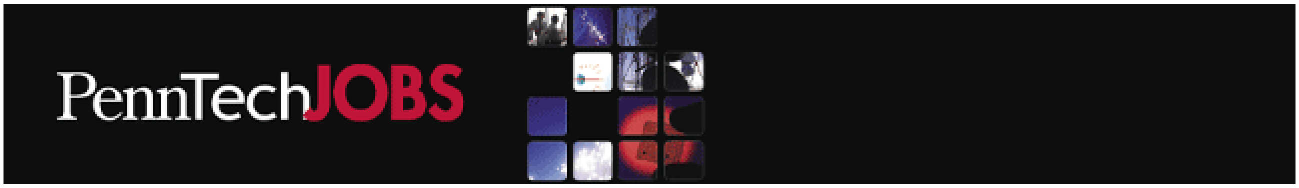


Portable Design

Power supply designers grapple with diverse efficiency standards

Standby power has become a hot topic, and every country seems to mandate a different solution

Richard Fassler - Power Integrations

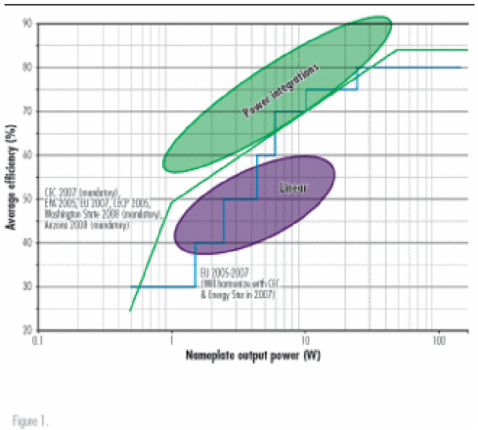
Low-voltage, transformer-based wall-warts-those little external power supplies used to power mobile phones, digital cameras, printers, scanners, and PDAs-have quickly become a pervasive part of our lives. The Environmental Protection Agency (EPA) estimates more than 3 billion are in use in the United States alone and about 10 billion worldwide. Individually these little black boxes don't consume large amounts of power. But since many are based on low-cost linear transformers, their efficiency generally runs less than 50%. Accordingly, a 3-W adapter, even when it's in no-load mode, is wasting half its rated power 365 days a year.

Multiplied by the billions, these small devices represent a huge draw on the electric grid. And with each watt of energy costing approximately $1.00 to $1.50 per year, the potential savings are tremendous. The State of California estimates that if the 20 million external power supplies sold each year were modified to meet proposed Tier 1 efficiency standards, the statewide energy savings would amount to 96 million kWh. Nationwide, the Lawrence Livermore National Laboratory estimates that standby power waste costs U.S. households more than $5 billion annually.

Given those numbers, it's hardly

surprising that over the last decade government agencies and industry organizations around the world have sought to establish new standards to improve energy efficiency in these ubiquitous devices. But that worldwide effort has become a nightmare for designers building products for sale in multinational markets. The slight differences from standard to standard make it increasingly difficult to cost effectively build a portable product for sale in Europe, Japan, the United States, and Asia. In Europe, designers must deal with at least seven different standards concerning power efficiency while those selling into the United States must consider four. New standards in Japan, Australia, and Korea further complicate the design process, and the process of crafting a power efficiency standard for the largest potential market, China, has only just begun.

Too many standards



Click here to enlarge image

Active mode efficiency standard. (Avg. efficiency = Avg. of measurements at 25%, 50%, 75%, and 100% load)

The effort to implement standards to improve the efficiency of external power supplies began to build in the late 1990s in Europe. The European Commission launched an initiative in 1999 called "Policy Instruments to Reduce Standby Losses of Consumer Electronic Equipment." That initiative led to a voluntary program or "code of conduct" for manufacturers of external power supplies and digital TV services. The code of conduct for external power supplies defined different targets by capacity. Power supplies rated less than 15 W were expected to meet a goal of 0.3 W in no-load mode. Supplies rated between 15 and 150 W were given a higher maximum target of 1 W. By January 1, 2007, the standard calls for all power supplies rated less than 60 W to have the same no-load power consumption of 0.3 W, with power supplies between 60 and 150 W to have a no-load consumption less than 0.5 W.

Today, designers building products for the European market must consider a wide range of standards. Blue Angel, a standard driven by the German government and nongovernmental agencies, defines a 2-W maximum for standby power in laptops and desktop computers. Nordic Swan, a voluntary eco-labeling system for the Nordic countries, has been in place since the late 1980s. The European Commission and national energy and environmental agencies are also pushing EU Energy+, an initiative primarily targeted at major appliances and white goods. At the same time, the European Union's Eco-Labeling Board is promoting the EU Eco label for a variety of electronic products. Anyone building products for European consumption must also consider the International ENERGY STAR program and the Group for Energy Efficient Appliances.

In the U.S., product designers face at least four different standards. In July 2001, President

Bush signed U.S. Executive Order 13221, which mandates that all federal agencies purchase products with low-standby energy consumption. The Federal Energy Management Program (FEMP) has set maximum standby power levels for 16 categories of products. Under the 80 Plus program, energy utilities and energy efficiency organizations are offering financial incentives to PC and power supply manufacturers that build products with a minimum efficiency of 80% when tested at each of three load conditions: 20%, 50%, and 100% of rated power output. This voluntary program has received support from FEMP.

The most widely recognized standard in the United States is the ENERGY STAR program sponsored by the Department of Energy and the Environmental Protection Agency. As of January 1, 2005, the program required that external power supplies less than 10 W must consume no more than 0.5 W in no-load mode to receive ENERGY STAR certification. Larger external power supplies between 10 and 250 W can run up to 0.75 W. Unlike most other standards, however, ENERGY STAR also set specifications for external power supplies in active mode when they were powering a product. The minimum average efficiency for power supplies with a nameplate output power of 1 W or less had to be greater or equal to 0.49 times the nameplate output power. Minimum average efficiency for supplies between 1 and 49 W was set as greater or equal to (0.09 × Natural Logarithm of the Nameplate Output) + 0.49. Larger supplies had to offer a minimum average efficiency of 84%. One important distinction between this standard and others was the use of an average value across different percentages of rated output. Average active mode efficiency for any power supply was calculated by taking measurements at 25%, 50%, 75%, and 100% of rated current output.

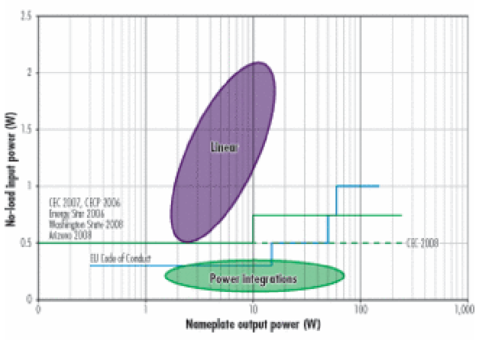


Figure 2.

Click here to enlarge image

No-load standard.

The most demanding standard in the United States, however, is the California Energy Commission's Efficiency Requirements for External Power Supplies and Consumer Audio and Video Equipment Sold in California, or CEC-400-2006-002-REV1. Like the ENERGY STAR program, the CEC-400 covers not only no-load requirements but specifications for active mode as well. The California standard basically adopted the same requirements as the ENERGY STAR program to determine compliance. Unlike the ENERGY STAR program, which is voluntary, the CEC-400 requirements are mandatory. Adopted in 2004, the standard's requirements were originally scheduled to go into effect on July 1, 2006. After meetings with manufacturers, however, the CEC agreed to push back that date to January 1, 2007. A number of states have followed California's lead and are adopting similar requirements.

In the meantime, Japan has taken a different approach to power efficiency. In response to its Law Concerning the Rational Use of Energy, implemented by the Japanese Ministry of Economic Trade and Industry (METI), the Japanese government has instituted a program called Top Runner. Instead of setting specific power limits, the program identifies the best product in each market in terms of energy efficiency. The power specifications for that product then become the target goal for that market. All similar products must meet those specifications by a predetermined date. This "best practices" approach has the benefit of encouraging continuous improvement. Once a date is reached, the program resets the specifications to a newer product and thereby continually drives energy efficiency to higher levels.

Elsewhere in Asia, most major countries are implementing their own standards. In 1998, the China Energy Conservation Project (CECP) began implementing a voluntary energy conservation program that has expanded to more than 90 product categories. The specification for external power supplies is still under development but is expected to follow ENERGY STAR guidelines. In Korea, the Korean Energy Management Corp. (KEMCO) has set 0.8 W as a no-load target for external power supplies and 1 W as a target for battery chargers. The program is currently voluntary but expected to become mandatory by 2010. And in Australia, the government has launched a 10-year plan that will outline target power specifications for 30 different product categories. The plan is currently voluntary but may shift to mandatory requirements if manufacturers don't comply.

Design implications

At the very least, this array of differing power efficiency standards forces product developers to invest the time to get up to speed on their requirements. Most of the standards discussed remain voluntary. But the potential sales implications of not receiving certification to a program like ENERGY STAR are becoming increasingly important.

Mandatory standards like the CEC-400 pose a more serious problem. Until recently, there was little incentive for portable product designers to build efficient external power supplies. Consumers were driven by the features embedded in the end product. Cost considerations generally drove external power supply design, and, in most cases, designers opted for a lower-cost linear transformer-based device.

Standards like the CEC-400 will make that increasingly difficult. Based on older technology, linear power supplies do not have the intelligence built in to identify a standby or sleep mode in an electronic product and reduce energy consumption. Instead, designers are building external supplies based on switching topologies. Switch-mode supplies increase AC frequency to thousands of cycles per second and, in the process, reduce the size and weight of the transformer, dramatically improving efficiency. But until recently, they have been more expensive to build than linear supplies, particularly for applications less than 5 W.

Over the last few years, however, innovations in power IC design have allowed designers to build much more cost-efficient switch-mode power supplies for applications less than 5 W. These new ICs are able to lower the duty cycle of the power supply or skip cycles to improve efficiency. By lowering the frequency of a switch-mode power supply, they also reduce switching losses and further enhance power efficiency.

Conclusion

The rising cost of energy and relentless demand for power has forced governments around the world to take a close look at power efficiency. The recent development of a broad array of energy efficiency standards reflects that concern. Unfortunately, the diversity of requirements across those standards presents new challenges for designers of external power supplies.

On the bright side, many of the standards bodies around the world are beginning to work toward harmonization of these divergent requirements. In a few years, this might lead to a single, universal power efficiency standard for external power supplies across all geographic markets. In the meantime, promising innovations in power semiconductors offer designers the opportunity to build highly efficient and cost-effective switch-mode power supplies to meet today's power efficiency requirements.

Richard Fassler is director of product marketing at Power Integrations (www.powerint.com).

Portable Design November, 2006
Author(s) : Richard Fassler

Return to Previous Page