Technology Edge

Power Supply Design and the *Thinking* Engineer

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Over the last 15 years, the design of switching power supplies has entered the mainstream. Now, no longer solely the responsibility of an expert, almost anyone involved in system design may end up putting together the switching power supply. Fortunately, people of all levels of expertise can use National's WEBENCH® online tools to design switching regulators. Because experts usually want to tailor their designs for specific components or targeted performance, these tools allow a great deal of customization of the designs. This means it is possible to take a design that works perfectly well and "optimize" it into oscillation. The online tools can be used to discover design problems and correct them - as long as thinking is applied as well.

Taking the First Step

The first step in online power supply design is defining the power supply requirements, including voltage range, output voltage(s) and load current(s). Possible solutions are automatically evaluated and one or two recommendations are presented to the user. This is the first place a designer can get in trouble: if the requirements are not correctly stated (for example, if the input voltage range is really higher or lower than the value entered), an unsuitable solution will be shown. It is easy to try several sets of requirements, but the user must have a clear understanding of the system needs. After a regulator-based solution is selected, components are identified for the circuit. Wherever possible, real components with part numbers are shown. The user has the option of changing the components to predefined alternates or to enter a custom component. There are guidelines given for the component values and any critical parasitic values. If a custom component is used that is quite different from the recommendations, be prepared for poorer performance.

Evaluating Performance

Once circuit components are selected, it is time to evaluate the performance. In general, look for frequency response values (crossover frequency and phase margin), peak currents and voltages, and thermal values (efficiency, junction temperature, and component temperatures). Even though these calculations are based on models, the results match well with the bench data.

Electrical and Thermal Simulation

Some solutions are supported by electrical simulation. These simulators will display the schematic and allow the user to further change components and run tests on the regulator circuit. Available tests include Bode plot, steady-state, line transient, load transient, and startup. (Note that Bode plots can be run only for those circuits using fixed-frequency regulator ICs.) For the online tests to be useful, it is critical that the user check all of the conditions of the test. Input voltage and load current may be varied for each test, and the defaults may not match the situation in the user's system. The user must think about what results should be expected and if the simulated results are different, to figure out why. Thermal simulation can be run for many solutions. The online tools evaluate the regulator circuit as implemented on a PCB using a reference design layout. Results showing component and board temperature are presented in a full color image as well as in a table. Because the thermal simulation is designed to run fairly quickly (giving results within a few minutes), the accuracy is not as high as it would be if a detailed CFD (computational fluid dynamics) multi-hour simulation were run. However, the temperature estimates are typically within 20°C of actual. This is close enough to identify if there are any hot spots on the board or components in danger of exceeding temperature ratings.

Testing a Protoype

The final step in the switching regulator design process before preparing for production is to build a prototype to test on the bench. Some solutions are supported with customizable evaluation boards, while other solutions have reference design boards available. With the power of the online tools, it may be tempting to skip this step - don't! Most designs will work fine, but some need careful layout for best performance. The real components may not exactly match the simulations, especially considering their parasitics, so the actual performance (including the effects of board layout) will be slightly different from the simulated results. Again, the key is to determine what is expected and to analyze any differences. Using lab tools including a good, high-speed oscilloscope, a DVM, a current probe, and thinking will give the designer the best chance of success.