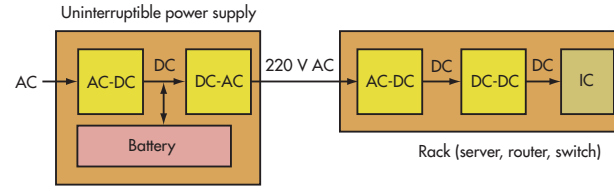
With Energy Star's decision to sunset programs for external power supplies as well as for applications using them, is power-supply efficiency no longer a concern? In some cost-driven power-supply applications, marketing is often challenged during the product development stage to provide the right balance between achieving high efficiency, good performance, and the lowest possible cost.

Today, the biggest requestors of high-efficiency power supplies are the manufacturers of large data centers, primarily because of the huge amount of electricity they consume. In 2007, the Environmental Protection Agency (EPA) estimated that the national annual "electricity cost" for servers and data centers could be a staggering $7.4 billion in 2011.

Data-center producers have told power-supply manufacturers that they are willing to pay a little more for higher-efficiency products because the operators are aware that the return on investment (ROI) is quite short. Many manufacturers are evaluating dc power systems to improve the efficiencies of their power usage for data centers.



2. Using fewer conversion stages, a more efficient data-center power topology with a dc bus system and battery backup operates more efficiently, delivering 380 V dc directly to servers.



3. Somewhat efficient, a conventional data center with an ac power system employs more conversion stages.

The dc power-distribution systems for data centers *(Fig. 2)* use up to 15% less power than conventional systems by removing one or more dc-ac or ac-dc conversion stages and by supplying 380 V dc directly to the servers rather than 220 V ac *(Fig. 3)*.

In consumer electronics, where the power draw is quite small, particularly in standby, there are hundreds of millions of devices deployed, such as laptops, cordless phones, digital cameras, wall chargers, and HDTVs, and the combined energy usage is considerable. The main drivers for efficiency improvement are the state and utility companies because of the substantial cost and time to build new power-generating stations.

Due to all the publicity given to the EPA's Energy Star programs and product ratings, average consumers have recently become more aware of their power usage. In many cases, if two products have similar prices, the typical consumer will usually pick the product with the highest Energy Star efficiency rating—the one with labels showing the expected electricity cost savings during a year of operation.

CURRENT STATE OF AFFAIRS

As an industrial power-supply manufacturer, TDK-Lambda is being asked by some customers for higher-efficiency power supplies. These customers are selling to end users like hospitals or large retailers that are going green. Sadly, the power supply's efficiency is not that important in some cases where the purchaser is driven by price only or isn't being mandated to reduce energy consumption.

Another area where high efficiency is important is in ac-dc chargers and dc-dc converters used in modern hybrid electric vehicles and fully electric cars. Efficiency standards for electric vehicles are something the consumer understands, primarily due to the fact that the costs for running conventional vehicles are significant and hybrids and/or full electrics offer a way to substantial savings in operating costs. ED