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The Copper Paradox

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The Copper Paradox

When does an increase in raw material prices lead to a decrease in consumer cost? Never, you might say. Well in the case of copper the unexpected is really happening. In the past two years the raw material price for refined copper has nearly trebled, yet for users of electronic equipment, all of which contains significant quantities of copper, the lifetime cost of their equipment can go down. This is not done with smoke and mirrors, but with switch mode power supplies.

The world price for copper has stabilised in the last few months, but at a price of around $3.30 per pound whereas back in early 2004 the price was $1.25 (London Metal Exchange). The price rise was driven by two major factors, supply and demand. Low cost copper deposits are becoming worked out and new extractions have to be established in increasingly remote and expensive to reach areas. This weakening on the supply side is coupled with a massive increase in demand from China as that country industrialises. China is reported to be opening a new power station every week. In order to supply the needs of its rapidly growing electrical and electronics industries, China has been obliged to buy copper from all over the world, leading to strong upward pressure on prices. (See fig).

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Stock chart of copper, five years, courtesy of Kitko Inc.

The increase in raw copper prices has generated a direct impact on the cost of power supplies used in all mains powered electronic equipment. About 90% of the component cost of the power supply is in the mains transformer, an item produced largely from an iron core and copper windings. With copper doubling in price the impact on the cost of mains transformers, hence power supplies, will be very significant.

As an example, a small mains transformer typically contains 75gm of copper wire. In the past two years the cost of 75gm of raw copper has gone from 24¢ to 52¢, an increase of 28¢. In refined wire form the cost increase will easily become 50¢, which is equivalent to the cost increases levied by transformer manufacturers over the same period.

There is a solution to this problem, rather than simply passing the cost increase on to the consumer. The solution is to change to switch mode power supplies (SMPS).

Historically, SMPS were complicated and costly. Thus they were only used in applications where their advantages justified the cost. However SMPS do come with many advantages. Firstly, they do not require a bulky and heavy mains transformer. Hence SMPS are small and light. SMPS can tolerate a very wide input voltage range, easily ranging from USA voltage (110 volts) to Europe (230volts). Linear supplies on the other hand require a different transformer winding for each voltage range. Another major advantage of SMPS is that in applications requiring multiple regulated voltages these can be easily provided whereas a linear power supply requires an additional regulator for each voltage.

Coming back to the point of SMPS not requiring a heavy mains transformer, in SMPS the one component that has a major cost element related to copper is absent. So the cost of building a SMPS has remained relatively constant over the past two years whereas the cost of linear supplies has increased by at least 50¢ due to copper.

Therefore the cost balance between SMPS and linear supplies is much closer than before, with the result that many electronic equipment manufacturers are re-designing to use SMPS rather than linear supplies. This change now brings in a significant long term cost benefit to consumers because SMPS are more efficient than linear regulators and can also achieve much lower standby consumption. For example, over a 10 year life a typical item of electronic equipment with a 20 watt power supply can save the user as much as $100 in electricity! Hence the increase in copper raw material cost has led to an overall cost benefit to the consumer. This is the copper paradox.

One segment where the drive to using SMPS has been particularly rapid is gas domestic appliances, principally gas water boilers and gas hobs. In Europe this equipment has to comply with a recent regulation, EN 298. This regulation stipulates that if the flame fails to establish or indeed goes out, then either the gas supply must be cut off or an ignition process initiated to ensure that no explosive vapour can gather. To meet EN 298 the appliance manufacturer must include at minimum a flame failure detection device for each burner and also circuitry to test that the flame failure device really can detect the absence of a flame! To construct a control/safety system of this complexity requires multiple power supply voltages. A good example of a modern gas control design is illustrated by the SIT 501 EFD, manufactured by the SIT group (See fig)

non

-volatile lock out, providing complete safety in the event of power failure. By using a SMPS this unit not only meets the EN 298 safety regulation, but also exhibits very low standby consumption, future-proofing the design against any future tightening of power consumption standards.

In California, the State Government has passed legislation severely limiting the standby power consumption of external power supplies. These exist as plug-in adaptors for mains powered units and as chargers for mobile phones, PDAs, laptops, etc. One survey by the Lawrence Berkeley National Laboratory found that a typical California home exhibits a standby power consumption of 50 watts, mainly due to linear power supplies. The new legislation effectively outlaws the use of linear regulators in new external power supplies. So over time this standby figure should reduce to below 10W and achieve and overall saving of 5% of residential electricity. Multiply this up over the homes in California and the saving becomes equivalent to the output of a whole power station.

The key element in building a SMPS is the controller circuit. A good example of a highly efficient controller in the 3-30 watts range is the Tinyswitch III from Power Integrations. This is the third generation of a family, originally introduced in 1998, of which 800 million units have been produced. TinySwitch-III features a 700 V MOSFET alongside low-voltage control circuitry on a monolithic IC. This level of integration enables simple, flexible designs with far fewer components than competing discrete and integrated solutions.

TinySwitch-III employs an ON/OFF control scheme, which delivers virtually constant efficiency regardless of load. By contrast, PWM and self-oscillating designs exhibit diminishing efficiency as load decreases. TinySwitch-III enables easy compliance with the most stringent standards for standby and no-load energy use, consuming less than 150mW of no-load power without the use of a bias winding on the transformer.

The advanced functions and features of TinySwitch-III ICs enable engineers to reduce input capacitance and transformer size while also eliminating expensive Y-type capacitors and common mode chokes from their power supply, thus achieving a compact and elegant design (See fig).

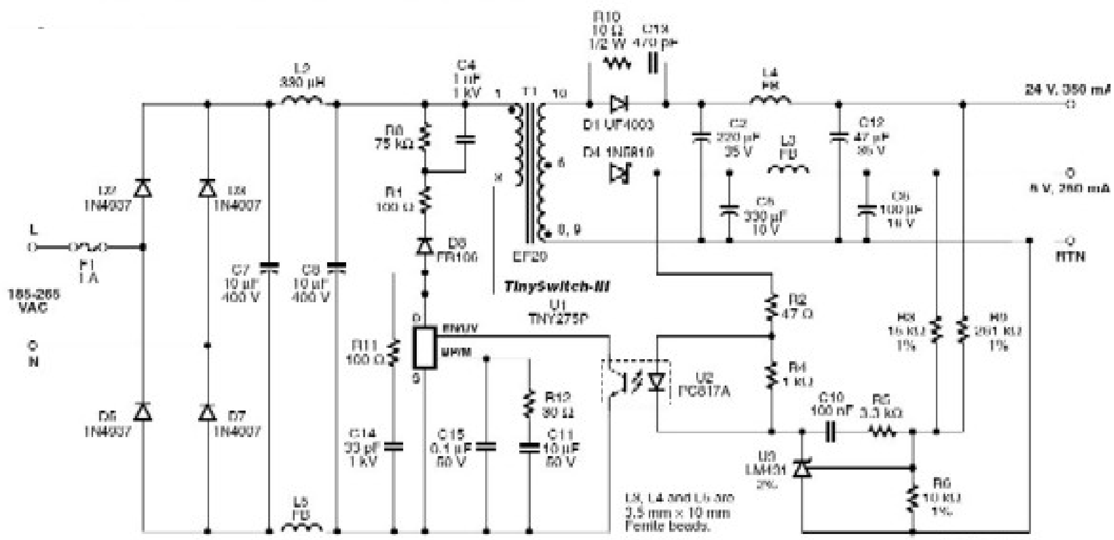

Figure 1. TinySwitch III 9.65 W Residential Heating Controller Power Supply

SMPS using efficient controllers such as the Power Integrations Tinyswitch III achieve exceptional operating efficiency over wide power and voltage ranges and are capable of ‘glow worm’ levels of standby consumption. The telling advantages of low weight, multiple output capability, wide input range and stable cost with copper becoming a precious metal, provide a win-win solution both for the consumer and the environment.

Author: Silvestro Fimiani

Silvestro Fimiani is Product Marketing Manager covering Appliance and Industrial Applicatio at Power Integratio the San Jose-based the leader in high-voltage analog integrated circuits for power conversion.

Mr. Fimiani gained wide experience in the analog and power semiconductor industry working with leading companies, and holds a degree in Physics from the University of Naples, Italy.

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