WHITE PAPER

Portescap

Inside the Machine: The Motion Systems Powering Modern Lab Instruments

RegalRexnord™

Diagnostic laboratories are experiencing rapid and profound shifts in demand, operations, and expectations. Rising test volumes, expanded diagnostic menus, persistent staffing shortages, and heightened sustainability goals are all reshaping what laboratories require from automated instruments. These pressures have placed increased emphasis on high performance motion technologies, which serve as the mechanical backbone of nearly every analytical, pre analytical, and post analytical workflow. Motors, gearboxes, encoders, actuators, and linear assemblies work in concert to move samples with precision, deliver reagents consistently, and ensure that results are reliable and repeatable. As automation grows more sophisticated, the quality and configuration of these motion systems have become central to instrument performance.

Industry Trends Elevating the Importance of Motion Technology

Across global diagnostic environments, several industry trends are profoundly influencing instrument design. Laboratories are processing greater numbers of tests, driven by chronic disease monitoring, infectious disease surveillance, and the expansion of molecular diagnostics. At the same time, workforce shortages are limiting the availability of skilled technologists, pushing automation to fill operational gaps once supported by manual labor. Instrument manufacturers are also being asked to deliver modular, compact systems capable of fitting into increasingly constrained laboratory footprints while still supporting broad assay menus. Sustainability has emerged as another major priority, with laboratories seeking equipment that consumes less power, generates less heat, and requires fewer replacement components. Collectively, these trends have increased the intensity with which manufacturers evaluate motion system efficiency, reliability, and integrability.

Rotational vs. Linear Motion: Core Functions in Diagnostic Devices

Within today's diagnostic instruments, rotational and linear motion systems each play distinct yet complementary roles in driving core analytical functions. Rotational mechanisms provide the speed and smooth torque delivery required for processes such as sample separation and fluid propulsion, while linear motion assemblies enable the precise positioning, transport, and metering that underpin reliable workflow execution. Together, these coordinated movements determine how efficiently samples move through an instrument, how accurately reagents are dispensed, and how consistently results can be produced. Understanding the specific contributions of each motion type helps illuminate the engineering decisions behind modern laboratory automation.

Rotational Motion in Diagnostic Processes

Rotational motion is essential in a range of diagnostic applications that require circular or high speed movement. One of the most prominent examples is centrifugation, a critical sample preparation step that relies on rapid acceleration and sustained high speed rotation to separate fluids and particles by density. Brushless DC (BLDC) motors are widely used in centrifuges because they offer stable speed control, long operational life, and precise acceleration and deceleration profiles. Their ability to support diverse spin programs ensures consistent separation quality across different instruments and sample types.

Another important rotational application is fluid propulsion through peristaltic pumps. These pumps deliver reagents into reaction vessels with exacting volumetric accuracy, making motor selection particularly consequential. BLDC and coreless DC motors are both well suited for these systems due to their low inertia and ability to coordinate rapid, synchronized dispensing cycles. Reliable rotational performance directly affects assay repeatability, reagent usage efficiency, and overall workflow speed.

Figure 1: The 16DCT Athlonix™ Brush DC and 16ECP24 Ultra EC™ BLDC motors deliver smooth, stable rotational motion ideal for centrifugation and precise peristaltic pumping—supporting accurate sample prep and reliable reagent delivery.

Linear Motion and the Control of Sample Handling

While rotational systems support high speed processes, linear motion enables the precise, controlled movement required for transport, positioning, and fluid metering within the instrument. XY sample transport is a foundational linear application, responsible for moving tubes, plates, or pipetting tools throughout the workflow. Stepper motors are traditionally favored for these axes due to their inherent positional accuracy and torque characteristics, which help maintain stable, predictable movement even at low speeds. In situations where higher speeds are required, coreless DC or brushless DC motors may be incorporated, though they often require gearing to meet torque demands. Lead screws or ball screws convert rotary motion into smooth, repeatable linear travel, and encoder feedback ensures accurate positioning.

Figure 2: The 42STH34D Hybrid Stepper and 42STLN34 Linear Hybrid Stepper deliver precise, reliable linear motion—perfect for fast, accurate XY transport and fluid metering in diagnostic systems.

Linear actuation also plays a defining role in decapping mechanisms. Because samples are frequently arranged in tightly spaced arrays, the actuation system responsible for removing caps must deliver sufficient force within a very limited diameter. Integrated BLDC motor gearbox assemblies with built in lead screws offer the compactness and power density needed for this task while reducing system complexity and minimizing points of mechanical wear. Their design simplifies assembly and improves reliability without increasing instrument size.

Figure 3: The 08ECP20 slotless BLDC motor, paired with the R08 gearhead and CM2150-1450N-A00A00-AFM lead screw deliver compact, high-torque linear motion ideal for fast, reliable tube decapping.

Fluid metering through syringe pumps and valve mechanisms represents another key linear motion application. Stepper linear actuators provide direct linear output with fine resolution, enabling the accurate, repeatable dispenses and valve positions required for sensitive fluidic operations. Their compactness allows multiple actuators to be installed in parallel within dense instrument designs, supporting modern modular layouts.

Motor Type	Technology Description	Key Benefits	Related Applications	Example Products
Brushless DC (BLDC) Motor	Electronically commutated motor with permanent magnet rotor	• Stable high speed control • Long operational life • Precise acceleration/ deceleration • Supports diverse spin profiles	• Centrifugation • Peristaltic pumps	• 16ECP36 Ultra EC slotless BLDC • 22ECP45 Ultra EC slotless BLDC • 32ECF Slotted Flat BLDC
Coreless DC Motor	Ironless, low inertia rotor design	• Rapid response • Smooth rotational control • Well suited for coordinated dispensing	• Peristaltic pumps	• 16DCT Athlonix brush DC • 22DCT Athlonix brush DC
Stepper Motor (with lead screw / ball screw)	Rotary stepper paired with mechanical screw to generate linear movement	• High positional accuracy • Good torque at low speeds • Predictable motion	• XY sample transport	• 35STH34D Hybrid Stepper • 42STH34D Hybrid Stepper • 42STLN34 Linear Hybrid Stepper
Coreless DC / BLDC (geared for linear motion)	Rotary motor paired with gearing to increase torque and convert into linear travel	• Enables higher-speed linear axes • Compact with good power density	• XY sample transport (when higher speeds required; with gearing)	• 16DCT Athlonix brush DC • 16ECP36 Ultra EC slotless BLDC • R16 Gearhead
Integrated BLDC Motor + Gearbox + Lead Screw Assembly	Compact BLDC drive with internal gearbox and screw for direct linear output	• High force in small diameter • Reduced system complexity • Increased reliability	• Decapping mechanisms	• 08ECP20 slotless BLDC motor • R08 gearhead • CM2150-1450N-A00A00-AFM lead screw
Stepper Linear Actuator	Stepper motor with embedded linear output mechanism	• High-resolution linear steps • Consistent, repeatable motion • Compact for dense instrument layouts	• Syringe pumps • Valve mechanisms • Precision fluid metering	• 20DAM can stack stepper • 26DAM can stack stepper • 28STLC33 linear hybrid stepper

Conclusion

As diagnostic laboratories face rising volumes, shrinking labor pools, tighter sustainability expectations, and greater pressure for consistent accuracy, the demands placed on motion systems are only intensifying. Today, instrument performance is inseparable from the design of the motors, actuators, and linear assemblies that drive every movement.

Manufacturers who take a holistic approach to motion – prioritizing integration, efficiency, and reliability – will be best positioned to meet these escalating demands. That is where Regal Rexnord brings unique value. Our comprehensive motion portfolio enables engineers to optimize each axis with components intentionally designed to work together: high speed BLDC technologies for demanding rotational tasks, compact integrated assemblies for force dense linear motion, and precise stepper based solutions for fluid handling and sample transport. This systems driven approach reduces engineering burden, improves long term reliability, and accelerates time to market.

By partnering early in the design process, Regal Rexnord helps customers build diagnostic instruments that move smarter, operate more sustainably, and deliver the performance modern laboratories demand — now and into the future.

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About the Company

Portescap, a proud member of Regal Rexnord, excels in addressing critical motion challenges with premium miniature electronic motors and components. For over 70 years, our extensive product range – including coreless brush DC, brushless DC, stepper, gearhead, encoder, and controller technologies – has powered applications across the aerospace and defense, automation, industrial power tools, medical, robotics, and surgical hand tool industries. Expert engineers collaborate with you from prototype to production, ensuring exceptional performance tailored to your specific needs.

As part of Regal Rexnord, customers benefit from seamless access to a vast brand portfolio and a robust global manufacturing and sourcing network. Dedication to innovation and sustainability drives us to design products that significantly impact daily life. Leveraging Regal Rexnord's broader expertise and resources, we aim to deliver sustainable solutions that power, transmit, and control motion, helping to create a better tomorrow.

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