



Optimizing Data Center Cooling with ECM-Enabled Pump Design

As data centers race to support AI, High Performance Computing (HPC), and ever-denser compute environments, liquid cooling is fast becoming a necessity. Whether used in direct-to-chip systems, immersion tanks, or rear-door heat exchangers, pumps are the unsung heroes of these thermal systems, maintaining coolant flow, managing temperature, and enabling energy-efficient operation.

But traditional pump motors haven't kept up. They're often oversized, inefficient under partial loads, and prone to mechanical wear. In dynamic environments like modern data centers, these shortcomings add up to higher energy costs, system instability, and increased risk of downtime.

That's where pumps powered by ECM's patented PCB Stator motor platform offer a new path forward.



PCB Stator Circulator Pump (L) vs Conventional AC Induction Pump (R)

CHALLENGE: COOLING SYSTEMS ARE ONLY AS SMART AS THEIR PUMPS

In high-performance data centers, liquid cooling pumps are expected to do more than just move fluid. They must operate quietly, respond to constantly changing loads, and deliver optimal efficiency – all while fitting into increasingly compact infrastructure.

But legacy systems fall short:

- Overpowered pumps waste energy, especially at partial load
- Oversized pumps take away space from servers and server racks
- Mechanical seals wear out or fail due to dry running
- Electromagnetic interference (EMI) complicates integration with sensitive control systems
- Single-speed motors lack responsiveness to fluctuating thermal demands
- Many conventional motors are not fully submersible and can struggle in immersion or high-moisture environments, limiting their use in advanced liquid cooling systems

These limitations not only increase cooling costs but also create design and maintenance headaches for facility teams.

SOLUTION: ECM'S PCB STATOR MOTOR PLATFORM FOR LIQUID COOLING PUMPS

Motors developed using ECM's patented axial flux PCB Stator technology and engineered with the PrintStator Motor CAD platform address these challenges at the source.

They're compact, precise, and built to operate efficiently across load ranges and cooling architectures.

Here's how motors built with ECM software and technology improve pump performance:

- **High Efficiency Across Load Range:** Thanks to their inherently flat efficiency curve, motors designed with ECM's platform maintain high operating efficiency across a wide range of load conditions. Whether running at full capacity or during light-load conditions, they consistently minimize energy waste – a major advantage in dynamic thermal environments.
- **Compact Form Factor:** The axial flux design enables lightweight, low-profile motors ideal for tight pump enclosures and space-constrained cooling modules.



Compact PCB Stator motor integration next to legacy pump motor

- **Fully Submersible:** Motors built with ECM's PCB Stator design can be configured for full submersion in dielectric or water-based cooling environments, making them well-suited for immersion cooling tanks or sealed coolant distribution units (CDUs) where fluid exposure is constant.
- **Quiet, Low-Vibration Operation:** The cog-free, direct-drive nature of PCB Stator motors results in ultra-smooth motion and reduced wear – perfect for 24/7 uptime environments.

- **Exceptionally Low EMI:** With sinusoidal stator windings, sinusoidal back-EMF, and no iron core, motors engineered using ECM's technology emit minimal electromagnetic interference (EMI). This ensures reliable operation even when co-located with sensitive electronics and high-frequency equipment.
- **Seal-Free Compatibility:** Motors designed through ECM's platform support magnetic drive pumps, eliminating the failure-prone seals used in traditional designs and reducing leak risk.

RESULT: A SMARTER, MORE SUSTAINABLE COOLING LOOP

Integrating motors developed with ECM's software and PCB Stator architecture into pump systems – from coolant distribution units (CDUs) to direct-to-chip and immersion loops – enables measurable improvements in performance, reliability, and cost control:

- Cut cooling energy consumption by 20–30%
- Improved responsiveness to real-time thermal loads
- Cleaner system integration with lower EMI
- Compliance with global IE5+ motor efficiency standards

Whether you're optimizing a legacy retrofit or designing next-gen cooling from scratch, ECM's motor platform helps data centers unlock better performance with fewer trade-offs.

LOOKING AHEAD: SOFTWARE-DEFINED PUMP DESIGN

With ECM's PrintStator CAD platform, OEMs and operators can design motor solutions tailored to specific pump requirements – from torque and speed to form factor and thermal load – in hours and days, not months.

In an industry where cooling is now mission-critical, ECM is enabling smarter, faster, and more sustainable solutions from the motor up.