

Designers' Series Part XVIII

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Power Supply Stress Testing

It seems that almost weekly we hear of another recall in the electronics world, most often associated with the power supply, or power components. These are, after all, the parts most likely to catch fire if not properly designed. The latest was a fire hazard in a power cord, of all things, leading to 14.1 million recalls!

It's time I think, to remind our readers of what it takes to make a power supply rugged. It's a topic we'll return to more in the future.

25 years ago, power supply designers used a series of tests to shake out design oversights. These tests were the result of real-world conditions that could happen, and which would highlight problems in the power supply. We'll focus on just one such test in this article.

The first design requirement is to allow for the proper margining of the input voltage. A power supply designed for 120 VAC input was expected to run indefinitely from 90 VAC to 132 VAC at full load and under all extremes of temperature.

On top of that, it was expected to continue to run at 150 VAC for 1 second with no failures. The 1-second limitation was to emulate real-world conditions with surges, but not overstress input capacitors. For a 240VAC line, this peak test voltage was doubled to 300 VAC. How many power supplies today would be able to pass this test?

Then, there was one further test that always gave us grief, but which had to be passed. Most engineers these days have never even heard of this:

1. Ambient temperature is set to the maximum and the power supply is run at full load to heat up parts.
2. The AC input line is set to 300 VAC.
3. The power supply control chip is disabled from switching by removing Vcc.

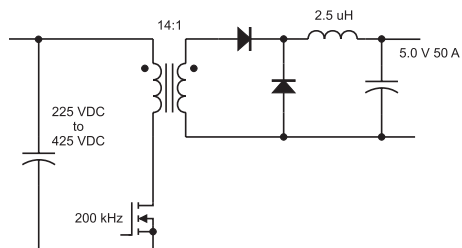


Figure 1 : Forward converter designed for rugged operation.

4. The soft-start of the control chip is disabled.
5. A hard short circuit (solder connection) is placed across the output of the supply.
6. The control chip is enabled by applying Vcc.

Figure 1 shows a typical 200 kHz converter design for a 200-425 VDC input line, and 5 V output at 50 A. In this converter, the transformer turns ratio is set by the low-line requirement. The wider the input range, the more stressful this test will be, something to bear in mind if your application calls for universal input.

Figure 2 shows the circuit waveforms simulated by Power 4-5-6 for this set of conditions. After the fourth current pulse, the duty cycle of the converter becomes very small, just 2%. This corresponds to a pulse width of 100 ns. Within 100 ns, the current sense network must sense the peak current limit and turn off the control logic. The control chip must then discharge the gate capacitance. If the pulse cannot be turned off this fast, the primary current will run away, and the converter will not survive.

When designing, set up this test to repeat every 10 seconds for 24 hours on your first prototype. Is this a fair test? That depends. If you want your converter to survive, and you don't want any product recalls, it is mandatory. If you want to compete with low-cost designs, and product recalls are part of your acceptable business cost, by all means, skip this type of testing, but make sure you are ready for the consequences.

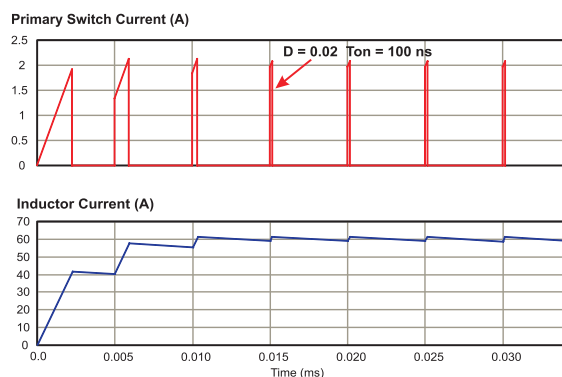


Figure 2 : Switch current and inductor current for the forward converter. Input voltage = 425 VDC, output load = short circuit, soft-start disabled. After 4th pulse, duty cycle must cut back to 2%, or control of the peak current is lost.