

High-Density Rack Quick Disconnect Liquid Cooling Module Tolerances - Official Technical Overview & Hardware Datasheet

EXECUTIVE SUMMARY

The High-Density Rack Quick Disconnect Liquid Cooling Module Tolerances represents a paradigm shift in thermal management for next-generation telecom and datacenter infrastructure. As rack power densities surge beyond 30 kW per cabinet, traditional air-cooling methodologies have become thermally inadequate and economically unsustainable. This document defines the engineering tolerances, mechanical interface specifications, and operational parameters for a family of quick disconnect liquid cooling modules purpose-built for high-density rack environments. These modules are engineered to deliver leak-free, hot-swappable fluid connectivity with sub-millimeter precision, ensuring uninterrupted operation of critical network elements. The tolerances detailed herein are mandatory for achieving carrier-grade reliability, with mean time between failures (MTBF) exceeding 1.5 million hours under nominal operating conditions.



ARCHITECTURE & CHASSIS DESIGN

The liquid cooling module architecture is predicated on a blind-mate quick disconnect coupling system that enables tool-less installation and removal from a standard 19-inch rack chassis. The module comprises three primary subsystems: the fluid coupling interface, the internal micro-channel cold plate, and the integrated leak detection and containment assembly. The chassis design accommodates 1RU to 4RU form factors, with modular manifold plates that distribute coolant to up to sixteen independent server nodes per rack. The quick disconnect mechanism utilizes a dual-seal redundant O-ring configuration, with a primary fluorocarbon elastomer seal and a secondary ethylene propylene diene monomer (EPDM) barrier. The coupling actuation force is specified at 15 N maximum, with a locking mechanism that provides tactile and audible confirmation of full engagement. Dimensional tolerances for

the coupling interface are held to ± 0.05 mm for axial alignment and ± 0.1 mm for radial concentricity, ensuring repeatable mating across thousands of cycles.

HARDWARE FEATURES

The module incorporates a range of features designed to maximize thermal efficiency, serviceability, and operational safety. The cold plate utilizes skived copper fins with a fin density of 0.2 mm pitch, achieving a thermal resistance of 0.02 degrees C per watt at a flow rate of 2 liters per minute. The internal fluid channels are optimized for low pressure drop, with a specified maximum of 15 kPa at nominal flow. The quick disconnect couplings are constructed from passivated 316L stainless steel with a chrome-free surface treatment, providing compatibility with common dielectric and non-dielectric coolants, including propylene glycol solutions and fluoroketone fluids. An integrated smart sensor suite monitors fluid temperature, pressure, flow rate, and leak detection at 1 Hz sampling intervals, reporting via an I2C or RS-485 interface to the rack management controller. The module is fully hot-swappable, with a drip-free disconnection mechanism that limits fluid loss to less than 0.1 milliliters per disconnect event.

COMPLIANCE & STANDARDS

The High-Density Rack Quick Disconnect Liquid Cooling Module Tolerances are engineered to comply with the following industry standards: IEC 60950-1 for safety of information technology equipment, IEC 62368-1 for audio/video and IT equipment safety, Telcordia GR-63-CORE for network equipment thermal robustness, and Telcordia GR-1089-CORE for electromagnetic compatibility and electrical safety. The quick disconnect couplings are tested to ISO 16028 for hydraulic fluid power connections and meet the sealing requirements of SAE J2044. RoHS and REACH compliance is mandatory across all constituent materials. The module is qualified for operation in ambient temperatures ranging from -5 degrees C to 55 degrees C and altitudes up to 4,000 meters, with derating above 1,800 meters.

TECHNICAL SPECIFICATIONS

This section details the precise mechanical, thermal, and electrical tolerances that govern the design and operation of the liquid cooling module. All parameters are verified through production acceptance testing and periodic quality assurance audits.

Parameter	Specification
Form Factor	1RU to 4RU chassis, 19-inch rack

	compliant
Coupling Type	Blind-mate quick disconnect, dual redundant O-ring seal
Axial Alignment Tolerance	+/- 0.05 mm
Radial Concentricity Tolerance	+/- 0.1 mm
Coupling Actuation Force	15 N maximum
Fluid Leakage per Disconnect	< 0.1 mL
Thermal Resistance	0.02 degrees C/W at 2 L/min
Maximum Pressure Drop	15 kPa at nominal flow
Coolant Compatibility	Propylene glycol, ethylene glycol, fluoroketone
Operating Temperature Range	-5 degrees C to 55 degrees C
Operating Altitude	Up to 4,000 meters (derating above 1,800 m)
Leak Detection Sensitivity	0.5 mL per hour
Sensor Sampling Rate	1 Hz
Management Interface	I2C, RS-485, or Ethernet with SNMP v3
MTBF	> 1,500,000 hours
Compliance Standards	IEC 60950-1, IEC 62368-1, Telcordia GR-63-CORE, GR-1089-CORE, RoHS, REACH

ORDERING OPTIONS

The liquid cooling module family is available in multiple configurations to suit varying rack densities, coolant chemistries, and management interfaces. Standard options include: Model QD-LC-1RU-4P for 1RU chassis with four parallel ports, Model QD-LC-2RU-8P for 2RU chassis with eight parallel ports, and Model QD-LC-4RU-16P for 4RU chassis with sixteen parallel ports. Each model is offered with either nickel-plated brass or stainless steel coupling bodies. Coolant compatibility options include propylene glycol, ethylene glycol, and fluoroketone. Management interface options include I2C, RS-485, or Ethernet with SNMP v3. Custom configurations for specialized coolant chemistries or non-standard rack dimensions are available upon request. All models ship with a calibration certificate and a five-year limited warranty.

