WHITEPAPER

OPTIMIZING BOARD-MOUNTED POWER WITH MASTER AND SATELLITE CONFIGURATIONS

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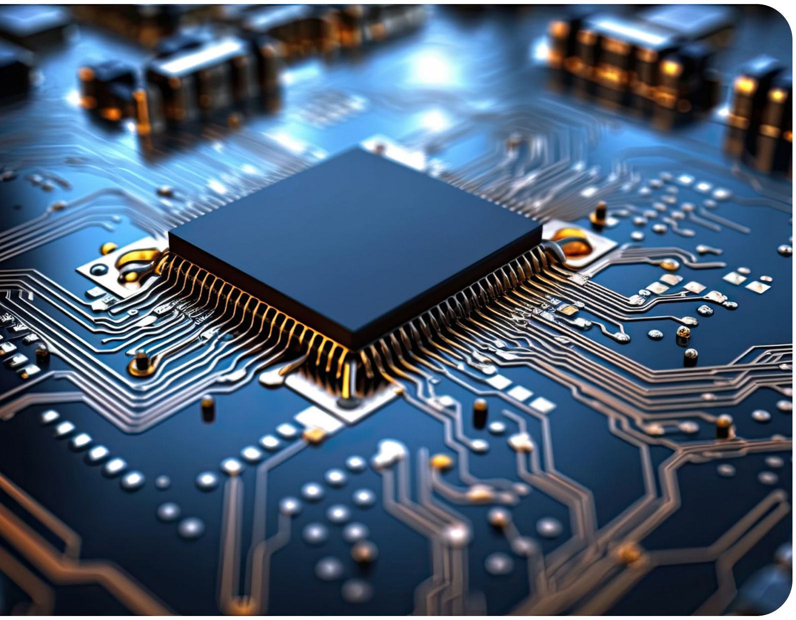
**By: Vesa Jokitulppo, Product Manager, OmniOn Power,
and Anurag Jagota, R&D Senior Engineer, OmniOn Power**

The last century has seen global reliance on electronic equipment rise exponentially. As power demands across industries have risen, engineers have set their sights on developing solutions that ensure infrastructure keeps pace with growing demand. While they've made considerable progress toward that end, technology continues to advance at a break-neck pace.

As the demand for power has grown, the board space available to power electronics that convert and distribute energy is shrinking. This is not a new dilemma, yet the stakes have never been higher as our world becomes increasingly connected.



It's in this context that a new vision for board-mounted power architectures has emerged: the master and satellite concept. This model has the potential to push the limits of power density while also providing flexibility to meet ever-evolving challenges engineers face when designing power-hungry devices and applications.

DESIGNING FOR DENSITY

The demand for more power-dense designs stems, in large part, from ever-shrinking end applications which limit the board space available for components in today's advanced technologies. Take today's high-powered networking equipment, for example. To keep up with exponential increases in data both generated and transferred with the rise of the Internet of Things (IoT), the deployment of 5G-enabled applications, and today's advanced computing operations, additional power must be incorporated onto printed circuit boards (PCBs) that are already packed to near-capacity with components enabling expanded functionality.

With little room remaining for the power components, power density becomes a key concern. This is just one example that illustrates why board optimization and power density are increasingly valuable in the design process of both the PCB and end applications.

In addition, with the latest integrated circuits (ICs) requiring significantly more power than their predecessors, and large power components sometimes challenging to fit at the point of load (POL), longer traces may be required to accommodate the distance between power module and the load. This distance adversely impacts POL response to high slew rate loads.

Cooling high-powered components and the modules enabling them also plays a part in the overall board- and power-density equations. To mitigate the heat generated from processing equipment, power modules, and other components on a PCB, board designers must consider which cooling method makes the most sense for their build. It could be to allow airflow between components, allocate space for heat sinks, or employ another method to disperse heat.

MODULAR AND DISCRETE POWER

Engineers are constantly seeking ways to build more efficient, reliable, and power-dense applications. One consideration is whether to utilize power modules or to implement discrete designs.

With a discrete approach, power designers must identify, bench test, qualify in-circuit, and source DC/DC converters, power metal-oxide-semiconductor field-effect transistors (MOSFETs), inductors, and any other components they need, piecing them together to meet the demands of their design. This approach affords engineers full control over their power architecture — from start to finish — which is an appealing prospect on the surface. However, it comes with some trade-offs: power density, higher development risk, increased time-to-market, more stringent capacity limitations, and more complex supply chains.

To reduce the development risk and design effort associated with discrete down designs, power designers may opt to use fully tested and characterized POL modules instead. These modular options are designed with integrated semiconductors, magnetic technologies, and other carefully chosen components that are purpose-built to work together. They offer an all-in-one alternative to discrete designs, helping engineers save board space, reduce build times, and design more efficient and power-dense solutions. And because POL modules are tested and qualified, their use can significantly improve time-to-market for the end-board build.

CHANGING THE GAME: THE MASTER AND SATELLITE CONCEPT

Building on the modular approach, we're now seeing an evolution in board-mounted power design, with master-satellite concepts being utilized. Master-satellite power architectures can be used to provide a single, higher-current output or two independent outputs using minimal board space.

This approach offers numerous advantages over previous modular power conversion options and discrete down designs, including:

- **Space savings:** The master modules control the operation of their associated satellites, eliminating the need for separate controls for each POL module. By "outsourcing" the satellites' controls to the master, this topology can significantly reduce the total power footprint on a board, allowing more space for other components (Figure 1).

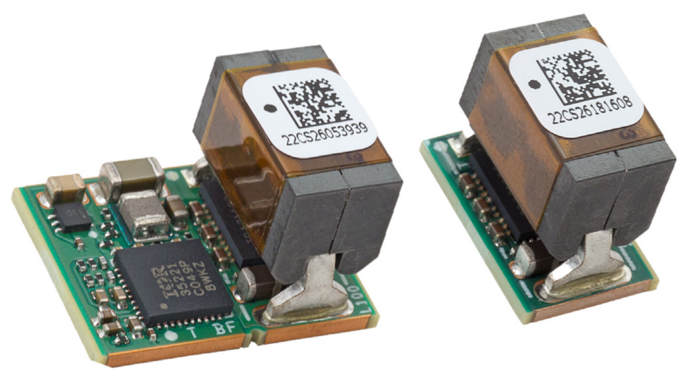


FIGURE 1. Example of master-satellite board space savings; A smaller satellite module can provide an additional 40 A maximum current without the need for its own controls.

- **More control:** A common pain point of using POL modules is fixed maximum current. With a master-satellite architecture, designers can increase output power by adding smaller-sized satellites.
- **Flexible output structures:** The master-satellite approach also allows for more flexibility in board placement. The satellite modules' smaller form factors can make these POL modules easier to place on a PCB. When application design parameters allow, the modules can also be placed in various locations and orientations relative to each other and the load — further enhancing design flexibility.

FIGURE 2. Example of design flexibility with multiple satellites or satellites with varying power levels

For example, a designer might employ a master-satellite grouping to use multiple modules in tandem which can provide higher power levels to a single load. Alternatively, they can be used in dual-voltage configurations to power two separate loads with differing voltage needs (Figure 2).

The master-satellite approach to board-mounted DC/DC power has the potential to bring electronics one step closer to truly optimized circuitry. When paired with other innovations that facilitate better space management and improved power densities, it could lead to significant technological advancements across industries and applications.

POWERING PROGRESS

Networking and telecommunications are two examples of industries expected to benefit from master-satellite power architectures. At the board level, today's networking and communications equipment is quite complex and power-hungry. This equipment is "always-on" and uses an ever-growing amount of power despite fixed footprints, making building to facilitate improved efficiency, reliability, and power density top priorities for designers. The power flexibility and density offered by master-satellite architectures make the technology well-suited to meet the unique demands of the latest data storage, computing, and AI processing equipment.

Next-generation mobile networks may also benefit from this power architecture. With high-frequency radios supporting significantly more bandwidth and throughput, new use cases enabled by 5G — such as autonomous vehicles, more connected and expansive advanced manufacturing operations, and smart cities, to name a few — will present the challenge of near instantaneous data transfers and analysis. To support this, backend network equipment will need to be bolstered with higher- powered solutions. A master-satellite concept at the board level could help meet these demands.

Of course, the benefits of a master-satellite power architecture are not confined to these sectors. Other applications — such as servers and storage equipment, industrial equipment, or test and measurement equipment, to name a few — may also find ways to leverage this architecture. As more people explore the option, additional use cases are likely to take shape.

THE OMNION POWER DIFFERENCE

OmniOn Power's newest addition to its proven DLynx™ family of non-isolated DC/DC converters, DLynx III, utilizes a master-satellite concept and can help designers optimize their board-mounted power designs to meet the demands of today and tomorrow. Its high-power POL modules are well-suited to the needs of networking, communications, and other industries that require high power quality, reliability, efficiency, and density.

The product family includes four master modules (40A, 80A, 120A, and 160A) that can be paired with 40A or 160A satellites in a variety single-or dual-output voltage configurations to meet the specific needs of the latest high-performance ASICs, FPGAs and SoCs. Tight transient response and low ripple values meet modern IC input voltage requirements.

OmniOn Power also provides free design tools — Power Module Wizard and Digital Power Insights — to support power designers and engineers in the selection and optimization of their DC/DC converters. The cloud-based Power Module Wizard tool allows users to select parts; create schematics; run simulations for stability, transient, and ripple; and optimize loop response, while Digital Power Insights aids in setup and configuration of PMBus control and monitoring parameters. Together, these tools help power designers and engineers optimize their board- mounted supplies at every stage of the design process.

To learn more about the DLynx III product family, click here.

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