



EXPLORE NEW
TECHNOLOGIES WITH

PSDwebinar

JOIN US FOR
LIVE SESSIONS WITH TOP
INDUSTRY LEADERS
AS THEY DISCUSS
THE LATEST TRENDS
IN TECHNOLOGY.

low-profile form factor designed to operate directly beneath the processor.

Based on Empower's FinFast™ technology, the Crescendo platform features high-frequency IVRs with integrated magnetics in a 6 mm x 7 mm package as thin as 1.25 mm. Importantly, this integration eliminates the need for large external inductors and decoupling capacitors to create the physical and electrical conditions necessary for vertical delivery. By mounting on the PCB backside, the solution delivers current vertically through vias to the processor die, shortening the path, tightening voltage regulation, and dramatically improving transient response.

Performance gains are substantial. Transient response improves by up to 20x compared to conventional converters, with peak current delivery scalable beyond 3,000 amps through module paralleling. The architecture also supports up to 5x greater power density and enables system-level power loss savings of up to 20%. Meanwhile, the removal of under-processor capacitor banks frees board space and reduces thermal congestion so that system designers can increase compute density or simplify board layouts.

Most importantly, this new platform is implemented with commonly available foundry processes, components and packaging. For system architects

tasked with delivering kW level power to processors with high density, the platform offers a practical, immediate, and performance-proven solution to the most pressing power bottlenecks in AI and HPC infrastructure.

Conclusion

Whereas computing performance has always been constrained by transistor counts or core frequency, today it's constrained by power delivery. As AI accelerators grow more capable, they also demand unprecedented amounts of power at increasingly lower voltages, within increasingly confined mechanical envelopes. The industry has responded with higher-voltage rack distribution, intermediate bus architectures, and new packaging strategies, but these only go so far. The final stage, where energy meets silicon, remains the most important and least forgiving.

VPD is a promising solution to that challenge. But as the term gains popularity, clarity becomes more important. Simply re-purposing existing slow power modules to the backside of the board does not constitute VPD. Instead, VPD must truly shrink the power delivery loop to enable fast response, dense packaging, and the removal of bulky passives that have long constrained placement and performance. The Crescendo platform is one of the few technologies to meet that bar.

[Empower Semiconductor](#)

Integrated E-Drives Redefined - Hollow-Conductor Cooling Meets Scalable SiC Inverter Technology

Electric drives form the backbone of modern transportation and industrial applications, quietly powering electric vehicles along highways, propelling aircraft through the skies, and driving efficiency in maritime propulsion systems

By: Benjamin Hengstler, Co-founder & Chief Software Officer at Hyperdrives, CISSOID

Whether accelerating a sports sedan with exhilarating torque or enabling

quiet, emission-free flight, motors and their accompanying inverters must deliver hundreds of kilowatts of reliable, compact, and efficient power. However, the markets for these applications face fierce competition, constant cost pressures, and an ever-growing demand for customized solutions, all within increasingly stringent regulatory frameworks. Rapid adaptability and short time-to-market cycles have become crucial competitive factors. Consequently, designers are challenged to develop systems that balance extreme performance requirements against cost constraints and the need for customization. Hyperdrives and CISSOID tackle these complexities by introducing technologies that dramatically enhance motor and inverter efficiency, reduce integration complexity, and significantly shorten development

timelines—enabling manufacturers to deliver powerful, innovative solutions swiftly and effectively.

Hyperdrives: Revolutionizing Thermal Management with Hollow-Conductor Technology

The key to Hyperdrives' revolutionary motor performance lies in its unique approach to thermal management. Recognizing that effective heat removal is crucial for maximizing motor performance and reliability, Hyperdrives has developed an innovative hollow-conductor cooling technology integrated directly into the stator winding. Rather than relying on external cooling jackets or oil sprays, the system routes dielectric coolant through channels embedded within the copper windings, efficiently extracting heat directly at the source.

Hyperdrives strategically chose a radial flux motor topology combined with hairpin windings due to their compelling advantages in both

electrical and thermal performance. Hairpin windings have become an industry standard in traction motors primarily because they offer exceptional copper fill factors—often exceeding 70% compared to conventional 40–50%. The rectangular hairpin geometry not only improves power density but also simplifies automated assembly, enabling repeatable quality and efficiency in high-volume production.

Additionally, hairpin technology inherently supports better thermal management. The rectangular geometry facilitates more uniform heat dissipation across the conductor cross-section, making it particularly suitable for the integration of internal coolant channels. By directly integrating coolant channels into these hairpin windings, Hyperdrives takes this advantage further, achieving continuous current densities of up to 75 Arms/mm²—approximately three times higher than conventional cooling

methods can sustain.

The industrialization of Hyperdrives' technology was carefully considered from the outset. By leveraging widely adopted hairpin winding production processes, the introduction of the hollow-conductor cooling required only limited modifications. Existing and proven automated manufacturing lines are combined with proprietary processes for joining and sealing - preserving high production throughput and reliability. Moreover, this integrated cooling approach allows Hyperdrives to utilize materials with lower thermal classifications, significantly reducing material costs without compromising reliability or performance.

This holistic integration not only boosts motor performance dramatically but also substantially enhances overall efficiency and operational lifespan. By enabling higher sustained operating currents without resorting to costly high-temperature materials or exotic designs, Hyperdrives has crafted a technology that is both cutting-edge and cost-effective. Ultimately, the adoption of this cooling method translates into smaller, lighter, and more powerful drive units, particularly valuable in automotive, aerospace, and demanding industrial environments.

CISSOID: Flexible High-Power SiC Inverter Solutions for Rapid Market Entry

To fully exploit the advanced thermal management benefits

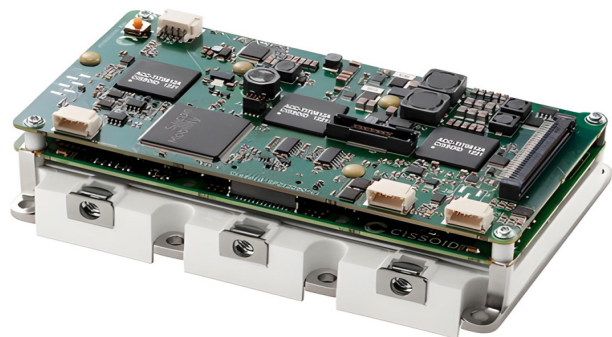


Figure 1: CXT-ICM3S Series – a highly integrated combination of 3-phase power module, gate drivers and control logic.)

Model	Current Rating	Cooling Interface
CMT-ICM3SB12340A	340 A _{RMS}	Flat base plate
CXT-ICM3SA12340A	340 A _{RMS}	Liquid cooling with PinFin
CXT-ICM3SA12450A	450 A _{RMS}	Liquid cooling with PinFin
CXT-ICM3SA12550A	550 A _{RMS}	Liquid cooling with PinFin

Table 1

provided by Hyperdrives' hollow-conductor technology, an equally innovative inverter solution is essential. CISSOID addresses this requirement by offering highly integrated Silicon Carbide (SiC) Inverter Control Modules (ICMS) that combine power electronics, gate drivers, and comprehensive control logic into a single compact package. Their flagship product line, the CXT-ICM inverter control module series, specifically targets high-performance automotive, aerospace, and industrial applications, ensuring maximum efficiency, reliability, and flexibility.

The CISSOID inverter platform is based on 1200V SiC MOSFETs, supporting DC bus voltages from 50 to 850Vdc. The platform includes several standardized variants, designed to meet a wide range of power and cooling requirements. The following table illustrates the main product variants and their respective capabilities

(see **Table 1** for an overview).

Each module incorporates SiC MOSFET power stages known for their ultra-low switching losses, enabling significantly higher switching frequencies compared to traditional silicon-based inverters. Integrated gate drivers ensure precise, rapid control of the MOSFETs, while embedded high-performance processors run sophisticated control algorithms to optimize efficiency, responsiveness, and performance.

Crucially, CISSOID's inverter modules come with an advanced and customizable software stack certified according to ISO 26262 ASIL-D standards. This software ecosystem provides proven field-oriented control (FOC), modulation strategies, comprehensive diagnostic functions, and integrated safety mechanisms. The control processor is ISO 26262 ASIL-D rated, and the inverter control modules

(ICMs) are ASIL-C Ready certified, facilitating the development of functionally safe drive systems.

Thanks to its advanced power stage design and SiC technology, the inverter platform consistently delivers peak efficiencies above 99%. More importantly for real-world applications, it maintains excellent performance across a wide operating range—typically achieving 93~94% efficiency and higher throughout the full speed and torque envelope of the drivetrain.

A defining advantage of CISSOID's inverter modules is their modular and standardized design, granting system integrators substantial freedom when adapting inverter layouts, cooling methods, and enclosure solutions. As a result, OEMs and Tier-1 suppliers benefit from rapid integration into diverse product configurations without extensive custom engineering. This approach significantly shortens development cycles and accelerates time-to-market, essential for competitive, innovation-driven markets.

Through the combined use of CISSOID's modular SiC inverter modules and Hyperdrives' advanced thermal management, engineers can deliver fully integrated, highly efficient electric drive systems tailored precisely to application-specific requirements, without compromising on performance or cost.

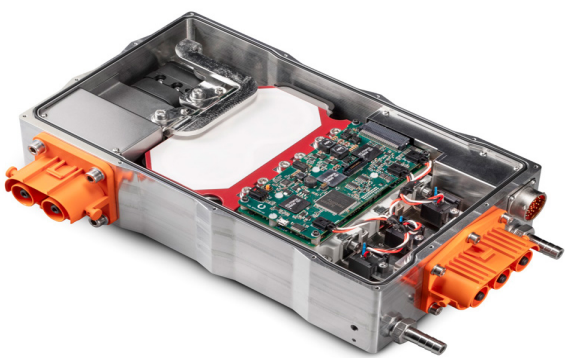


Figure 2: EVK-PLA1060 Series - 3-Phase Silicon Carbide Inverter Reference Design

Integrated Solutions: Reducing Complexity, Weight, and Cost

Traditionally, motors and inverters are developed separately and connected using phase cables, separate housings, and distinct cooling circuits. This segmented approach introduces unnecessary complexity, weight, and increased costs, particularly challenging in performance-critical and volume-sensitive applications.

The integration of Hyperdrives' hollow-conductor-cooled motors with CISSOID's SiC inverter modules streamlines the entire e-drive architecture. Shared cooling loops eliminate redundant components, reduce overall system size, and significantly improve thermal performance. This integration simplifies manufacturing and installation processes, enhances reliability, and dramatically cuts weight, cost, and complexity—critical advantages in automotive, aerospace, and industrial markets. For smaller-scale or highly customized applications, this combination provides unparalleled flexibility without sacrificing economies of scale.

Flexible Performance Scaling: Hyperdrives ONE and ULTRA with CISSOID Inverter Technology

The practical benefits of combining Hyperdrives' innovative hollow-conductor cooling system with CISSOID's flexible SiC inverter modules are clearly demonstrated by two distinct products: the **Hyperdrives ONE**, optimized for automotive and high-performance road vehicles, and the **Hyperdrives ULTRA**, specifically engineered for aerospace and aviation applications. Both systems leverage the same underlying technological principles, yet are finely tuned to their respective use cases through intelligent scaling of inverter performance and careful optimization of the integrated cooling solution.

A direct comparison highlights how modular integration with CISSOID inverters allows rapid adaptation to differing market demands (see **Table 2**).

The Hyperdrives ONE prioritizes high torque and power for automotive traction applications, delivering robust continuous power outputs with remarkable efficiency

at speeds typical for road vehicles. Utilizing CISSOID's high-current CXT-ICM3SA inverter variant, it offers a robust, power-dense, and cost-effective solution ideal for automotive OEMs seeking maximum performance in a compact, easily integrable package.

In contrast, the Hyperdrives ULTRA emphasizes maximum rotational speed and exceptional weight reduction, critical factors in aerospace and aviation applications. Utilizing the same CXT-ICM3SA inverter module but configured specifically to accommodate the higher operational speeds and demanding thermal conditions in aviation, Ultra achieves outstanding power-to-weight ratios of over 12 kW/kg continuous and 15 kW/kg peak on a system level over the full voltage range from 500-800V. By leveraging optimized thermal management enabled by the hollow-conductor cooling technology, the ULTRA significantly reduces overall system mass, directly translating into increased payload capacity, extended flight range, and improved operational efficiency.

This product comparison exemplifies how CISSOID's modular inverter technology perfectly aligns with Hyperdrives' advanced cooling approach, enabling swift and cost-efficient adaptation to diverse performance and application requirements. Whether the priority is maximizing torque for ground vehicles or achieving highest possible rotational speeds and minimal mass for airborne ap-

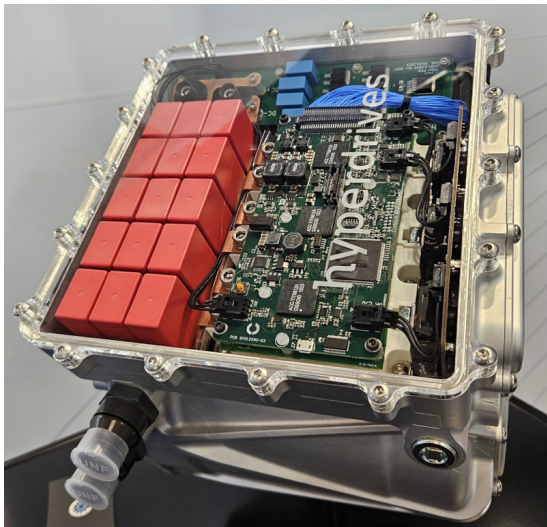


Figure 3: Hyperdrives One: hollow conductor cooled power unit

Specification	Hyperdrives ONE(Automotive)	Hyperdrives ULTRA (Aerospace)
Operating Voltage	800 V	800 V
Peak Power	350 Kw	320 kW
Continuous Power	260 kW	250 kW
Max. Torque	380 Nm	180 Nm
Max. Rotational Speed	16,000 rpm	27,000 rpm
Weight	36.3 kg	19.6 kg
Power Density (Peak, incl. inverter & housing)	9,6 kW/kg	15,8 kW/kg
CISSOID Module Variant	CXT- ICM3SA12550A (550 A)	CXT- ICM3SA12550A (550 A)
Cooling Method	Hollow-conductor dielectric cooling (combined inverter & motor cooling loop)	Hollow-conductor dielectric cooling (combined inverter & motor cooling loop)

Table 2

plications, the integrated system architecture ensures that each variant delivers precisely optimized performance without unnecessary design overhead or inflated development costs.

The integration of Hyperdrives' groundbreaking hollow-conductor cooling and CISSOID's advanced SiC inverter modules represents a major step forward in electric motor and drive system design. By offering exceptional flexibility, scalability, and efficiency, these

solutions empower OEMs and system integrators to rapidly develop customized, high-performance electric drives tailored precisely to their application needs.

To learn more about how these technologies can accelerate your product development, please contact the Hyperdrives or CISSOID teams directly. We look forward to collaborating with you on your next innovative project.

CISSOID

Special Report: Lighting + Illumination



INSIDE:

Intelligent RGB LED Platforms for Automotive and Industrial Innovation...

32

Basics of TFT LCD, OLED, and Micro-LED Displays...

36

The Benefits of LED Lighting in Agriculture...

40