Energy-Saving Initiative

Making efficient use of electricity in the home

Recent IC developments enable high efficiency power conversion and extremely low standby power

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According to some estimates, electrical power generation accounts for approximately 40% of all carbon dioxide emissions. If the demand for electricity could be cut, major progress could be made towards reducing global warming and protecting our environment. New research has identified just how much electricity is wasted in private homes—even before they are occupied—and designers of equipment are considering, in some cases forced by legislation, new approaches to delivering energy-efficient products.

Heating, air conditioning, lighting, cooking and refrigeration were the first elements easily identified as major power users in homes and as such received a great deal of attention. Subsequent regulation has been directed toward building and insulation standards for climate control and hot water systems. However, there are many other sources of energy waste.

Often overlooked are the insidious consumers of electricity—products that appear to have been turned off, but which in fact continue to use many watts while they lie idle. External power supplies (wall warts), DVD players, set-top boxes, and TVs all fall into this category. Recent government legislation and programs have focused on setting maximum no-load and standby power consumption limits and designers of such equipment must find new solutions.

Background research

Several new studies are being undertaken, including one by the Lawrence Berkeley National Laboratory (Berkeley, CA) that focused on electrical equipment in 13 new, unoccupied homes in California.

Spot metering was performed on all the builder-installed electrical appliances in both operating and standby modes. Results showed that the average power consumption of these unoccupied homes was 800 kWh/year—with about half of this being consumed by equipment in low power standby modes; 440 kWh/year of standby power usage translates to a continuous standby power of about 50 W—without anyone living in the house! Several devices exhibited higher than expected standby consumption: a gas fireplace, 5 W; a structured wiring panel with a power supply for video cameras and a broadband router, 20 W; and a garage door opener, 5.4 W.

Given the rapid development of new consumer products, it is safe to assume that homeowners will demand a plethora of other devices, such as home entertainment systems and wired and wireless networking equipment that could be equally wasteful in standby mode.

Digital television adapters present an illuminating example of the interaction between new technology and government regulation. After February 2009, approximately 30 million of them will be required in the U.S. homes that are not connected to cable or satellite television. Currently, Energy Star is working on specifications that will introduce a 1-W sleep mode maximum and a mandatory auto power down mode after a few hours of inactivity.

External power converter modules

As public awareness of global warming has increased, regulatory agencies around the world are putting increasingly strict energy efficiency guidelines and regulations into place, and moving away from the existing patchwork of in-

Table 1. Energy Star / CEC External Power Supply Efficiency Specifications

Nameplate Output	Minimum Efficiency in Active Mode
0 to <1 W	0.49 * Nameplate Output
=1 and =49 W	0.09 * Ln(Nameplate Output) + 0.49
>49 W	0.84
	Maximum Energy Consumption in No-Load Mode
0 to <10 W	0.5 W
=10 to = 250 W	0.75 W

Where Ln(Nameplate Output) = Natural Logarithm of the nameplate output expressed in watts.

The Electronic Products Energy-Saving Initiative calls upon the design-engineering community to take a leadership role in environmental responsibility by developing energy-efficient products. Power efficiency should be a check box in all phases of product design, starting with product definition. A year-long series of brief, informative contributed articles from leading companies will provide insight into energy-saving methodologies for diverse applications. The iconic building on the left, our new corporate headquarters in New York City, earned the U.S. Green Building Council's gold rating for environmental sustainability. We walk the talk—come join us and make a difference.

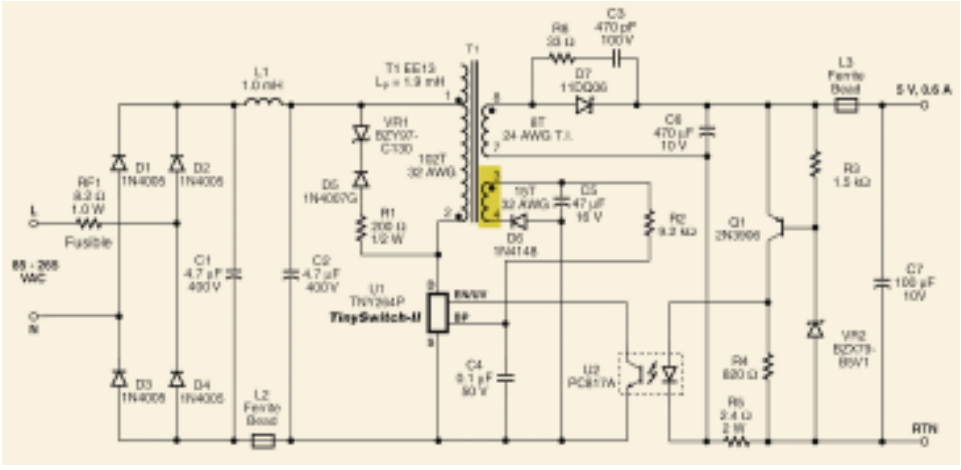

Fig. 1. A power supply design with a bias winding uses less than 30 mW in the no-load state.

dividual regional and national standards. The most obvious example concerns external power supplies: many authorities—including the European Commission, CECP (China), the Australian Greenhouse Office, and KEMCO (Korea)—plan to adopt the same specifications as those laid down by Energy Star and the California Energy Commission (CEC). Lastly, some bodies are shifting from asking for voluntary compliance to imposing mandatory implementation of the standards. In the U.S., many States have followed the lead of the CEC and implemented mandatory requirements.

This external power supply specification shows another important regulatory trend. As well as demanding a 0.5-W max no-load power consumption for low-power adapters, it calls for an minimum active-mode efficiency over a wide load range, as shown in *Table 1*.

High efficiency at no or low cost

In the emerging regulatory environment, designers are required meet these more stringent requirements. Achieving such efficiency improvements is a real challenge, but there is good news. Recent developments in IC technology are enabling power supplies that achieve a constantly high efficiency over the operating power range, and an extremely low standby consumption—at no extra cost.

Until recently, many power supplies, both internal and external, used a line frequency transformer with a linear regulator. This traditional approach rarely achieves 50% efficiency, and wastes many watts at no-load. The rise in the

price of copper in recent years has removed the cost advantage of linear supplies, so virtually all new models today are designed using switching techniques.

A highly energy efficient power supply technology called EcoSmart that enables much higher efficiency when in standby and no-load conditions was introduced Power Integrations in 1998. It also reduces the number of external components—lowering system cost and improving reliability.

ICs such as the EcoSmart technology devices have circuitry that senses a low-power state and takes one or more steps to improve efficiency. They lower the duty cycle, limiting the power to the load and drawing less input current. Secondly, they "cycle skip," waiting for the device to "wake-up," using energy only during a short cycle period. This effectively lowers the average operating frequency, reducing switching losses and improving efficiency.

As an example of what this new breed of power conversion chips can achieve, *Fig. 1* shows a power supply constructed using a TinySwitch-III regulator. Its bias winding, and just three associated external components, cut the standby consumption for the circuit from 300 mW to just 30 mW. So, an additional component cost of just $0.01 achieves a saving in energy of $0.27 per year. The graph in *Fig. 2* shows that this design provides a remarkably consistent efficiency over the full power operating range, matching the current regulatory trend.

A goal once proposed was the house whose reduced power requirement could be met by solar panels alone. Although great progress has been made thanks to intelligent building design, there is still some way to go due of the growth in power consumption by items such as door openers, security cameras, and other accessory items. The use of high-efficiency switching supplies is now a 'must' for all electronics equipment designers. By replacing wasteful linear supplies with switching power supplies design engineers can easily meet new regulations aimed at energy efficiency.

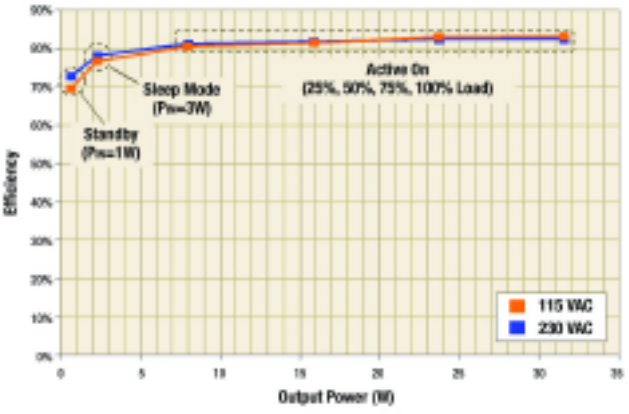

Fig. 2. The power supply designs operating efficiency is high over a broad range of loads.

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Needs additional corrections	AAs	Final—ready for pdf