

Direct-to-Chip (D2C) Liquid Cooling Module Thermal Resistance Metrics - Official Technical Overview & Hardware Datasheet

EXECUTIVE SUMMARY

The Direct-to-Chip (D2C) Liquid Cooling Module Thermal Resistance Metrics platform represents a definitive engineering breakthrough in thermal management for next-generation telecom and datacenter infrastructure. As rack power densities surge beyond 30 kW per cabinet, traditional air-cooling architectures are no longer sufficient to maintain silicon junction temperatures within reliable operating envelopes. This document provides a comprehensive technical overview of the D2C Liquid Cooling Module, detailing its thermal resistance performance, mechanical integration, and operational specifications. The module is engineered to deliver ultra-low thermal resistance from the die junction to the facility water loop, enabling sustained operation of high-performance ASICs, FPGAs, and multi-gigabit forwarding engines at maximum thermal design power (TDP) without performance throttling. This official OEM datasheet is intended for systems engineers, thermal architects, and infrastructure planners who require precise, verifiable metrics for deploying liquid-cooled telecom hardware in carrier-grade environments.



ARCHITECTURE & CHASSIS DESIGN

The D2C Liquid Cooling Module features a precision-machined cold plate assembly that directly interfaces with the processor die, eliminating the thermal interface layers associated with traditional heat-sink and air-cooling solutions. The architecture is based on a hermetically sealed microchannel cold plate utilizing high-purity copper construction with a proprietary anti-corrosion coating. The module integrates a leak-proof quick-disconnect coupling system compliant with OCP (Open Compute Project) standards, facilitating hot-swappable serviceability without draining the facility water loop. The chassis-level design accommodates a 1RU modular form factor, with support for up to four independent D2C modules per chassis, each serving a dedicated high-power ASIC or optical engine. The structural frame is constructed from corrosion-resistant aluminum alloy, providing both rigidity and weight

optimization for rack-mounted deployments. The module includes integrated flow, pressure, and temperature sensors for real-time thermal telemetry, accessible via an on-board management controller with IPMI and Redfish API support.

HARDWARE FEATURES

The D2C Liquid Cooling Module delivers a suite of hardware-level features designed to ensure optimal thermal performance, operational reliability, and seamless integration into existing telecom infrastructure. Key features include an ultra-low thermal resistance cold plate optimized for high-flow, low-pressure-drop operation; a redundant dual-pump configuration with automatic failover for continuous coolant circulation; a secondary containment shroud to mitigate any potential fluid leakage; and a comprehensive sensor array for continuous monitoring of coolant inlet/outlet temperatures, flow rate, and differential pressure. The module also supports a wide range of facility water temperatures, enabling economizer-based cooling for reduced operational expenditure. The cold plate mounting mechanism applies uniform pressure across the die, ensuring consistent thermal contact across all operating conditions. The module is compatible with industry-standard dielectric coolants and treated water loops, providing flexibility in facility-side infrastructure.

COMPLIANCE & STANDARDS

The D2C Liquid Cooling Module is designed and tested to meet the most stringent international standards for telecom and datacenter equipment. The module is compliant with NEBS Level 3 (GR-63-CORE and GR-1089-CORE) for operation in central office environments, ensuring robustness against seismic events, temperature extremes, and electromagnetic interference. It also adheres to the OCP Liquid Cooling specification, IEC 60950-1 for safety, and RoHS and REACH directives for environmental sustainability. The module has been qualified under Telcordia GR-487 for outdoor cabinet deployments, ensuring reliable operation in extreme environmental conditions. Additional certifications include CE, FCC Part 15, and VCCI for global electromagnetic compatibility. The cold plate and coupling assemblies are rated for a minimum of 10,000 mating cycles, ensuring long-term serviceability and lifecycle reliability.

TECHNICAL SPECIFICATIONS

The following table provides a detailed registry of the D2C Liquid Cooling Module's thermal resistance metrics and operational parameters. These specifications are derived from validated laboratory testing under controlled

conditions and represent typical performance values.

Parameter	Specification
Form Factor	1RU Modular Chassis (up to 4 D2C modules)
Thermal Resistance (Junction-to-Coolant)	0.015 °C/W (typical, at 2 L/min flow rate)
Thermal Resistance (Case-to-Coolant)	0.008 °C/W (typical, at 2 L/min flow rate)
Maximum Heat Dissipation per Module	600 W (continuous)
Coolant Flow Rate (Nominal)	2.0 L/min per module
Coolant Flow Rate (Maximum)	4.0 L/min per module
Pressure Drop (at 2 L/min)	15 kPa (typical)
Operating Coolant Inlet Temperature	15 °C to 45 °C
Maximum Operating Pressure	6 bar
Coolant Compatibility	Treated water, propylene glycol solutions, dielectric coolants
Coupling Type	OCP-compliant quick disconnect, blind-mate
Leak Detection	Integrated sensor with automatic shutoff valve

Monitoring Interface	IPMI 2.0, Redfish API, SNMP v3
Power Supply	12 VDC, 1+1 Redundant (module controller)
Compliance	NEBS Level 3, OCP, IEC 60950-1, RoHS, REACH
MTBF	> 500,000 hours (calculated per Telcordia SR-332)

ORDERING OPTIONS

The D2C Liquid Cooling Module is available in multiple configurations to suit different deployment scenarios. Standard ordering options include the base module with OCP-compliant quick disconnects, a variant with integrated leak detection and automatic shutoff valves, and a high-flow version optimized for processors with TDP exceeding 500 W. Each module is shipped with a factory calibration certificate and a unique serialized identifier for traceability. Spare parts kits, including replacement cold plates, coupling assemblies, and sensor modules, are available for field maintenance. Please contact your authorized OEM sales representative for specific part numbers and availability.

