Technical Article

Shrink Module Size with Flip Chip on Lead (FCOL) Package Technology

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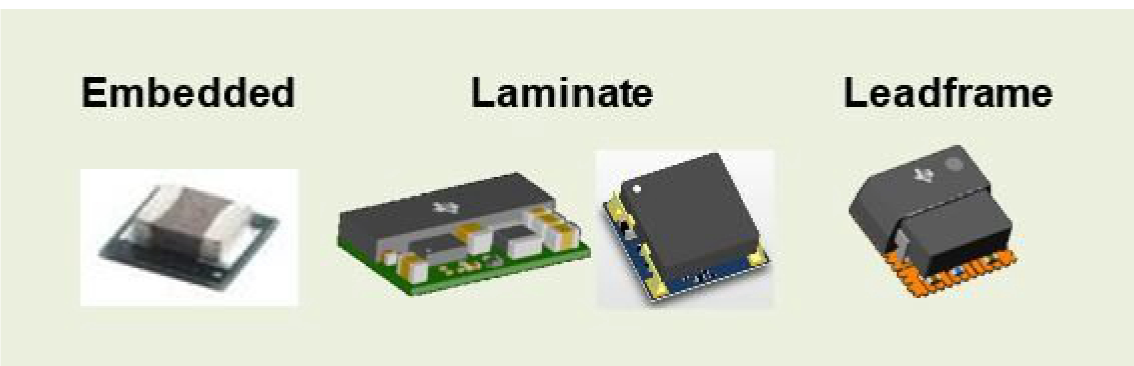
Power modules are becoming increasingly popular in many market segments – the ability to buy a power supply that already includes the switching inductor is a big advantage. The main reasons engineers are choosing power modules as opposed to a discrete alternative are:

- **Reduced Solution Size.** Power Modules are typically smaller than what designers can easily develop on their own. The ability to integrate active circuitry under the inductor can significantly reduce solution size and enables you to put more functions in a smaller space
- **Reduced Development Time.** Power Module designers are power experts; they put tremendous effort into ensuring the components used in the module are reliable and of the right value to ensure excellent performance. They choose the optimal control topology and confirm the layout is of high quality. The result is a solution that is robust, high performance and easy to use.

In order for the power module market to continue to expand, the modules need to continue to get smaller and include more compelling features.

Power modules are built with several different manufacturing techniques, each with pros and cons. Figure 1 highlights some of the different approaches, including embedding the integrated circuit (IC) in a laminate, putting components onto a laminate and overmolding (or not), or putting components onto a metal leadframe and overmolding.



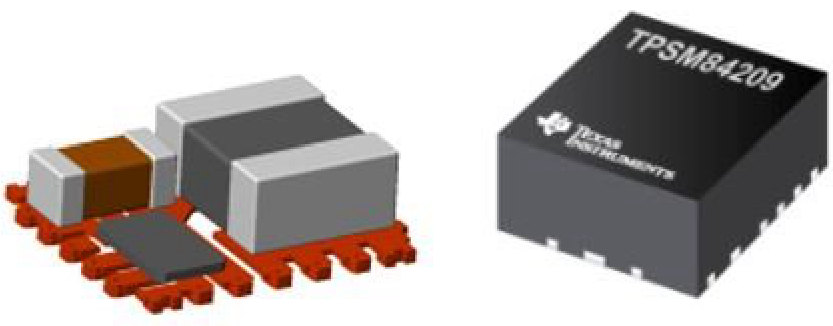
Example of Various Package Types Offered by Texas Instruments

All of these approaches can be designed with the inductor over the active circuit. In the embedded approach, the IC is integrated into the laminate and the inductor is placed on top (as in the TI TPS82130). For higher-current, laminate and leadframe-based designs (see the TPSM846C24), the active circuitry is placed under a stilted inductor. While in theory it is possible to implement these same techniques with a discrete design, in practice it is complicated to achieve in volume production.

The embedded approach enables the smallest module size for a given power level, but thermal limitations of the power IC in the laminate reduce the amount of power that this packaging technique can handle. Using a stilted inductor is also not a good approach when you need lower-current small-chip inductors.

Another factor to consider when developing a power module is how the IC is packaged. An unpackaged IC is best, as it is smaller and costs less than a packaged alternative. But it is more difficult to handle and test in production, and until now has not been a common approach. Most power modules either embed the silicon in the laminate and place the inductor over the top, or use a packaged IC mounted onto a leadframe or laminate.

In order to address the need for small size and good thermals, TI has added a new package approach to its portfolio. Called flip chip on leadframe (FCOL), a bumped die is mounted onto a leadframe along with passive components and then overmolded. TI has just released its first product with this new technology, the TPSM84209. (See Figure 2 for a look at how the module looks from the inside and outside.)



A More Detailed Look at the inside and outside of the TPSM84209 Power Module

Here are the advantages:

Smaller Package Size.

The TPSM84209 is in a 4x4.5x2mm package. This is the smallest 28V/2.5A power module on the market. With FCOL technology – the solution is smaller than if a discrete solution was used to implement the same circuit

Overmolded Package.

Some engineers like to use an overmolded package. In select applications it is preferable for there to be no exposed active circuitry. Aplastic overmold also improves thermals

Improved Thermals.

The Θja of the TPSM84209 is just 32.7°C/W vs 46.1°C/W for the TPS82130 (a 17V/3A embedded MicroSiP™ module). This allows higher output currents at higher temperatures (see Figures 3 and Figure 1)

Good Emi.

Because the IC is mounted on a metal leadframe that is soldered directly to the printed circuit board (PCB), it is possible to design very small products that meet Comité International Spécial des Perturbations Radioélectriques (CISPR) 11 specifications. The evaluation module (EVM) for the TPSM84209 has gone through electromagnetic interference (EMI) testing at an approved Underwriters Laboratories (UL) lab and it passes CISPR11 up to Class B.

Excellent Reliability.

Like all of TI's modules, the TPSM84209 has gone through an extensive manufacturing qualification process which includes tests such as high temperature storage, life test, biased humidity and board-level reliability. The package/device is specified to moisture sensitivity level (MSL) 3 and 260°C/3X reflow.

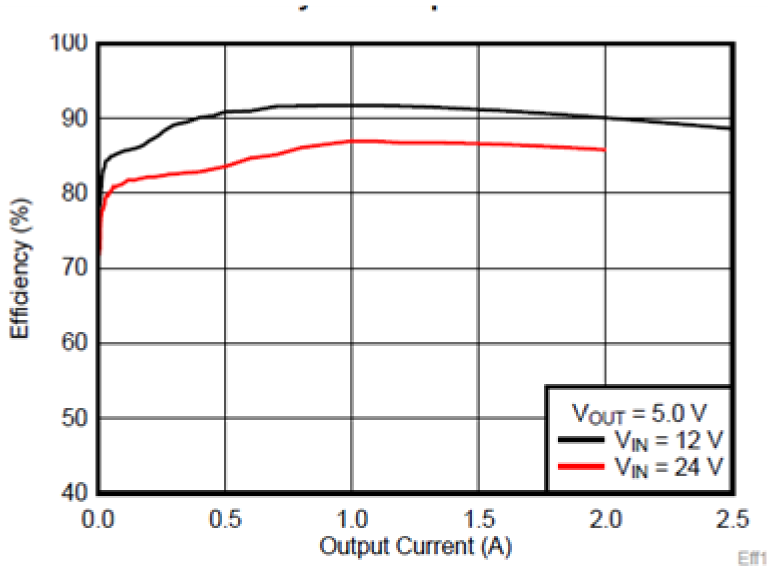


Figure 1. TPSM84209 Efficiency vs Output Current

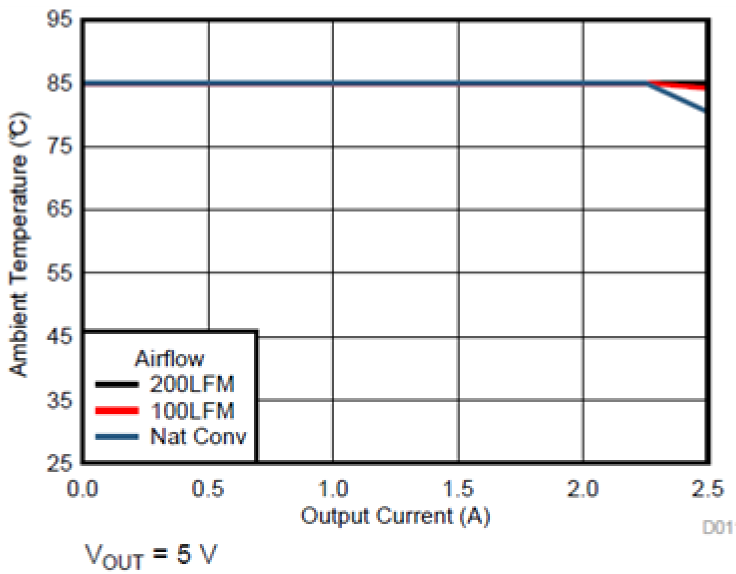


Figure 2. Safe Operating Area 12Vin, 5Vout

There is no single package technology that is suitable for every product or application requirement. TI uses several different technologies to enable the optimal module performance at different power levels. The new FCOL package is a good new option for when size is a key concern. Get more information on TI's DC/DC power module portfolio.

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