Liquid-cooled servers and optical modules



Overview

Modules Liquid Cooling Solutions | ToneCoolingThis article provides an in-depth analysis of how, under extreme 400W heat density, the perfect synergy betwe.

Key Takeaways

Optical modules are critical high-heat components in servers, and integrating them into liquid-cooled systems is essential for maintaining performance, reliability, and energy efficiency in high-density data centers. Optical Modules as Heat SourcesOptical modules, including transceivers and silicon photonics devices, convert electrical signals to optical signals for high-speed data transmission. As data rates increase to 400G, 800G, and beyond, their power consumption rises significantly, often exceeding 15–30W per module, creating localized thermal hotspots in server racks and switches.

In dense server environments, these modules can collectively generate several kilowatts of heat, which traditional air cooling cannot efficiently dissipate.

Liquid Cooling Integration

Liquid cooling, including cold plate and immersion cooling, provides a more effective thermal management solution for optical modules. In cold plate systems, modules are thermally coupled to liquid-cooled plates that remove heat directly from the component. Immersion cooling submerges servers and optical modules in dielectric fluids, allowing heat to transfer efficiently without electrical interference.

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This approach prevents thermal hotspots, maintains optimal operating temperatures, and extends the lifespan of optical modules and associated networking equipment.

Benefits of Liquid-

Cooled Optical Modules

Enhanced Performance: Stable temperatures prevent throttling of high-speed optical modules, ensuring consistent data transmission and reducing bit error rates. Higher Density: Liquid cooling allows for increased server and rack density by efficiently managing the concentrated heat from multiple optical modules. Energy Efficiency: By reducing reliance on air conditioning and fans, liquid cooling lowers power usage effectiveness (PUE) and operational costs.

Support for Next-

Generation Speeds: Integration with liquid cooling enables optical modules to handle emerging 224G, 400G, 800G, and future 1. 6T data rates without overheating.

Technical Considerations

Module Design: Liquid-cooled optical modules often feature hermetically sealed housings and silicon photonics integration to reduce power consumption and improve thermal conductivity. System Integration: In fully liquid-cooled servers, airflow is minimal, so optical modules must be designed to transfer heat directly to the liquid loop to avoid localized overheating. Operational Reliability: Maintaining module temperatures below critical thresholds prevents degradation of lasers and DSPs, reducing failure rates and extending service life.

Conclusion

The relationship between optical modules and liquid-cooled servers is fundamentally driven by thermal management needs. As optical modules become more power-dense to support higher data rates, liquid cooling is no longer optional but essential. Proper integration ensures stable performance, higher server density, energy efficiency, and longer component lifespan, making it a cornerstone of modern high-performance and AI-focused data centers.

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Article Content

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Principle: Entire servers, including optical modules, are submerged in a dielectric coolant (a fluid that is non-conductive and non-corrosive to electronic components). Heat from the...

Arista targets AI data centers with new liquid cooled pluggable optic ...

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Arista Networks this week announced that it has developed a 12.8 Tbps liquid cooled optics module that it says will help address the power and performance needed for AI data center

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Cisco (CSCO), the traditional enterprise networking giant, is rapidly pivoting toward the AI data center networking market. Both companies'' switches, routers, and optical modules will directly

CPO will soon replace pluggable optical modules, and Rubin will

This groundbreaking switch features a liquid-cooled design to efficiently cool the onboard silicon photonics. The NVIDIA Quantum-X Photonic InfiniBand switch enables new network architecture

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The demand line still looks strong: AI accelerator shipments, ASIC racks, optical networking, liquid cooling, power, and data-center construction are still expanding. The issue is not that AI

Huawei Launches Open-Access SuperPoD Architecture

Its floating blind-mate liquid-cooling connector ensures zero coolant leaks, and the unique materials and techniques used by its cooling system

Cisco Announces Silicon One G300, Advanced Systems and Optics

The Cisco Silicon One G300 will power new Cisco N9000 and Cisco 8000 systems that push the frontier of AI networking in the data center. The systems feature innovative liquid cooling

NVIDIA GB300 NVL72 | 48U | Rack Solutions | Supermicro

Liquid Cooled Rack-Scale Solution with 72 NVIDIA B300 GPUs and 36 Grace CPUs ... Supermicro NVIDIA GB300 NVL72 New

Infrastructure for Scalable AI Reasoning | NVIDIA Vera Rubin Platform

Compatible with liquid-cooled NVIDIA MGX servers, it delivers up to 4x performance for scientific simulations, 6x for AI-for-Science training, and 8x for inference compared to Hopper.

AI Server_Baiduwiki

Industry forecasts predict that from 2026 to 2028, shipments of 800G/1.6T/3.2T Optical Modules will reach 44 million, 79 million, and 158 million units, respectively. 4 Beyond core computing and

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These are the materials, equipment, and component companies that enable HBM4 manufacturing, 3nm fabrication, co-packaged optics, and 1 MW liquid-cooled racks. The alpha is

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