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SMALLER, DENSER, AND MORE POWERFUL

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The lines between industries and disciplines have significantly blurred as businesses across sectors add digital equipment to their toolboxes. The bounds of computing capacity may appear to be the most limiting factor in the pursuit of progress, but the truth is that the limits of power distribution — related to density, risk, reliability, efficiency, flexibility, and more — have just as much to do with it. After all, programmers and computer engineers can only expand the bounds of computing capacity if they have the tools to power boosted performance.

This is especially true in today's networking, communications, and data center applications. Consumers' ever-increasing demand for data storage, high-speed networking, and mobile access is continuing to drive the pursuit of new materials and new equipment that allow developers to pack more computing capacity, into smaller, more complex products.

These ever-shrinking footprints and increased computing capacity needs bring about the all-too-familiar challenge of needing more power in less space to meet evolving computing demands. This has accelerated the demand for more optimized and highly dense power equipment. And the global reliance on connected systems for business, governance, and daily communications will only continue to grow exponentially as:

- 5G deployments continue.
- High-performance computing applications proliferate the market.
- Businesses increase their reliance on cloud-based operations and applications.
- Internet of Things (IoT) and Industrial IoT networks mature.

Unless addressed, current density limitations and efficiency concerns in data centers and today's high-power networking infrastructure could prove significant barriers to progress. In this context, optimizing power for these applications will be essential, and that process starts at the printed circuit boards (PCBs) level.

UNDERSTANDING POWER-DENSE DESIGN

Electrical engineers are continuously seeking to optimize power supply designs for highly demanding applications such as computing, networking, and communications equipment. Despite the seemingly straightforward nature of the task — developing higher-powered applications — achieving high power density often requires balancing a variety of factors, including:

1. Available board space allotted for the power footprint.
2. Load requirements for components.
3. Cooling requirements and design.

Perhaps the least flexible of the three is the board space available for power. PCB space and the amount of it allocated for power components is often a fixed footprint driven by the end-design of a device, its application, or by the mechanical dimensions of an end product.

The voltage and current requirements of each end-application play a role in the power design process. These specifications influence what components and materials would be best for a particular build as well as how the PCB can be laid out. Failing to space components appropriately can contribute to increased i2r losses, particularly in high-current builds like those used for the latest field programmable gate arrays (FPGAs) and application-specific ICs (ASICs). Furthermore, over-crowding a board with components and power modules can increase heat at a circuit and board level — which brings us to the last major consideration: cooling.

Cooling is an integral consideration for PCB designers and electrical engineers as it affects the longevity and performance of an overall device. Despite power engineers' best attempts to achieve maximum efficiency in circuits, power losses and heat generation are unavoidable. Losses shed as heat must be dissipated effectively and efficiently to maintain optimal circuit performance. As such, designers must plan adequate space for airflow, heatsinks, or other cooling methods — while remaining cognizant of the overall build footprint. This makes designing for appropriate cooling essential to achieving power-dense PCBs.

To keep pace with the world's demand for increased computing power and networking capabilities, however, board designers and power engineers must find new solutions that push performance even further.

OVERCOMING OBSTACLES TO POWER A CONNECTED WORLD

Accommodating growing power needs is hardly unique to the networking and telecoms sectors, but the exceptionally high demands for applications such as data centers and quantum computing make the task particularly complex. High-capacity networking and communications equipment often have various high-powered components on their PCBs, each with its own voltage and current requirements. Add this complexity to the increased importance placed on efficiency and risk mitigation in these mission-critical applications, and the need to innovate from a board-level power perspective becomes even more clear.

The development of modular point-of-load (POL) DC/DC converters represented a first step toward optimized PCB design. These modules combine semiconductors, magnetic technologies, and other carefully chosen materials into a single, tested, and validated component that's designed to optimize performance, thermal derating, power density, and reliability. For years, modular designs have been helping engineers across disciplines save board space, reduce build times, and design more power-dense end solutions.

Data center operators, original equipment manufacturers (OEMs), and power engineering specialists have been working together for some time to identify solutions that can meet data storage, computing, networking, and processing equipment's unique, ever-increasing demands. And the latest such innovation is a new approach to modular POL converters – one that utilizes master and satellite module pairings to save space, provide improved design flexibility, and to meet the high current needs of today's advanced networking equipment.

THE MASTER-SATELLITE OPTION

Using a master-satellite POL concept can offer networking and communications equipment designers an elegant solution that can power complex boards with diverse voltage and current requirements. By utilizing groupings of purpose- built modules with shared controls, master- satellite architectures can offer flexible, dense, and precise power distribution at numerous points of load. And because satellite modules do not require a separate controller, they can achieve this in a much smaller footprint than other common modular options (Figure 1).

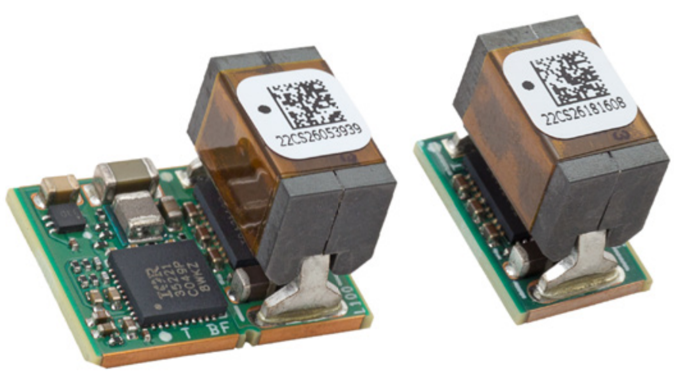

FIGURE 1. Example of master-satellite board space savings; A smaller satellite module can provide an additional 40 A maximum current without the need for its own controls.

The benefits of using a master-satellite POL power architecture could be significant, especially for high-power devices like those found in data centers. These benefits include:

1. Improved power density

Master-satellite configurations can facilitate power-dense designs since the master modules control their associated satellites – eliminating the need for separate controls in each POL module. As a result, the topology can significantly reduce the total solution size of board-mounted power when compared to common "parallelable" approaches. For example, board designs featuring OmniOn Power's DLynx™ III modules can yield power densities in excess of 200 amps/sq. inch, among the highest available today.

2. Reduced design risk, increased reliability, and streamlined builds.

Though often cheaper, custom-built discrete power architectures can lead to time-consuming and complicated board designs. Instead, opting for modular POL converters, like the ones used for master- satellite architectures, can speed design time, and improve time to market.

Part of the allure of POL modules is that OEMs typically test and validate their products against strict industry requirements and criteria, reducing design risk by ensuring certain performance standards and helping to deliver more reliable builds across applications. This extensive testing allows OEMs to offer fully characterized datasheets and simulations, so designers know exactly how a module will perform before they even begin their board build. This not only helps ensure reliability and quality, but it also improves time-to-market.

3. More flexibility

Engineering is an endeavor based on experimentation. As a given build progresses and the demands of the product come into focus, the power demands of the product may change — and that could mean changes to the overall board layout. When building FPGAs for networking equipment, for example, taking a master-satellite approach can help ensure designers have the freedom to adjust builds throughout the process to accommodate complex needs.

Despite their "fixed" nature, modular options can be quite flexible and are often customizable to meet a diverse range of needs. The master-satellite approach to power architectures can further enhance flexibility. The master modules control the conversion and distribution functions of other modules within their groups, eliminating the need for separate controls in each satellite. This allows designers more freedom to tailor the board power and layout to their specific needs. Other features of the architecture, like the DLynx III line's common, nested pinouts, support flexibility by enabling incremental product load adjustments throughout the development process.

BETTER BOARDS, BETTER END SOLUTIONS

We sit on the precipice of significant technological expansion and innovation. Powering the technology behind that innovation, however, remains an increasingly challenging task as concerns about energy efficiency weigh heavily on the minds of consumers and the budgets of providers.

A recent report from GSMA Intelligence found that telecom operators accounted for approximately 2.5% of total global energy consumption in 2021. Energy use accounts for 15-40% of telecom operators' total operating expenses, so it's no surprise that the vast majority of them (92%, according to the report) see sustainability and efficiency improvements as very or extremely important in the coming years. In the data center space, studies estimate that the percentage of global energy used in data center operations will continue to grow in the coming years – with a 2020 European Commission report estimating that data centers will account for 3.2% of global energy use by 2030. Studies like these further demonstrate the importance of efficiency in the networking world.

Much like designing for density, designing for efficiency is a complex process. Taking a discrete approach to building board power architectures can open the door to potential factors that may impact overall circuit and board efficiency. To understand how power components will function and the efficiencies they will achieve, rigorous testing is required. And that takes time and resources. As mentioned, using fully tested and validated modular POL converters can help solve for efficiency and functionality unknowns that can be common in discrete designs. In addition, utilizing a master-satellite architecture can further improve efficiency as the small form factor of the satellite DC/DC converters allows for them to be positioned closer to points of load than alternatives, thereby minimizing long traces and helping to reduce i2r losses.

Of course, the pursuit of more efficient options won't stop here. Engineers are already looking ahead and exploring new solutions to further optimize power designs.

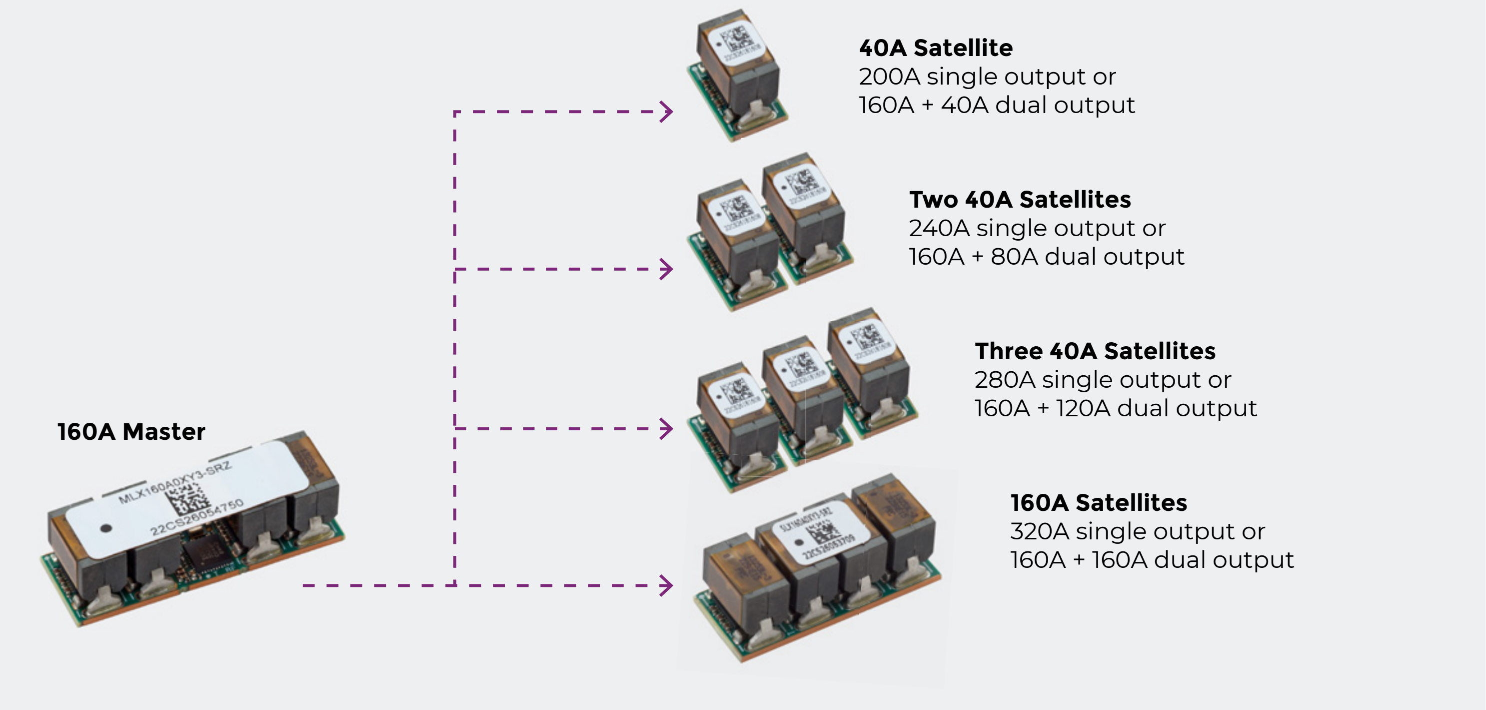

FIGURE 2. Example of design flexibility with multiple satellites or satellites with varying power levels

THE OMNION POWER DIFFERENCE

To help meet the board power needs of the latest networking, communications and industrial applications, OmniOn Power has developed new non-isolated DC/DC converters that utilize the master-satellite architecture mentioned above. Building on its proven DLynx family of POL modules, the DLynx III modules can help designers power their boards of today and tomorrow.

The high-current DLynx III POL modules offer single- or dual-output voltage configurations of up to 320A to meet the specific needs of applications including the latest high-performance ASICs and FPGAs. Master modules feature an integrated controller that helps improve transient response and ripple. With four available master module options (40A, 80A, 120A, and 160A) and two satellite modules (40A and 160A), the DLynx III family of POL modules offers a valuable combination of power quality, reliability, efficiency, and density in flexible configurations (see Figure 2).

In addition, OmniOn Power offers digital tools to help streamline the power design process. These include:

- **Power Module Wizard**, a cloud-based program that allows users to select parts, create schematics, and run simulations on stability, transient response, and ripple.
- **Digital Power Insights**, which aids in setup and configuration to monitor and control performance with PMBus, helping power designers and engineers optimize designs at every stage of application development.

POL modules like the new DLynx III converters are part of OmniOn's comprehensive, end-to-end power solutions that provide power quality, reliability, and efficiency throughout the power chain.

To learn more about the DLynx III product family, please visit our website.