Universal Quick Disconnect Blind-Mate
Fluid Connector Development, Testing and Specification
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Starting in 2017 Intel engaged with OCP industry partners to enable liquid cooling ingredients

• Hand-mate Universal Quick Disconnects Specification: approved 2020
  Specification presented at OCP Global Summit 2019

• Blind-mate Universal Quick Disconnects Whitepaper and Specification Approved 2021

• UQDB was presented in ACS Cold Plate call and OCP Incubation Committee
Intel’s Eco-System Enabling

Focus: Manifold Distributed Liquid Cooling Ingredients

Technology Cooling System (TCS) = Cooling Loop from CDU through the rack/IT equipment

Facility Water System (Primary Side)

Cooling Fluid

Cooling Distribution Unit (CDU)

Liquid-to-Liquid

Universal Quick Disconnects (UQD) and Blind-mate UQDs (UQDB)

Rear View

Server Rack

TCS Cooling Ingredients:
- Cooling Fluid
- Universal Quick Disconnects (UQDs)
- Blind-Mate Universal Quick Disconnects (UQDBs)
- Cooling Distribution Units (CDUs)
Problem Statement: Currently fluid connectors for electronics cooling are proprietary and non-interchangeable. Servers must be sourced with customized SKU (mfg. part no. connector) to interface with the cabinets.

UQDB Adds Value to Electronics Cooling Industry

- Eliminates need for single sourced proprietary parts
- Simplifies the supply chain
- Global availability with sourcing in, Europe, US, China
- Refresh simplified
- New components can easily be added to the liquid circuit
- Encourages suppliers to innovate
- Common and interchangeable – improves adoptability
- All parts meet the expected performance

Multi-Sourced Universal Quick Disconnect Blind-Mate
UQDB Dimensions

- Minimum set of prescribed dimensions
- Each supplier can differentiate on self-alignment mechanism and internal flow geometry
- Geometry allows multiple self-alignment features, enabling design flexibility for suppliers to differentiate
UQDB Requirements & Performance Testing

To verify interchangeability among suppliers:
- Performance requirements specifically derived for the electronics cooling industry
- The specified requirements address performance criteria for Pressure, Flow Rate, Temperature, Cv (Flow Coefficient), Durability, and life

<table>
<thead>
<tr>
<th>Parameter</th>
<th>UQDB02</th>
<th>UQDB04</th>
<th>UQDB06</th>
<th>UQDB08</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum operating pressure</td>
<td></td>
<td>100 psi</td>
<td></td>
<td></td>
<td>Required</td>
</tr>
<tr>
<td>Minimum burst pressure</td>
<td></td>
<td>300 psi</td>
<td></td>
<td></td>
<td>Required</td>
</tr>
<tr>
<td>Minimum Cv&lt;sup&gt;3&lt;/sup&gt; at minimum engagement</td>
<td>0.25</td>
<td>0.80</td>
<td>1.55</td>
<td>2.40</td>
<td>Required</td>
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</tbody>
</table>

Flow Rating<sup>4</sup>
- At least 0.55 GPM
- At least 1.7 GPM
- At least 3.0 GPM
- At Least 4.7 GPM

Recommended Manufacturer discretion (ratings shall be published by supplier)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temperature range&lt;sup&gt;5&lt;/sup&gt;</td>
<td>17°C - 65°C</td>
<td>Required</td>
</tr>
<tr>
<td>Shipping temperature range&lt;sup&gt;6&lt;/sup&gt;</td>
<td>-40°C – 75°C</td>
<td>Required</td>
</tr>
</tbody>
</table>

<sup>1</sup> Cv are reported for water.
<sup>2</sup> Flow rating is for water.
<sup>3</sup> Support for higher temperature range is desirable as an option as there are known solutions that may operate in the range 17°C - 75°C. It is expected that rating would be published by supplier.
<sup>4</sup> Shipping may include charged systems.

\[
C_v = Q \sqrt{\frac{SG}{\Delta P}}
\]

\[
Q = C_v \sqrt{\Delta P}
\]

- Measure: flow rate, pressure drop
Test Setup

- Hose length calculated for uniform flow at UQDB: 12 inches
- Test: 3 flowrates
- Record pressure delta values

Test Matrix

<table>
<thead>
<tr>
<th>Socket</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
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<tbody>
<tr>
<td>Plug</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>x</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>B</td>
<td>✔</td>
<td>x</td>
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<tr>
<td>C</td>
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<td>✔</td>
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<tr>
<td>D</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>x</td>
</tr>
</tbody>
</table>

4 Suppliers, run 4 iterations

Test fixture to test in varying mating conditions

- Nominal vs minimum engagement
- Radially aligned vs full 1mm of radial misalignment
- Flow direction through UQDB pair (Socket to Plug vs Plug to Socket)
Baseline – Calibration

- Establish baseline pressure drop without UQDB
Post-Processing Example

Sample Pressure Drop
Pressure drop through UQDs – Subtract baseline pressure drop

Solve for Cv
Linear fit using
\[ Q = C_v \sqrt{\Delta P} \]
Low Cv relates to a high resistance

As Cv decreases in single blade, flow decreases. Total flow distributed through rack, potentially negative impact on single-blade cooling.

UQDB Impact Solver

Vary flow rate through each blade so that pressure drop is equal. Sum of blade flowrates equal to system flowrate.

Previous Results: pressure drop through servers/racks outweighs affect of varying pressure drop through UQDBs.

Takeaway: Little to no risk in using UQDBs from various suppliers
Call to Action

Review the UQD hand-mate and UQDB specifications and UQDB whitepaper for more information
  • https://www.opencompute.org/contributions

Get involved in the ACS Coldplate sub-project group
  • Monthly meetings 11-12 AM ET
  • https://www.opencompute.org/projects/acs-cold-plate
Thank you!