

RIVO MULTITRADE OPTICAL SYSTEMS

224g optical module heat dissipation



Overview

224G Optical Module Thermal Design Solutions The ultra-fine and high-density electrical layout of 224G+ high-speed optical modules greatly improves signal.

Key Takeaways

224G optical modules generate significant heat, requiring advanced cooling strategies such as forced airflow, liquid cooling, and optimized heat sinks to maintain performance and signal integrity.

Thermal Challenges in 224G Modules

224G optical modules operate at extremely high data rates, which increases power consumption and heat generation. PCB and package temperatures can rise significantly, potentially exceeding 150°C in extreme scenarios, which affects the Dielectric Constant (Dk) and Dissipation Factor (Df) of PCB materials, leading to degraded signal integrity, reduced eye height, and narrower eye width. High temperatures also compress system design margins, making thermal management critical for reliable operation.

Cooling Strategies

1. Forced Air Cooling:

- Directs airflow over heat sinks and module surfaces.
- Effective for moderate power densities, typically up to 10 kW per rack.

- Low-risk and relatively simple to implement, but may be insufficient for the highest power 224G modules .

2. Liquid Cooling:

- Circulates a high-thermal-mass fluid (water, dielectric oils, or propylene glycol mixtures) through cold plates interfacing with heat-generating components.
- Provides superior heat dissipation, especially when fluid flow is targeted to hot spots.
- Can be combined with passive components to enhance thermal transfer .

3. Direct-to-Chip Liquid Cooling:

- Fluid flows through a cold plate directly contacting the module or chip surface.
- Required for very high power densities, typically 25–50 kW per rack.
- Offers the most efficient heat removal but adds complexity and maintenance requirements .

4. Heat Sinks and Thermal Interfaces:

- Many 224G connectors, such as the Amphenol ExtremePort OSFP 224G, include riding heat sinks on the cage to improve thermal performance .
- Proper thermal interface materials and optimized heat sink design are essential to maintain module temperature within safe limits.

PCB and Material Considerations

- Use ultra-low-loss PCB materials with $Dk < 3.5$ and $Df < 0.002$ to minimize temperature-induced signal degradation .
- Control copper foil roughness and optimize manufacturing processes to maintain impedance and reduce insertion loss.
- High-temperature simulations and material selection are critical to ensure COM margin and signal integrity at 224G speeds.

Summary

Effective heat dissipation for 224G optical modules requires a multi-layered approach: selecting low-loss PCB materials, implementing active cooling (forced air or liquid), and integrating heat sinks at the module and connector level. For extreme power densities, direct-to-chip liquid cooling may be necessary to maintain performance and reliability while preserving signal integrity .

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