New Energy Efficiency Standards for External Power Supplies

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External power supplies (EPS), those chargers and adapters that energize everything from our cordless phones to our notebook computers, have recently become the target of new energy-efficiency standards. With more than a billion units sold worldwide each year, and about 10 billion currently in service1, EPS make up the largest single category of power supplies. Roughly half of the EPS currently in use are inefficient, line-frequency-transformer and linear-regulator based models.2 Besides having efficiencies as low as 25 to 50 percent, the no-load power consumption of these devices is typically 1W or more. The amount of energy wasted annually by inefficient EPS — in the United States alone — is estimated to be between 30 billion and 60 billion kilowatt hours, which costs from $2.5 billion to $5 billion per year.3 This comprises approximately 1 to 2 percent of all electricity generated in the U.S., and is equal to the output of about 26 average-sized power plants.4

Few Linear Supplies Will Meet the New Standards

Switched-mode power supplies (SMPS) have already replaced most line-frequency or linear-regulated supplies in applications above 10W, because the size and weight of high-power linears makes them unattractive. Linears have remained popular in lower-power applications due to their simplicity, low parts count and low cost. However, since very few linears will be able to meet the new standards, they will all have to be replaced by switchers.

Many SMPS May Not Meet the New Standards

Complying with the standards requires more than simply designing an SMPS with the same power rating as the linear supply it will replace. For example, ringing choke converters (RCCs) are enticing since they offer a low-cost bill of materials, and since PWM IC-based supplies may not be economical for many low-power applications. However, RCCs have no inherent thermal protection, a feature that even most linears can claim. Basic RCCs also lack under- and over-voltage protection, and the TO-92 transistors that they typically employ cannot meet safety agency creepage requirements. Furthermore, the devil is in the details

when it comes to meeting the energy standards, and a careful analysis reveals some tough hurdles for RCCs and even for PWM IC-based converters.

No-load Power Consumption Requirements

As an example, the new standards require an EPS that delivers 10W to consume no more than 500 mW when it is unloaded. Reducing the switching frequency of an SMPS at no-load is the only way to meet this threshold. However, the switching frequency of most RCCs goes up as their load drops, making it difficult for them to consume less than 500 mW at no-load. As for PWM ICs, very few have a switching frequency reduction function, meaning that the engineer must design a discrete circuit around the IC. This adds parts, design time and cost to the power supply.

Active-mode Efficiency Requirements

The new standards also require high efficiency across the power supply's entire power delivery range. The standards are based on a model developed by Energy Star®, which requires that the operating efficiency of an EPS be measured at 25, 50, 75 and 100 percent load. The efficiency score for an EPS is the average of these four measurements. Thus, the efficiency of an EPS must be reasonably good across the full load range to meet the active-mode standard.

This condition presents yet another problem for RCC and PWM IC-based designs. Unless the switching frequency of an SMPS goes down as the load drops, its efficiency will be significantly lower at 50 and 25 percent load. This may cause the unit's average efficiency to fall below the minimum limit, even if its full-power efficiency is fairly high. Again, few PWM ICs (and no simple RCCs) are capable of reducing their switching frequencies at diminished loads, and those that can still require an engineer's attention, which increases design cycle time and cost.

Highly Integrated Power Conversion ICs Meet the Standards

As energy-efficiency standards first began to emerge a few years ago, some power conversion IC manufacturers began to integrate automatic frequency reduction features into their devices. This enables power converters designed around those ICs to easily meet the new energy-efficiency standards. Since the supply's switching frequency automatically adjusts with the load on its output, its efficiency stays high across the full power delivery range. Some ICs also reduce their switching frequency even further when the supply is unloaded, which helps meet the no-load power consumption standards.

Because these ICs also have many other functions integrated into them, such as over-temperature shutdown, under- and over-voltage protection, cycle-by-cycle current limiting, and switching frequency modulation, they help designers meet their cost goals by keeping design cycle times short and component count low. Additionally, some newer, highly integrated power conversion ICs are accompanied by powerful, easy-to-use, computer-aided engineering (CAE) software that makes calculating design parameters and component values a quick and painless task. Some CAE tools will even design the transformer for an SMPS.

Conclusion

The dates for compliance with the new energy-efficiency standards are fast approaching, and non-compliant EPS will need to be replaced or redesigned soon. Given all of the factors and variables involved, designing new SMPS converters around the latest power conversion ICs is the fastest way to ensure that safe, reliable and compliant designs are ready for mass production before the

deadlines for compliance arrive.

References:

1 Ecos Consulting, “Power Supply Efficiency: What have we learned?,” February 2004, page 1.

2 Ecos Consulting, Davis Energy Group, and Energy Solutions (comps.), “Codes and Standards Enhancement Initiative for PY2004: Title 20 Standards Development: Analysis of Standards Options for Single-Voltage External AC to DC Power Supplies,” May 3, 2004, page 7.

3 Ecos Consulting, “Power Supply Efficiency: What have we learned?,” February 2004, page 2.

4 (26 power plants) Environmental Resource Center, “Environmental Tip-of-the-Week: 8/3/2001,” www.ercweb.com/news/tipreq.asp?tip=8/3/2001

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