

Micro-Channel Liquid Cold Plate for High-TDP Network ASICs Hardware Deep-Dive and Performance Specification

SYSTEM OVERVIEW

This document defines the engineering and performance characteristics of the Micro-Channel Liquid Cold Plate (MCLCP) platform, a carrier-grade thermal management solution purpose-built for high-TDP network ASICs deployed in next-generation telecom infrastructure. As line-rate forwarding engines, traffic managers, and security processors scale beyond 400W and 800W per package, conventional air-cooling architectures approach fundamental physical limits. The MCLCP platform addresses this thermal ceiling through direct-to-die micro-channel impingement, delivering a thermal resistance as low as 0.012°C/W and enabling sustained operation of ASICs rated up to 1,500W TDP within standard 1RU and 2RU shelf envelopes. The solution is designed for integration into Central Office, Edge, and AI-adjacent data center environments where reliability, serviceability, and thermal headroom are non-negotiable.



INTERNAL ASIC & BACKPLANE

The cold plate assembly is engineered around a copper micro-channel matrix with channel widths ranging from 80 μm to 200 μm , optimized for single-phase water-glycol coolant. The internal fin geometry is tailored to the specific die hotspot map of the target ASIC, providing non-uniform flow distribution that prioritizes high-power zones. The base plate is machined from OFHC copper with a nickel-plated finish and a flatness tolerance of $\leq 25 \mu\text{m}$ across the die contact area, ensuring uniform thermal interface material (TIM) bond-line thickness. A structural stainless-steel stiffener surrounds the ASIC socket zone, maintaining controlled compressive load between the cold plate and the package lid. The cold plate interfaces with the host board through a blind-mate fluid coupling system rated for 10,000 mating cycles, with integrated drip-free quick disconnects. A secondary backplane-level manifold distributes coolant to

multiple ASIC cold plates within the same chassis, enabling centralized flow control and monitoring.

POWER & THERMAL MECHANISMS

The system supports facility water or liquid-to-liquid heat exchange with a recommended inlet temperature range of 20 °C to 45 °C. Nominal flow rate per cold plate is 1.5 L/min at 1.0 bar pressure drop, scalable to 3.0 L/min for 1,500W-class ASICs. The thermal resistance of the cold plate alone is specified at 0.012 °C/W at 1.5 L/min, with a total junction-to-inlet resistance of 0.035 °C/W including TIM and package spreader. Leak detection is provided through an integrated capacitive sensor array at the quick-disconnect interface, with alarm output via I²C and dry-contact relay. The cold plate is qualified for continuous operation at 80 °C coolant temperature and 15 bar burst pressure. Redundant pump and coolant distribution units (CDUs) can be deployed in 1+1 configuration, with automatic failover and flow balancing across parallel cold plate branches.

PHYSICAL LIMITS

The MCLCP assembly is available in three standard footprint variants: 60 mm × 60 mm, 80 mm × 80 mm, and 100 mm × 100 mm, each with a height profile

of 18 mm to 24 mm depending on the connector and manifold configuration. The unit weighs between 320 g and 680 g, excluding fittings and hose assemblies. Operating altitude is rated to 4,000 m, and the assembly is qualified to NEBS Level 3 and GR-63-CORE seismic Zone 4 requirements. The cold plate is designed for a 15-year service life with no scheduled maintenance beyond annual coolant quality checks.

PARAMETER REGISTRY

Parameter	Specification
Cold Plate Technology	Copper micro-channel impingement, 80–200 μm channel width
Thermal Resistance (Cold Plate)	0.012 $^{\circ}\text{C}/\text{W}$ at 1.5 L/min
Thermal Resistance (Junction-to-Inlet)	0.035 $^{\circ}\text{C}/\text{W}$ including TIM and spreader
Maximum ASIC TDP Support	1,500 W
Coolant Type	Single-phase water-glycol (25 – 50% PG)
Nominal Flow Rate	1.5 L/min per cold plate (scalable to 3.0 L/min)
Pressure Drop	1.0 bar at nominal flow
Inlet Temperature Range	20 $^{\circ}\text{C}$ to 45 $^{\circ}\text{C}$

Maximum Coolant Temperature	80 °C continuous
Burst Pressure	15 bar
Quick Disconnect Rating	10,000 mating cycles, drip-free
Leak Detection	Integrated capacitive sensor, I ² C and dry-contact alarm
Form Factor Variants	60×60 mm, 80×80 mm, 100×100 mm
Height Profile	18 mm to 24 mm
Weight	320 g to 680 g
Operating Altitude	Up to 4,000 m
Seismic Rating	GR-63-CORE Zone 4
Compliance	NEBS Level 3
Service Life	15 years
Warranty	5 years standard, extendable to 10 years

GLOBAL SUPPORT INFRASTRUCTURE

The MCLCP platform is supported by a global network of thermal engineering labs, with regional qualification centers in North America, EMEA, and APAC. Each deployment includes access to thermal simulation models (Icepak and FloTHERM), mechanical STEP files, and ASIC-specific thermal characterization

reports. A 24/7 technical assistance center provides escalation support for coolant chemistry, pressure drop anomalies, and leak detection events. Field-replaceable cold plate kits and quick-disconnect service loops are stocked in regional depots for 48-hour delivery. The platform is backed by a 5-year limited warranty, extendable to 10 years with an advanced replacement program.

