<<TECHNOLOGY BACKGROUNDER>>

Introducing Vicor's Converter housed in Package (ChiP) Technology

Scalable power component packaging technology breaks new barriers for performance and design flexibility, and delivers breakthrough 4X increase in power density

The pace of innovation in power electronics technology is accelerating quickly, driven by customer requirements for greater power efficiency, density and design flexibility. However, this continued need for greater power component performance is straining the limits of conventional component packaging technology.

Thermal issues in particular are becoming acutely problematic as systems grow increasingly dense and power components are moved ever closer to the point of load, which can constrain design flexibility. The drive to produce smaller power components has outstripped commensurate improvements in efficiency.

Open frame "brick" power components, which can only be cooled by forced air, are becoming power density-limited as a result. Power components need to be more thermally adept and support flexible thermal management. Power density and heat dissipation density cannot continue to rise without fundamental advances in packaging technology.

To meet these challenges, Vicor has pioneered a breakthrough power component packaging platform – "Converter housed in Package" – or "ChiP" for short. Vicor's ChiP technology enables smaller and more flexible component form factors, simplifies design processes, and lowers energy costs significantly.

Next generation components based on Vicor's new ChiP packaging technology can provide a staggering 4X increase in power density and 20% reduction in power loss vs earlier generation components, equipping customers to achieve previously unattainable system size, weight and power efficiency targets that enable breakthrough product performance. ChiP technology has already demonstrated power densities up to 3kW/in^3, and up to 850/in^2, at up to 98% efficiency. In time, ChiP technology will support even greater levels of performance.

Unparalleled Scalability & Design Agility Through Advanced Packaging Technology

Vicor's ChiP technology is made possible by Vicor's power management expertise and world-class manufacturing capabilities, with many stages being analogous to semiconductor wafer fabrication. Like wafer fabrication, individual converters are arrayed to utilize 100% of the PCB material, with no area lost to lead/pin attach. The array is then sawn into individual 'chip-scale' components with no superfluous, non-value-added packaging, thus minimizing space used in customer designs.

ChiP utilizes integrated magnetic structures penetrating through a high density interconnect substrate with symmetrically two-sided layout to essentially double power density. Similar to how microprocessors are sawn out of scalable wafers, a multiplicity of ChiPs are constructed on a panel, molded, and then sawn into as many as 80 individual power components, exposing "bar codes" from which interconnect terminals are formed. X- and y-dimensions are flexible, allowing low- or high-power converters, with additional flexibility in the z-axis to allow optimized magnetic transformer or inductor designs.

The initial lineup of Vicor components based on ChiP technology includes five different package sizes, with more on the way. This is enabled by the underlying scalability of the ChiP manufacturing process. Process flexibility enables a wide range of power component sizes to be built using the same manufacturing tooling and processes without waste, resulting in unprecedented cost-effectiveness. This dimensional flexibility is reflected in the package reference, again analogous to semiconductors. For, example a "4623" package measures 46mm by 23mm as sawn.

As of now, ChiP technology supports packages as thin as 4.7 mm in ChiP sizes ranging from 1323 to 6123 with current capability up to 180A, voltage capability up 430V and power capability up to 1.5kW. With an expanding array of package sizes, voltage capability up to 800V and power capability up to 4kW per ChiP-based component are possible. ChiP-based offerings will include both through hole and surface mount products.

Symmetrical (top-bottom, side-to-side) layout enables powertrain components to be distributed within the package for improved thermal performance. Optimized mold compound material and advanced layout design enhance thermal pathways to the smooth, flat ChiP exterior.

Vicor's ChiP packaging offers flexible cooling paths to the ambient environment, supporting single-or dual-sided cooling plus dissipation through the ChiP leads, as well as cold-plate

options and standardized finned heatsinks. This flexibility minimizes the thermal impedance between the ChiP and the environment, enabling customer applications with higher power density and new, innovative form-factors.

Vicor's ChiP technology offers excellent power performance and can accommodate many different conversion topologies. It supports all known power distribution architectures with enabling converter functionalities including AC-DC conversion with power factor correction (PFC), isolated bus conversion, DC-DC conversion, buck, boost and buck-boost regulation and point of load current multiplication. ChiP technology supports high frequency zero-current and zero-voltage switching power conversion topologies performing isolation, voltage transformation and regulation in any suitable combination within the ChiP-based module.

Vicor's ChiP-based devices can include on-board microcontrollers which offer a high degree of factory- and user-defined capabilities, command and telemetry potential. This provides more control – and more flexibility – for the system designer to develop advanced, intelligent, differentiated applications. In the same way that Vicor's online tool suite – PowerBench – now offers mass customization at everyday pricing with fast delivery, ChiP's powerful capabilities can be harnessed and tailored for unique application requirements.

A New Era for Power Components, from AC to Point of Load

ChiP technology enables Vicor's vision of complete systems, from the AC wall plug to the point of load, assembled from power component 'building blocks' comprising ChiPs and SiPs. This ensures higher performance, faster time to market and lower cost solutions than traditional power component methodologies.

A broad range of power component choices provides customers with flexibility in configuring power system solutions that effectively address their performance and cost objectives. The benefits of Vicor's ChiP packaging technology – efficiency, density and design flexibility – are essential in many markets

In datacenter environments, ChiP packaging technology can be applied from AC- or 400V DC input all the way to the processor and memory loads. ChiP-based components are optimized for ETSI, ITU and EMerge Alliance high voltage DC distribution standards. This yields huge gains in power savings and eliminates the cost and bulk volume consumed by traditional silver box power supplies, freeing up valuable real-estate for additional compute performance.

For factory automation, test or process control, the flexible, modular nature of ChiP-based components enables great freedom to create application-specific power systems quickly and simply. For these and other applications, ChiP technology liberates engineers to unlock the full potential of their system designs. Perhaps more importantly, the new ChiP platform enables Vicor’s customers to create new ‘leapfrog’ designs with sustained technical and commercial advantages to increase market share in highly competitive industries.

Through dramatic leaps in packaging technology and manufacturing processes, Vicor continues to set the pace of innovation for power management performance from AC to the point of load. Vicor's significant investment in ChiP packaging technology positions the industry for a new era of system optimization.

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