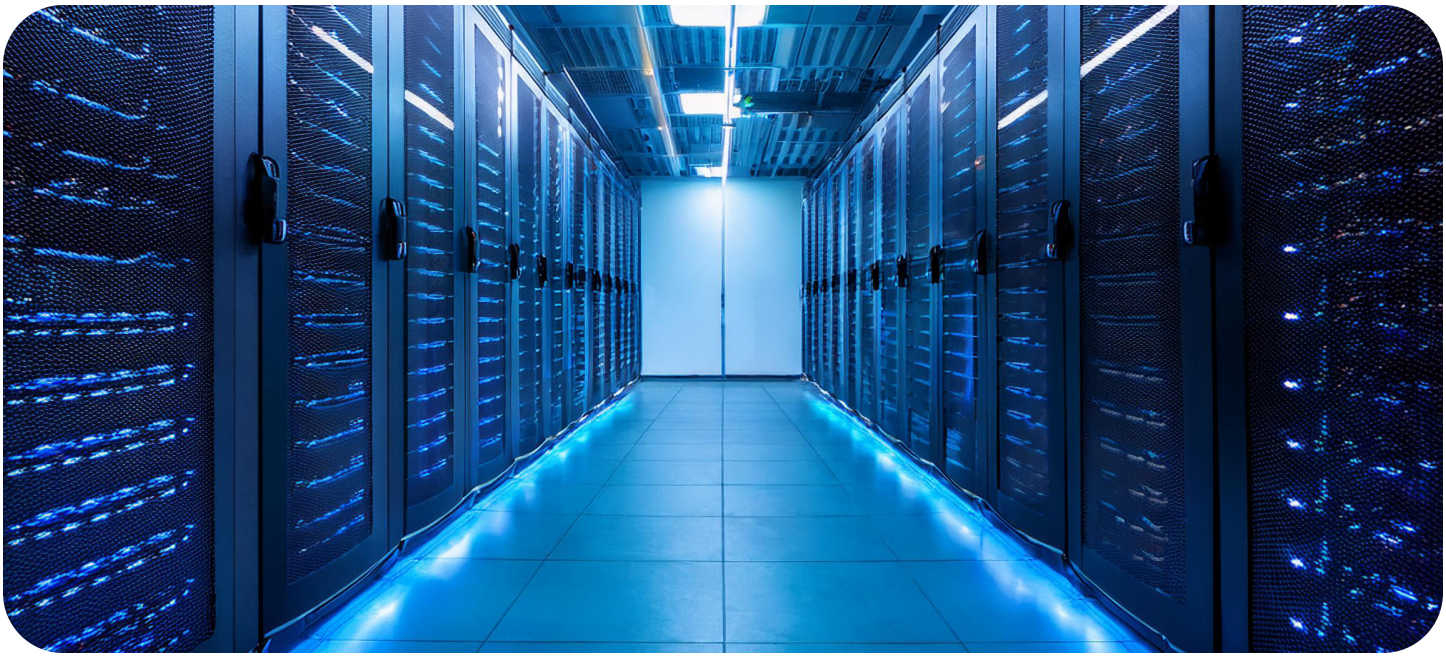
Location and QD Specification

Liquid Cooling Quick Disconnects – Which Ones, Where and Why



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CONNECTORS FACILITATE LIQUID COOLING SUCCESS

As the demand for more processing power increases, so do power densities and the heat generated by them. To better manage the heat, data centers are adopting liquid cooling at a rapid pace. This is not surprising given that liquid cooling is up to 1,000 times more efficient at moving heat away than air.

Liquid cooling is already used in the world's fastest, most powerful computers. AI now necessitates its use in data centers. Soon it will be found more commonly in university labs, engineering companies and other places that run intense simulations. Liquid cooling systems also manage heat in other rapidly expanding applications like electric vehicle charging stations, medical electronics, telecommunications, and green energy equipment.

Because liquid cooling is now a necessity in a growing range of applications, it is time to overcome the traditional concerns about the proximity of liquid with expensive and sensitive electronics. Quick disconnects (QDs) — in this case, non-spill or "dry break" connectors — are vital in creating reliable cooling systems and supporting the modularity for serviceability that these applications demand.

COOLING AND QDS IN DATA CENTERS

Some of the most complex liquid cooling systems are found in large data centers where literally thousands of QDs enable the use of liquid cooling loops. Coolant distribution units (CDUs), rack manifolds, internal server manifolds, and cold plates are main components within these cooling loops, which are necessary to cool the heat-generating components within the server, namely the central processing units (CPUs) and graphics processing units (GPUs).

The performance requirements for QDs vary by their location within the overall system, so it is important to understand what to look for at each point. This guide covers key considerations for specifying QDs in data centers; however, the

same core concepts apply to selecting connectors for use in the cooling loops of many other applications.

FLOW COEFFICIENT AND PRESSURE DROP: KEY CONSIDERATIONS

The first step in QD selection is characterizing each connector set's flow coefficient. Sizing the wrong QD can result in inefficient performance or even product failure, especially if the connector set is smaller than the application requires.

Flow coefficient (Cv) is defined as the flow rate (Q) in U.S. gallons per minute (GPM) with water (specific gravity, or SG, of 1.00) that results in a 1 PSI pressure drop (ΔP) across a connector. (The flow coefficient is unitless.) CPC determines the Cv of any given connector pair (body and insert) with empirical testing using water, observing the pressure drop across a connection at a given flow rate. A formula below is then used to calculate the resulting Cv at each flow rate and averaged to characterize the connector set's performance. The higher the flow coefficient, the better the QD's flow performance.

$$Cv = Q\sqrt{\frac{SG}{\Delta P}}$$

Formula 1.

CDU-TO-MANIFOLD: MANAGING HIGH FLOW RATES

Coolant distribution unit (CDU)-to-manifold connections support modularity and serviceability of the CDUs, particularly when they need to be repaired or replaced.

Connectors in the CDU rack distribution manifolds also are exposed to the highest flow rates — 10 GPM or more. With such high flow rates, the pressure across the entire cooling loop must be high enough to ensure adequate fluid velocity and heat ejection for the liquid cooling system and the application's electronics to work to their full potential.

High flow and low pressure drop are important for the CDU/rack manifold connection as it is one of the highest upstream connection points in the cooling system. Optimizing flow performance upstream delivers high performance and flexibility downstream.

CDU-to-manifold connections are usually the largest connections made with quick disconnects. CPC's largest non-spill QDs, the Everis® LQ10/BLQ10, have a Cv of ~9.3. This means these connectors will have the lowest pressure drop and the highest allowable flow rate.

Connections downstream from the CDU will require less and less flow, allowing for smaller connections along the way. Also, the closer to connection points are to electronics, the greater the need for non-spill performance.

RACK MANIFOLD-TO-SERVER: QDS EASE SERVICE

QDs also connect rack manifolds with individual servers. After connecting the rack's main inlet and outlet to the server's inlet and outlet, fluid flows through the cooling loop rejecting heat coming from the server. At this point, the flow through the manifold is segmented into many different paths, depending on how large the servers are.

QDs in these locations allow for easy and efficient servicing, removal, and replacement of servers in the rack, which is important given the number of potential connection points. For example, if all of the servers are held to 1U in height in a standard 19-inch rack, there could be a multitude of different loops stemming from the manifold. Since these are in parallel, the flow is split as well, resulting in lower flow rates for these connections, though flow rates are very application dependent (more heat necessitates higher flow rates).

Everis® LQ2, LQ4, LQ6, and LQ8 products are commonly used to make rack manifold-to-server connections.

CONNECTOR NAME	NOMINAL FLOW SIZE	CV
EVERIS® LQ2	1/8"	0.4
EVERIS® BLQ2	1/8"	0.4
EVERIS® LQ4	1/4"	1.4
EVERIS® BLQ4	1/4"	1.4
EVERIS® LQ6	3/8"	2.2
EVERIS® LQ6	3/8"	2.2
EVERIS® LQ8	1/2"	6
EVERIS® LQ10	5/8"	9.5

Table 1: Everis® QDs Flow Performance

All the connections mentioned so far are hand-mated—a latching mechanism locks the insert (male) connector into the body (female) connector, securing them together.



Figure 1: At left, color-coded hand-mate Everis(R) LQ6 QDs with latches. At right, blindmate Everis(R) BLQ6 quick disconnects which require an external locking system.

Another connector configuration, blindmate QDs, are commonly seen when a server rack or power conversion unit has a distribution manifold with fluid connections, as well as electrical connections at the back of the tower. Figure 1 shows the difference between hand-mated quick disconnects which are self-locking and blind mate connectors.