Re: Suggestions for 1kW, unregulated SMPS

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On Dec 4, 6:19 am, dha...@xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx (Haude Daniel) wrote:

> "Unregulated SMPS" probably sounds funny, but this is it: At my lab we frequently heat up metal samples in vacuum by placing them near a hot tungsten filament and applying a high voltage, essentially making the sample the anode of a vacuum diode. This typically happens at voltages of around 1kV and currents of .5A, but 1kW total power isn't unheard of.
>
> Now we have some homebuilt units that take care of this. They consist of a custom−wound mains transformer with a bridge rectifier for the HV, and the power is regulated via filament temperature. These beasts work OK, but the transformer makes them heavy and expensive.
>
> Now we need a few more, and the natural path to follow would of course be to make them switched−mode −− except that I've never done an SMPS. I may be wrong, but I think this should nevertheless be doable since I need no regulation at all; the first version would just have a pot to adjust the duty cycle. So this thing would consist of no more than a PWM controller, an IGBT H−bridge, a transformer and a diode bridge. The output needs to be short−circuit proof; I'd do that by adding some series inductance to make the primary dI/dt slow enough to be safely cut off by the overcurrent trip.
>
> The only tricky part that I'm aware of is the design of the gate drive circuit −− it mustn't ring and it must be quick to reduce heat dissipation and avoid cross conduction. The transformer, of course, is a critical part in any SMPS design, but I figure that a poorly wound xformer can't have any ill side effects except having too little output power due to stray inductance.
>
> Ah yes, and an 1kW SMPS running from a single−phase 230V line needs PFC and soft−start. Will have to read up about that.

> Should I do it? Maybe it's a bit stupid, seeing that only 5 of these things are needed at the moment and there exists a design that works and can be assembled and tested by the techie who originally designed it (he wouldn't touch a switcher with a 10−foot pole). However I'd like to have a bit of fun of my own but I don't enjoy having to pick bits of black epoxy out of my face.
>
> And I know that a 1000V supply capable of delivering 1A is no joking matter. But since the secondary won't consist of anything besides the rectifier bridge and the output jack I won't have to do much there.
>
> BTW, I can't use the filament/sample constellation itself as a rectifying diode. For one thing this would require some kind of flyback design, and, more importantly, the anode gets often hotter than the cathode.
>
> −−Daniel

You'll probably get lots more detailed responses than this one, but here are a few questions and pieces of advice:

1) Do you need isolation? If not, you could consider using a boost converter with 1000 V ouput as a single stage PFC/PWM. There are also PFC topologies that provide isolation. Control loop BW is always rather poor, though.

2) Full−bridge output SMPS poses extra challenges keeping DC out of the transformer. Be careful, or use a series capacitor right from the start. Don't believe the app notes that say that current mode control prevents DC imbalance (flux walking). That promise is only realized under controlled conditions.

3) Push−pull topology requires a larger transformer, but circuit is less complex.

4) There is much literature available on gate drivers. For a project like yours, simply choose one of the many good integrated gate drivers.

5) The most important design element is layout. Study SMPS layout carefully. Where di/dt is high, no inductance is too small to be ignored. Where dv/dt is high, same is true for capacitance.

6) You will be needing some high voltage differential probes.

7) Get ready to make some smoke.

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3)

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