Technical Article

Increasing Power Density with Dual-channel Power Modules

Aaron Grgurich

The constant push for more component integration and greater power density, on top of demanding project schedules, can leave engineers in difficult situations when designing a system power architecture. Looking specifically at test and measurement or optical module applications, the problem statement is no longer limited to the area (x-axis and y-axis) of the design; rather, it becomes a three-dimensional jigsaw puzzle, where the height (z-axis) of a design is also a constraint.

Fortunately, you can use high-power-density buck power modules to add much-needed flexibility to your power design. A buck power module integrates a buck controller, power switches, a power-stage inductor, and other passives such as high-frequency bypass capacitors and compensation components, all in a single device. In this article, I will explain how modern power modules, in particular dual-channel modules, help address challenges related to solution footprint area and z-height through multiphase operation.

Shrink Your Solution Size

In industrial applications such as test and measurement and avionics, designers must meet stringent solution-size constraints in all three dimensions. Modern high-power-density modules help meet these requirements by offering tighter integration, unique board placement and closer placement to loads. They further save board space and reduce bill-of-materials cost by integrating passives such as high-frequency capacitors, bootstrap components, and one or more power-stage inductors. Using a bare die within the integrated circuit makes it possible to place high-frequency capacitors closer to the power stage within the module than when using a discrete converter, especially if there are printed circuit board (PCB) component clearance constraints. These solution-size benefits apply to both single- and dual-channel power modules.

Get More Flexibility on the Board

In applications with height constraints, low-profile power solutions can open up new possibilities in the PCB layout. The system's physical form factor, or system enclosure, can limit the component height on the back side of a PCB, thus reserving that part of the board for low-profile components such as capacitors and resistors. You could tuck a low-profile module underneath the overhang of a heat sink of another device, like the heat sink of a field-programmable gate array or processor itself, making use of previously restricted board area. As shown in Figure 1, the TPSM5D1806 buck power module is one example of a low-profile module. At 1.8-mm tall, the TPSM5D1806 is shorter than many 1206 or 1210 ceramic capacitors.

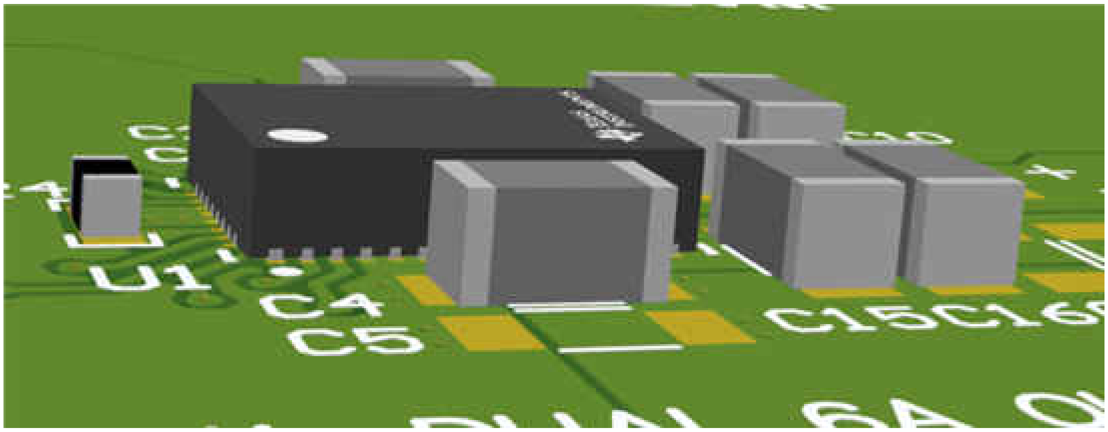

Figure 1. Low-profile Design of the TPSM5D1806 Power Module with Surrounding Bypass Capacitors

The low z-height, combined with the small x-y solution size, may open up options to place the power module closer to the loads it is powering, which enables more accurate and effective regulation by reducing longer parasitic traces. You will still need to place taller solutions farther away from the load.

Take Advantage of Dual-phase Operation

While both single- and dual-channel modules offer the benefits of smaller solution size and the increased flexibility of placing components on the board, dual-channel power modules such as the TPSM5D1806 have a unique advantage over single-channel power modules when it comes to power density. In addition to dual-output mode (see Figure 2), designers can use a dual-channel power module and connect them together into a single-output, **dual-phase** configuration. Splitting up the current between the two integrated inductors enables you to use vertically shorter inductors, each with lower saturation current ratings, saving space in the z-axis. In contrast, a single-phase solution would require a taller inductor to match the current capability of a dual-phase solution.

Dual-output modules also require less input capacitance by switching the channels out of phase from each other, reducing the peak and root-mean-square input currents and further saving space in the x- and y-axis. The article, “When to Use Single vs. Dual DC/DC Buck Regulators,” explains this concept in greater detail.

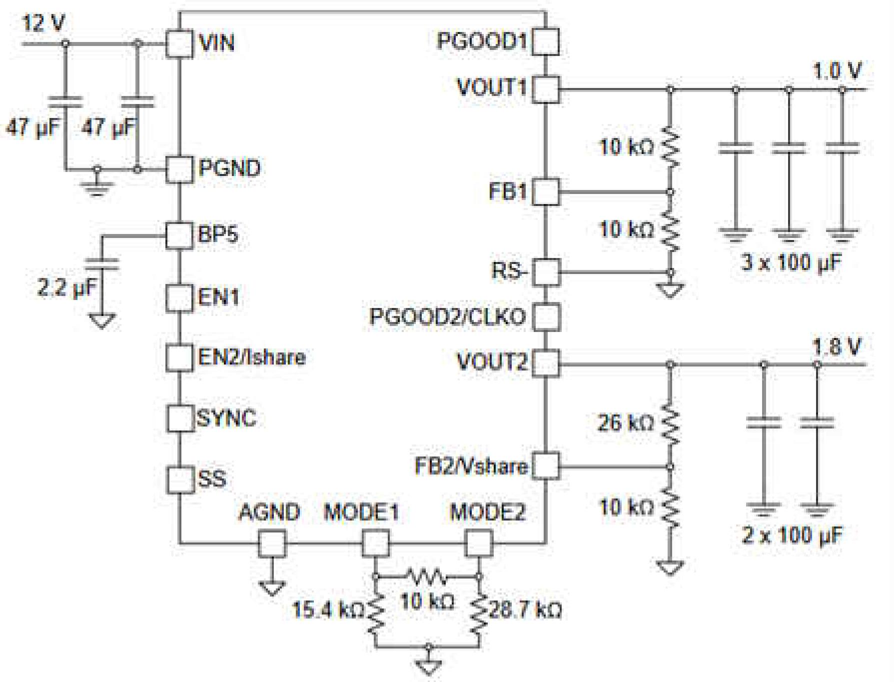

Figure 2. TPSM5D1806 Power-module Design Layout in a Dual-output Configuration

Conclusion

Implementing dual-channel buck power modules into a design can help you take advantage of all of the power-density benefits associated with power modules, including a small solution size with a low profile, more board space and greater flexibility for other design considerations. However, dual-channel power modules offer additional power-density advantages when used in a single-output, dual-phase configuration, helping you work more easily in tight and power-dense designs while maintaining the flexibility of choosing between single-output (dual-phase) or dual-output (one phase per output) configurations.

Additional Resources

- To learn about power-module operation limits, see the application report, “Understanding Power Module Operating Limits.”
- To learn about reducing power-supply noise with power modules, check out the technical article, “3 Ways to Reduce Power-Supply Noise with Power Modules.”

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2023, Texas Instruments Incorporated