Revolutionizing Power Supplies: The Advantages of Integrated Power Modules

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Introduction

In the fast-paced world of electronics, the demand for efficient and compact power solutions is ever-growing. As technology advances, engineers are constantly seeking ways to simplify design, reduce board space, and expedite the development process. MPS meets these demands by offering the widest portfolio of power modules on the market. These devices integrate the power stage, control loop, and inductor in a single SMD package (see Figure 1).

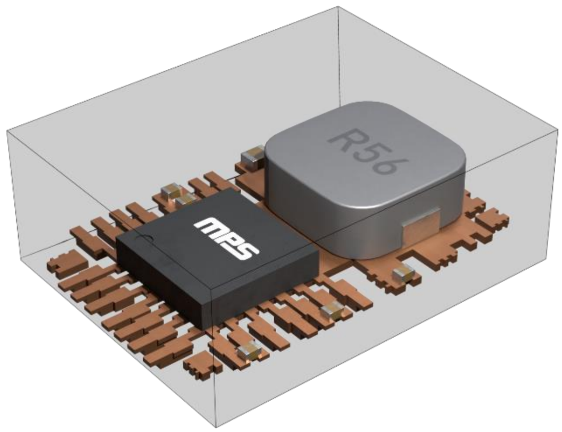

Figure 1: MPS Power Module

This article explores the numerous advantages of using integrated power modules over traditional discrete DC/DC power supplies.

Simplified Design and Reduced Board Space

By integrating the power stage, control loop, and inductor, MPS power modules offer unrivaled power density. The converter, inductor, and other passive components are directly placed on the lead frame using MPS's patented MeshConnect™ technology, achieving increased thermal dissipation, higher reliability, and lower parasitic inductance. This leads to significantly simplified design, effectively reducing the design time and iteration cycles.

MPS power modules integrate passive components such as the bootstrap (BST) capacitor, VCC decoupling capacitor, input decoupling capacitor, and feedback resistive divider. This allows engineers to focus on higher-level aspects of the system, rather than spending time on discrete component selection and optimization. The integrated passive components simplify design by streamlining the process and reducing the BOM, which addresses challenges with component compatibility issues and the component sourcing process. Furthermore, MPS power modules are pre-validated, eliminating the need for extensive testing and verification of individual components. This accelerates the time-to-market for electronic products.

Multiple-output power modules such as the MPM38111 can be used to increase power density. By delivering two or more separately controlled outputs (e.g. two MP2152 devices), the required number of input capacitors and overall board size are reduced (see Figure 2).

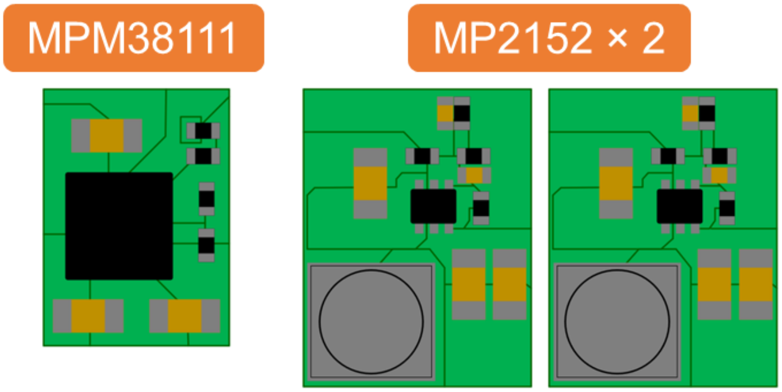

Figure 2: Size Comparison between a Dual-Output Power Module and Two Single-Channel Discrete Systems

In addition to simplifying the design process, MPS power modules offer a compact solution with reduced footprint compared to discrete alternatives. For applications where space is at a premium, designers can create smaller and more portable devices. In addition, the integrated components optimize board layout to reduce parasitic elements and enhance overall system performance.

With MeshConnect™ technology, MPS power modules can deliver high currents in very compact packages. Consider the MPM3864, a 6A power supply in an ECLGA-19 (3mmx3mmx1.85mm) package, making it ideal for space-constrained applications such as optical power modules or handheld computing devices.

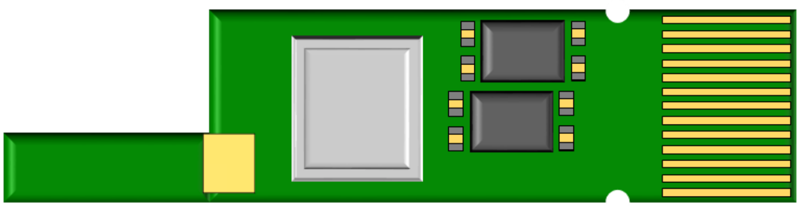

Figure 3: Example of the MPM3864 on an Optical Module

Increased Design Flexibility

As systems become more complex, power tree design is becoming an increasingly time-consuming effort due to the increased number of rails, strict voltage regulation requirements, and sharp load current transients, all of which require very precise fine-tuning. MPS modules help engineers quickly complete fine-tuning with the digital communication interfaces incorporated into the modules. Using MPS's Virtual Bench Pro software, designers can easily change aspects such as the output voltage (V_{OUT}), switching frequency (f_{SW}), and protection thresholds. Advanced parameters can also be adjusted to fine-tune operation, such as the blanking time, compensation loop gain, and slope compensation ramping voltage (see Figure 4).

Figure 4: Use MPS's Virtual Bench Pro to Easily Configure Digital Devices

The MPM3698 is a dual-output power module that delivers up to 120A of total current in a BGA (15mmx30mmx5.18mm) package. This device is designed to power the core rails of high-end FPGAs and ASICs, and is fitted with an advanced control loop that allows designers to tune many aspects of the control loop through its digital interface.

Nonlinear control methods such as active voltage positioning (AVP) can be tuned to optimize transient response. Advanced communication protocols including SVID and AVSBus can also be configured, in addition to providing precise telemetry of the input voltage (V_{IN}), V_{OUT}, input current (I_{IN}), output current (I_{OUT}), and device temperature.

Advanced Control Methods: Constant-On-Time (COT) Control

MPS power modules typically provide constant-on-time (COT) control, making them ideal for powering digital loads between the microcontroller unit (MCU) and the high-power system-on-chip (SoC). COT control improves power conversion and transient response by fixing the switching period's on time, allowing for changes in f_{SW} according to the load requirements.

Transient response significantly improves due to the following two factors:

1. The control loop's operation is independent of the clock signal.
2. The converter can increase its f_{SW} to deliver energy faster to the output.

As a result, V_{OUT} is impacted less during sudden load current transients compared to conventional control methods. Figure 5 shows a comparison of current-mode control and COT control.

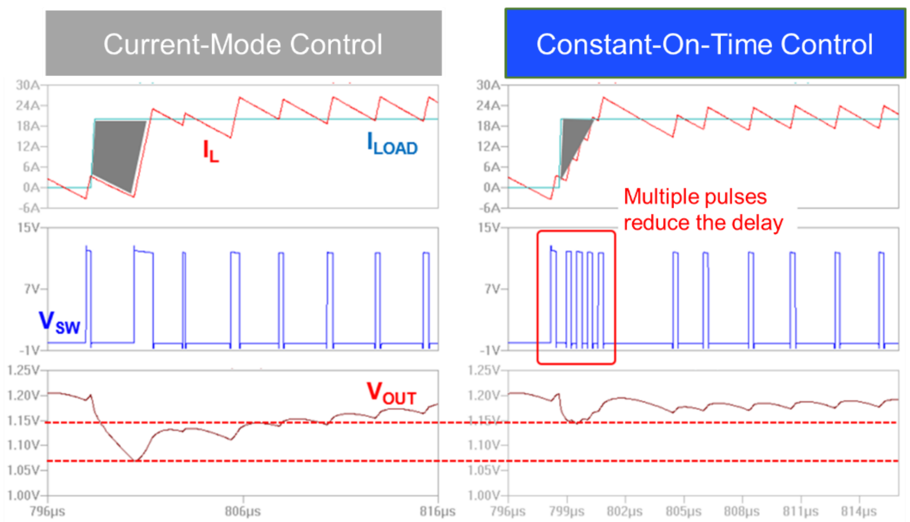

Figure 5: Current-Mode Control vs. COT Control

Another benefit of COT control is the converter's greatly reduced f_{SW} during periods where the load is significantly diminished (e.g. when the MCU enters sleep mode). COT control enables much higher efficiency at light loads without being forced to switch via a clock signal or being required to implement pulse-skip mode (PSM).

EMI Reduction for Power Modules in Industrial Applications

Integrating the entire converter into a single package inherently leads to smaller switch nodes, reducing electromagnetic interference (EMI). This is crucial to meet electromagnetic compatibility (EMC) standards. Furthermore, the compact nature of integrated power modules contributes to smaller hot loops, which minimizes the loop area and mitigates EMI concerns. A more robust design against EMI ensures reliable operation in various environments (see Figure 6).

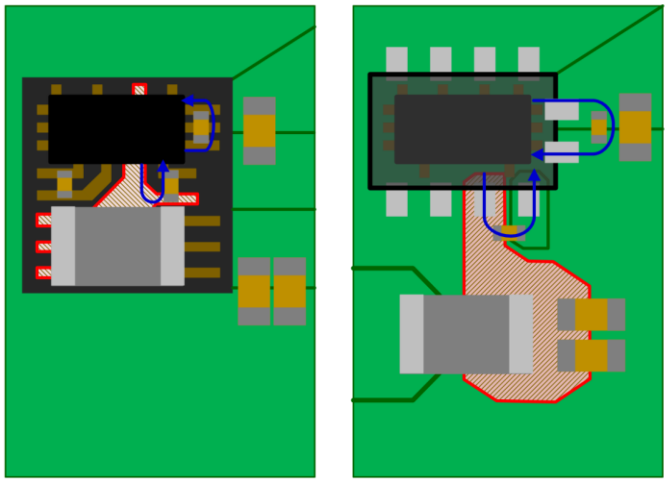

Figure 6: Reducing the Switch Node and Hot Loop Size with MPS Power Modules

MPS also offers modules with EMC pre-compliance for standards such as CISPR25.

Conclusion

Power modules with integrated inductors offer numerous advantages, including simplified design, reduced board space, faster development times, and EMI reduction. As the electronics industry continues to evolve, embracing innovative solutions like integrated power modules is paramount to stay ahead in the competitive landscape. The integration of essential power components marks an important development for achieving more efficient and compact power supply designs.

MPS is leading the market shift toward integrated power components by offering a wide range of compact, easy-to-use power modules. With output currents ranging from below 1A to above 100A, and input voltages ranging from below 6V to above 72V, speed up and simplify power supply design using MPS's robust portfolio of multiple-output power modules.