

Liquid Cooling Concept for Optical Modules



AI Overview

Liquid cooling significantly enhances thermal management in optical modules, enabling higher data rates, improved reliability, and energy efficiency compared to traditional air cooling.

Overview Liquid-cooled optical modules are designed to efficiently remove heat generated by high-speed optical transceivers, which can exceed 15W per module in dense data center environments. Unlike air-cooled modules that rely on metal fins and airflow, liquid cooling uses water or other thermally conductive fluids to rapidly transfer heat away from the module, maintaining stable performance and extending component lifespan.

Cooling Methods

- Cold Plate (Indirect) Cooling** A metal cold plate with internal coolant channels contacts the optical module via a thermal interface material (TIM). Heat is conducted from the module to the cold plate and then carried away by circulating liquid.
- Advantages:** easier to service, retrofittable, safe, and compatible with existing infrastructure. Commonly used with OSFP-RHS flat-top modules, which maximize contact area for efficient heat transfer.
- Immersion (Direct) Cooling** The optical module is fully immersed in a dielectric liquid that directly absorbs heat from all components. Can be single-phase (liquid remains stable) or two-phase (liquid undergoes phase change for enhanced heat removal).
- Advantages:** superior thermal performance, uniform cooling, ideal for ultra-high-density and high-power systems. Often paired with silicon photonics modules to reduce power consumption and improve energy efficiency.
- Spray and Direct-to-Plug Cooling** Targeted liquid jets or sprays directly cool hotspots on the module. Provides rapid heat removal for localized high-power areas, supporting extreme data rates like 400G, 800G, and 1.6T.
- Benefits** Higher Data Rates: Supports high-speed interconnects in AI clusters, HPC,...

Article Content

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An apparatus includes a cage structure and a cooling plate configured to contain a cooling liquid to cool the cage structure. The cage structure has a front end, a top surface adjacent to the...

Liquid Cooling Solutions Spurs Next-Gen Optical Module Evolution

How Liquid Cooling Enables the Optical Leap Liquid cooling, once confined to high-performance computing, is now becoming essential for next-gen optical infrastructure. It addresses

Simulation and experimental investigation of liquid-cooling thermal ...

For the unique architecture of CPO, this study analyzes its heat dissipation needs in detail, and a thermal management scheme is designed. The thermal management scheme is

Liquid-Cooled Optical Transceivers for 800G/1.6T

The core concept of liquid-cooled optical modules is the integration of liquid cooling technology with optical transceivers to achieve efficient thermal management, thereby enhancing the

Immersion liquid cooling for electronics: Materials, systems ...

The current work systematically reviews the research progress on immersion cooling technology in electronic device thermal management, including the properties of immersion coolants,

Introduction to Liquid-Cooled Optical Modules and Development Trends

Liquid-cooled optical modules are specialized optical interconnect devices developed for high-density AI computing clusters. They use coolant to directly dissipate heat from core components

Modules Liquid Cooling Solutions | ToneCooling

Review Modules Liquid Cooling Solutions for IGBT and SiC cooling. Covers cold plate layout, coolant flow, pressure drop, leak testing, DFM review,

Molex Releases Report on Thermal Management Challenges and ...

Molex's In-Depth Report of Thermal Management Solutions for I/O Modules addresses the limitations of legacy approaches for thermal characterization and management and explores new

What is Liquid-Cooled Optical Module□

Liquid-cooled optical modules are a powerful thermal management technology utilized in optical systems. The aim is to convert heat in optical systems into cooling effects, thereby enhancing

Liquid Cooling for Optical Networking Equipment

This article provides insights into a successful upgrade of an air-cooled coherent metro router into a Hybrid Liquid/Air-cooled system. Additionally, an innovative solution is presented for integrating liquid

Immersion Cooling Of Optical Transceivers

In this video from SuperComputing 2019, Arlon Martin and the Samtec Optical Group are demonstrating the latest developments in full-scale immersion cooling. Using Samtec Flyover® technology and FireFly™ optical modules, Arlon explains the tradeoffs between air, conduction and liquid cooling.

DC Sustainability: Liquid Cooling for Optical Networking Equipment

Additionally, the article presents an innovative solution for integrating liquid cooling into pluggable optical modules, addressing the challenging thermal demands associated with small form ...

Gigalight Liquid-Cooled Optics: A Thematic Study on Data Center ...

As a leader in optical interconnect technology, Gigalight is pioneering immersion liquid-cooling extenders and silicon photonics liquid-cooled optical modules, driving data centers toward

FiberMall Launches Liquid-Cooled Optical Modules and AOCs, Driving ...

FiberMall, a global leader in optical communication solutions, today officially announced the launch of multiple liquid-cooled optical modules and active optical cables (AOCs) spanning data

Understanding Liquid-Cooled Optical Modules and Heat

What is a Liquid-Cooled Optical Module and How Does Its Heat Sink Work A liquid-cooled optical module helps control heat in fast data systems. You use this

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The liquid cooled optical cage structure provides single phase liquid cooling that minimizes the overall form factor of the cooling plate to avoid interference with face plate features...

Simulation and experimental investigation of liquid-cooling thermal ...

Abstract This study explores the application of cold plate liquid cooling technology in co-packaged optics (CPO). By integrating optical modules and the switch chip on the same substrate, CPO shortens the

Beyond Air Cooling Limits: OSFP-RHS Optical Modules and the

Liquid cooling is now standard in AI data centers. HaloWill explains the advantage of OSFP-RHS flat-top optical modules in liquid-cooled architectures, helping you tackle the thermal

Liquid-Cooled Optical Modules: Deep Dive into NVIDIA Blackwell

Explore the liquid-cooled optical module technology driving the NVIDIA Blackwell platform. Essential analysis of how liquid cooling enables high-density 1.6T and 800G transceivers for future AI clusters.

Immersion Liquid Cooling Optics - GIGALIGHT

GIGALIGHT offers 10G to 800G rates immersion pluggable optical modules with SFP+,SFP28,QSFP+,QSFP28,QSFP56,OSFP-RHS,QSFP112,QSFP-DD and OSFP

Deep Dive into Liquid-Cooled Optical Modules in the NVIDIA ...

As computing systems shift toward liquid cooling, an often-overlooked component, the optical module, is becoming a key focus. In highly integrated environments like NVIDIA's

Immersion Liquid Cooling Interconnect Solutions

Immersion Liquid Cooling Solutions Learn about immersion liquid cooling optical transceivers, active optical cables (AOC) and direct-attach copper cables (DAC). GrowsFiber's immersion cooling optical

Full-Scale Immersion Cooling of Optical Transceiver, PCBs

In this video from SuperComputing 2019, Arlon Martin and the Samtec Optical Group are demonstrating the latest developments in full-scale immersion cooling. Using Samtec Flyover ®

Introduction to Liquid-Cooled Optical Modules and Development Trends

Approach 2: Module-Embedded Microchannel Liquid Cooling Microchannels are pre-embedded inside the optical module housing, paired with quick-connect fluid couplings, allowing

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