APPLICATION NOTE

Application Guidelines for Non-Isolated Converters

Reliability Considerations Comparing POL Modules to Discrete Implementations

Introduction

Comparing the expected reliability of assembled DC/DC modules vs. discrete designs, there are several aspects that need to be considered. This application note will highlight those considerations.

First, we are considering two different methods of providing power to individual loads on a circuit board. One approach involves fully assembled power modules, where the modules are separate sub-assemblies that typically get attached to the main circuit board by using thru-hole pins or SMT pins. This approach typically involves a few external components (mostly input & output capacitors and one or more SMT resistors) also placed on the main circuit board, but all the main power train components are on the sub-assembly Power Module.

The second approach forgoes the separate sub-assembly and has all components in the power design attach directly to the main power circuit. Conceptually this approach could involve approximately the same components as with the sub-assembly method, though in practice there may be differences.

One obvious distinction in terms of the reliability of these two approaches involves the reliability-affecting aspects chosen by the Power Module vendor and the choices (whether intended or not) made by the designer doing a discrete design. These would include:

1. Component and design de-rating guidelines (including Design For Manufacturability requirements).
2. A robust design methodology, with the major aspects of the design locked into the module (limiting the ability of the user to inadvertently introduce problems with the power circuitry).
3. Thorough qualification, HALT and HASS testing prior to production, specific to the power assembly.
4. Thorough testing, and in some cases burn-in, of the Power Module before the assembly is attached to the main circuit board (significantly reducing the likelihood of rework on the larger circuit board)
5. A closed-loop FA process that results in continuous improvements in the reliability of the Power Module over the life of production, resulting in ever-improving MTBF numbers.

Design Process Considerations

For OmniOn Power Modules, our design process requires that all components are analyzed, comparing their measured stresses (both electrical and thermal) and applicable limits (including consideration of external standards such as IPC-9592, component vendor ratings, as well as internally-developed guidelines based on many decades of Power Module production). Once the design engineers believe the design is mature, peer design reviews are held to challenge the design, and Design for Manufacturability experts are also required to review and approve the design. Because of this rigid process, users of OmniOn's Power Modules can be confident that the designs represent required de-rating and design guidelines. With a discrete design, the burden of determining the conservativeness or aggressiveness of a design falls on the circuit board designer. While it's certainly possible to take a conservative approach, most users do not have the background and experience to make this determination. And in cases where something goes wrong, they "own" the design, so the responsibility falls upon them.

The second item to consider regarding the "who owns the design" aspect involves how much variability in the design rests with the circuit board designer. With Power Modules, the core of the design is locked within the subassembly. Only basic guidelines involving routing and capacitor placement usually need to be considered. With a discrete component approach, the scope of design aspects that must be paid attention to are dramatically more significant, so the opportunity to inadvertently introduce issues rises exponentially. This variability makes it more difficult to insure a robust and reliable design, and that burden falls squarely on the circuit board designer, not the Power Module supplier.

Reliability Testing Considerations

Once the design reviews are complete and an OmniOn Power Module design is proposed for production, units are built and sent to various other OmniOn groups for analysis. One set of units are sent to a Qualification Group, whose job it is to ensure that the design meets the planned specifications and that OmniOn design guidelines have been satisfied. Other units are sent for HALT testing, with the results of those tests reviewed by both Engineering and Quality organizations, to identify opportunities to enhance the reliability of the design before production begins. HASS testing is also utilized to further improve the expected reliability of the new design.

Power Circuit Testing During Manufacturing

Because a discrete power design is part of a much larger circuit board assembly, the ability to isolate and test the power design separate from the main board is much more limited. This is true during design, prior to production (when weak links in the power design should be identified). But also significant is the inability to test the discrete power circuitry prior to the main circuit assembly (whereas a Power Module arrives having already been thoroughly tested at the time of manufacture). This difference can lead to more (and often expensive and difficult) rework required on the main circuit board due to power quality issues.

Continuous Improvement Methodology

One final consideration affecting the reliability of the power design involves what is done with any quality issues found in the field. As a matter of practice, OmniOn's Failure Analysis process follows the industry standard 8D process. Included in the OmniOn process is the requirement that corrective actions must be implemented so that any identified weaknesses are improved, making future builds that much more reliable. This approach results in ever -improving MTBF data over the life of the Power Module production. Additionally, OmniOn's standard process is to take random samples and re-run certain qualification tests over the life of the product to insure there has been no changes over time that could impact reliability. Because assembled modules are sold to a wide variety of customers and applications, those designs likely already have established field MTBF data available at the time a designer is considering their options. Lastly, test data Cpk is monitored in the factory, insuring that product variation stays within established limits. While a discrete power design could also follow some of this continuous-improvement methodology, the burden to do so falls on the circuit board designer (and associated quality groups), rather than on the Power Module vendor. In many cases, the focus is on the main circuit board, and the discrete power design is not a focus as it is for the Power Module vendor. With each new discrete board implementation, the field MTBF history starts over, adding uncertainty as to the expected reliability until sufficient units have been installed and run for some time.

Summary

In summary, there are integral aspects of the design, qualification, production and failure analysis processes that are in place to address and ensure reliable OmniOn Power Modules. While some aspects of a discrete power design could attempt to duplicate these results, other aspects are inherently more difficult with discrete implementations, and in all cases the burden to try to improve the power design reliability falls on the shoulders of the board designer.

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