Powerful solutions come in small packages

Innovative SiP power modules simplify and accelerate system development

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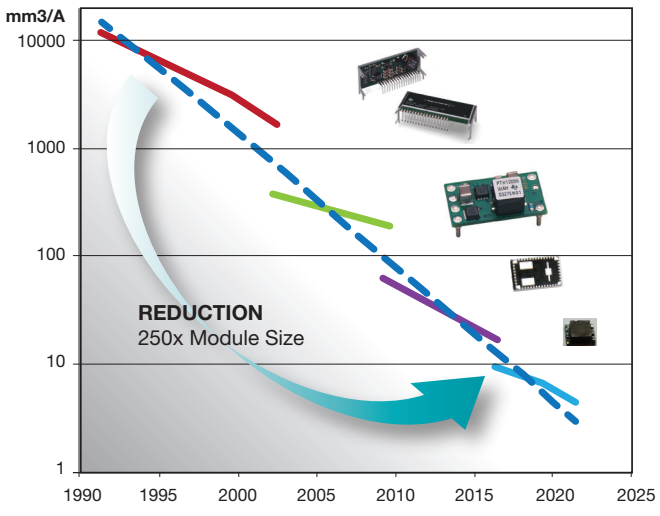
To the larger community of electronics designers, advanced power-supply design remains something of a mystery.

Power supplies require expertise that many system developers lack, such as how to select the type of power supply or meet compliance specifications. It's no small wonder that developers often prefer to look for a ready-made solution that takes away the headaches of power-supply design.

System-in-package (SiP) power modules from Texas Instruments provide ready-made, easy-to-use solutions for power supplies. SiP modules integrate a complete DC-to-DC converter power system in a single package using three-dimensionally stacked components. The result is increased power density and simpler designs for TI customers, helping them accelerate time to market and realize higher revenues. Developers can add a single device with a pre-tested, point-of-load power supply to their boards, avoiding the hassles of power design and devoting more time to product functions where their own expertise and added value are greatest.

Module Volume Density Trend



Power modules have paralleled the tremendous downscaling that has taken place in circuitry. In the past 25 years, TI has brought an average module size reduction of 25 percent annually – and aims to continue this trend.

TI's portfolio of more than 200 different SiP modules allows developers to select the right solution for the right system. Application areas include large, performance-driven systems such as communications infrastructures, data management, office equipment, building automation, industrial, and transportation and defense, right down to small, often cost-sensitive systems such as sensors, appliances, consumer electronics, and even portable and wearable systems. In short, affordable SiP modules exist for almost all electronic applications, backed by in-depth development tools that help ease module selection and implementation.

Complex systems require straightforward solutions

The wizardry of power design seems to grow even more mysterious as systems become smaller and more complex. Product miniaturization puts extra pressure on designers to scale down the power system, and mobility requires designs that squeeze longer running times from batteries. Efficient usage demands that newer equipment accept higher-voltage inputs near the point of use. Highly integrated systems with complex loads require increasing numbers of voltage and

current levels, implemented using complicated power trees, multiple power-supply stages or both. Circuit analysis often yields numerous possible implementations, with various trade-offs for efficiency, size and cost.

Power-supply topologies also complicate development decisions. Traditional linear voltage regulators are relatively straightforward and flexible for designers, but they require significant airflow and board space for cooling. By contrast, switched-mode power supplies (SMPSs) are becoming increasingly attractive in many applications. The high power efficiency of SMPSs limits the space needed for heat dissipation, prolongs battery life in portable systems, and helps lower operating costs for line-powered equipment. Developers must carefully control the timing in high-frequency switches, however, and prevent them from interfering with low-frequency circuitry in the rest of the system or transmitting back onto the input power line. High-frequency switches also require protection from external noise and internal parasitics.

All of these factors affect the difficulty of and time required for development, design debugging and manufacturing test, while power has its own safety requirements that complicate the process further. System developers may find the complexity overwhelming, especially small development teams that do not have an expert devoted to power-supply design. SiP modules remove the difficulties of power design and smooth the development process, allowing designers to concentrate on areas where they can add maximum value to their products.

Faster development, reduced time to market

The effect on development time when using a SiP module can be decisive for the success of a product. A market report by the independent Darnell Group found that a SiP module-based design requires 45 percent fewer man-hours to complete than a design based on a discrete DC-to-DC regulator. Such a large savings in development time can easily make the difference in realizing increased revenue and profit from being early to market with a new product. In addition, a reduced the bill of materials, along with fewer mounting steps, helps simplify manufacturing, increases pass rates during test, and improves overall reliability. Managing the cost of buying and taking inventory of extra components is also significantly reduced. For all of these reasons, SiP modules are not only cost-effective compared to discrete solutions – they may even be the key to succeeding with the product in the marketplace.

Advanced packaging, flexible options

SiP modules leverage TI's long-standing experience in creating packages for power products. To minimize space, SiP modules employ embedded-die laminates, copper-clip integration, stilted inductors and other advanced 3-D stacking techniques. Dual-frame structures with wide copper leads, along with other heat-dissipation techniques, yield excellent thermal characteristics throughout the product line. Good thermal response allows the modules to operate at a wider range of temperatures for enhanced reliability in the field.

Also important are design techniques that minimize electromagnetic interference (EMI), assuring that SiP modules are compatible with host systems. The devices are subjected to an extensive battery of characterization tests for EMI, temperature, vibration and other ambient factors to ensure maximum compliance with standards and system operating conditions.

Today's complex systems run on various voltage levels, and SiP power modules can support multiple voltage rails. The available module selections will accept a variety of input voltages with input options covering a range of point-of-load voltage rails, providing exceptional flexibility in application.

The net effect of these features is increased power density that saves board space for the device footprint, traces and cooling. And as devices shrink, power density continues to increase by roughly 25 percent per year, ensuring that future generations of end-equipment designs will have even more space-saving options available.

Types of SiP module packages

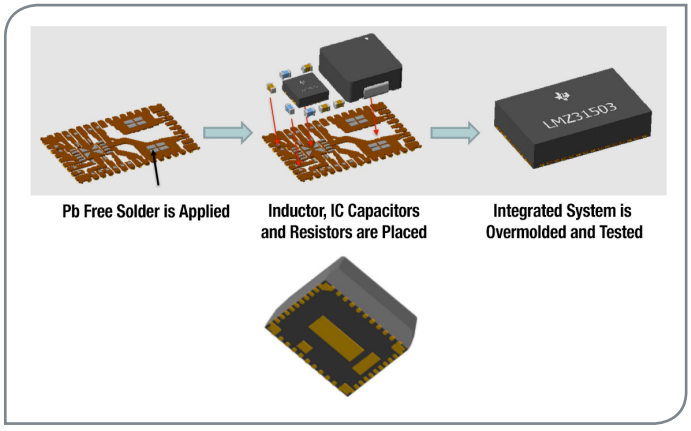
The broad portfolio of SiP modules provides flexibility for a wide range of applications and varied manufacturing environments. Leaded and no-lead options support different requirements in mounting and end use, and miniaturized packages offer extremely compact solutions where space is at a premium. Signals located at the periphery of all modules provide straightforward access for ease of debugging and test. Package options are free of lead (Pb) and compliant with the Restriction on Hazardous Substances (ROHS) directive as well as J-STD-020, which covers moisture-sensitivity levels

QFN modules

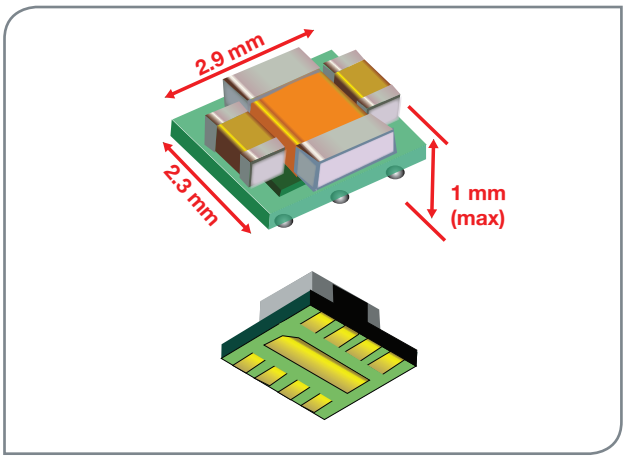
For maximum compression in advanced systems, TI provides power-supply modules in a quad flat no-lead (QFN) package. Using package-in-package technology with mature manufacturing processes, QFNs provide advantages for systems with multilevel boards and advanced mounting techniques. A copper lead frame and plastic encapsulate enable the lowest thermal path for superior safe-operating-area performance, and short electrical paths and closed-loop magnetics provide best-in-class EMI protection. The modules are easy to use, with all signals accessible, and with compensation and programming already integrated.

MicroSiP modules

In miniaturized systems such as portable and wearable electronics, the scale of the package matters not only in area, but also in volume and weight. TI's plug-in MicroSiP modules provide the current required for these applications, with current density that is among the best available in the industry. Inside the module is a high-performance laminate substrate with an embedded PicoStar™ multichannel power management device, plus discrete passive components located on the topside. Occupying only half the board space of discrete solutions, innovative MicroSiP modules allow new flexibility in system-level designs.



Simplified QFN module assembly flow



MicroSiP cross-sectional view

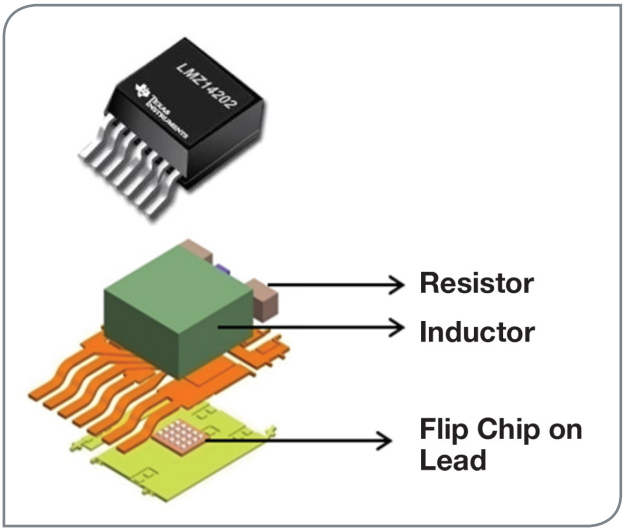
Leaded modules

Industrial systems often operate under harsh conditions and have strict requirements for heat, vibration and EMI protection. For these types of systems, TI offers a leaded module packaging technology that features a flip chip or inverted die mounted on a dual lead frame. The dual lead frame shortens electrical paths for best-in-class EMI protection, and the copper lead frame with a thermal pad enables superior thermal performance. Passive components are stacked over the chip in the package to provide a space-saving complete power system with external leads that make mounting straightforward and provide easy access. These modules include ruggedized options for applications with harsh environments.

Design support and manufacturing

SiP power modules are fully enabled in TI WEBENCH® design tools, which help design engineers design power applications in minutes. WEBENCH includes easy-to-use expert analysis that allows developers to make value-based comparisons at a system and supply level before committing to a design. With simple inputs from the user, the tools provide multiple TI design options to suit the application needs of any power load servicing industrial, communications, enterprise, personal electronics and automotive equipment. Details of trade-offs for space, cost, efficiency and performance are included, enabling designers to make important power-supply decisions right away. Additional support for SiP modules includes evaluation boards, reference designs, documentation and training.

TI is focused on enhancing all of the features of SiP modules that lead to ease of use, product-line flexibility and power density. TI is the industry leader in power solutions breadth and depth, offering a wide portfolio of discrete power products as well as power modules. The company's power expertise stands behind SiP modules, including flexible, worldwide manufacturing and strong packaging and reliability labs for module development and qualification.



Example of a leaded module construction

Powering the future

The pressures of increased complexity – including miniaturization, multiple power rails and the need for more power-efficient topologies – make power-supply system design seem even more difficult. Fortunately, SiP power modules from TI provide easy-to-use complete DC-to-DC converters with many options for different applications and manufacturing requirements. SiP modules increase power density and help speed time to market, making them a cost-effective option for new systems in a wide variety of application areas. From giant multichannel equipment to the tiniest wearable electronic accessories, TI's SiP modules are powering innovative systems for the future.

For more information, see TI's module overview page at www.ti.com/powermodules.

To learn more about TI packaging, visit www.ti.com/packaging.

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