

AI Data Center Liquid Cooling Hardware White Paper

Precision metal components for cold plates, manifolds, connectors, busbars, brackets and power modules



Prepared for AI infrastructure, data center hardware, sourcing and supplier-quality teams.

Executive Summary

AI data centers are pushing rack power density higher, which makes liquid cooling hardware a practical supply-chain topic rather than only a thermal-engineering topic.

Precision metal components in cold plates, manifolds, quick connectors, busbars, brackets, sensor mounts and sealing assemblies must be reviewed together because leakage, flatness, burrs, plating, cleanliness and electrical clearance can affect system reliability.

Zhengna Technology supports made-to-drawing precision hardware through CNC machining, Swiss-type machining, stamping, sheet metal fabrication, springs, fasteners, copper and aluminum component manufacturing, finishing, assembly and inspection.

Why AI Data Center Liquid Cooling Hardware Matters

High-density AI accelerators and server platforms increase heat flux and power-delivery requirements. Direct-to-chip liquid cooling, cold plates, manifolds, connectors and CDU-adjacent hardware create new demand for precision machining, sealing surfaces and repeatable inspection.

The buyer challenge is not simply buying a fitting or a bracket. The harder question is whether the supplier can control the physical interfaces that prevent leakage, pressure drop, corrosion, electrical risk and assembly damage.

Component Map

Component	Typical function	Buyer risk
Cold plates	Transfer heat from GPU/CPU/ASIC packages to coolant	Flatness, channel geometry, sealing surface, cleanliness
Manifolds	Distribute coolant across modules or rack assemblies	Port accuracy, pressure drop, thread fit, leak path
Quick connectors	Enable serviceable liquid loops	O-ring groove, thread quality, surface finish, insertion force
Copper busbars	Deliver high current in compact power modules	Conductivity, plating, hole location, edge safety
Brackets and mounts	Hold hoses, sensors, cold plates and power modules	Burrs, bend angle, vibration, cable protection
Fasteners and clips	Retain modules, connectors and covers	Torque behavior, coating, spring force, fatigue

Material And Process Selection

Material / process	Where it fits	Control focus
Copper / copper alloy	Cold plates, busbars, conductive inserts	Conductivity, oxidation, burr control, plating, cleanliness
Aluminum alloy	Cold plates, manifolds, brackets, light housings	Flatness, anodizing thickness, thread strength, corrosion
Stainless steel	Fittings, shafts, fasteners, corrosion-resistant hardware	Surface finish, passivation, thread quality, galling risk
CNC / Swiss machining	Connectors, ports, precision fittings and manifolds	Concentricity, O-ring grooves, threads, deburring
Stamping / sheet metal	Brackets, shields, clips, supports	Burr direction, springback, flatness, hole position
Cold heading / springs	Fasteners, pins, spring clips and retainers	Thread fit, coating, spring force, fatigue



Critical Quality Checklist

- Sealing surfaces: flatness, roughness, scratch control and O-ring groove dimensions.
- Fluid passages: burr removal, chip control, cleaning method and pressure/leak test planning.
- Threaded ports: gauge fit, thread depth, plating effect and torque expectations.
- Copper busbars: hole position, edge radius, plating, conductivity and packaging protection.
- Brackets and clips: bend angle, vibration resistance, cable clearance and edge safety.
- Assembly interfaces: stack-up tolerance, mixed-material corrosion risk and serviceability.



Prototype-To-Production Roadmap

Stage	Buyer goal	Supplier focus
Concept prototype	Confirm fit, coolant path and packaging	CNC samples, material review, basic leak-risk review
Engineering validation	Confirm thermal, fluid and assembly assumptions	Critical dimensions, sealing surface, thread and burr control
Pilot batch	Measure repeatability	Inspection plan, pressure/leak test, packaging and documentation
Production	Scale stable supply	Tooling, process control, traceability, change management

RFQ Checklist

- 2D drawings, 3D files, part function and revision level.
- Material, coating, plating, cleanliness and packaging requirements.
- Sealing surface, O-ring groove, thread and pressure/leak test expectations.
- Conductivity, insulation, edge radius and plating requirements for busbars.
- Prototype quantity, pilot-batch quantity, annual volume and target production timing.
- Inspection report, material certificate and traceability expectations.

References

- NVIDIA data center liquid cooling and AI infrastructure public materials.
- ASHRAE thermal guidelines and liquid cooling guidance for data processing environments.
- Uptime Institute analysis on AI data center power, cooling and density constraints.
- Google Search Central helpful-content and AI features guidance.
- Bing Webmaster Tools AI Performance guidance.