WHITE PAPER

Portescap THOMSON

The Motion Behind the Results: Engineering Integrated Actuation for Point-of-Care Diagnostics

RegalRexnord™

Introduction

Point-of-Care (POC) diagnostic devices continue to transform how clinicians and patients access medical testing. Historically, most diagnostic assays, ranging from blood chemistry to infectious disease identification, were performed in centralized laboratories using large, highly specialized equipment operated by trained technicians. While effective, this process introduced delays tied to sample transport, laboratory capacity, and staffing limitations. These challenges became especially visible during the COVID-19 pandemic, when PCR demand overwhelmed central labs and often led to multi-day turnaround times.

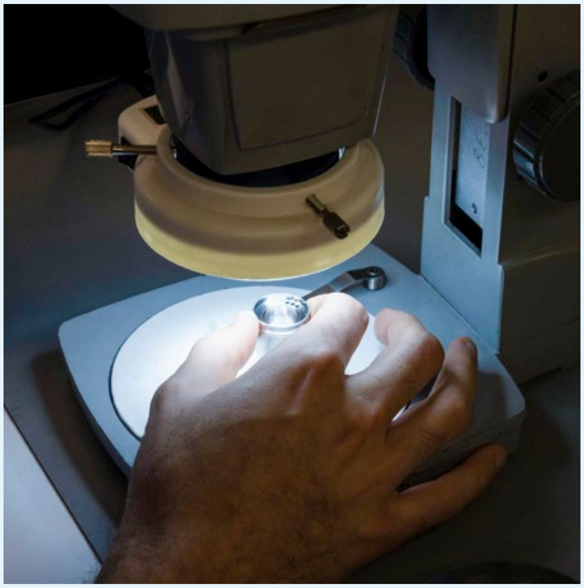
As POC platforms expand in capability, motion architecture has become a core design priority. These systems depend on tightly coordinated rotary and linear actuation to manage sample movement, reagent dispensing, valve sequencing, mixing, and safety mechanisms. Each axis must deliver repeatable precision while fitting within strict limits on size, cost, and power constraints. The engineering behind these systems is ultimately what drives the speed, consistency, and quality of diagnostic results.

Types of Point-of-Care Diagnostic Platforms

POC devices generally fall into two categories: handheld and bench-top systems. Handheld devices are compact and portable, typically designed for simpler, single-step assays that require minimal sample manipulation. The motion architecture is limited, often just a single actuator or none at all. Size, power consumption, and cost constraints further limit the use of multi axis motion.

Bench-top POC devices, however, support highly automated, multi-step workflows. These instruments integrate fluid handling, reagent transfer, mixing, thermal management, and detection capabilities within a small footprint. Many designs incorporate 15 to 20 coordinated axes of motion; this complexity is the primary reason benchtop instruments rely heavily on engineered rotary and linear actuation, making motion architecture a core part of their performance, reliability, and cost profile.

Motion Demands Shaping POC Device Design



Advanced POC analyzers rely on tightly engineered motion systems—making expert-designed actuation essential for achieving the accuracy, speed, and reliability clinicians depend on.

Despite the diversity of tasks within a POC system, core motion requirements remain consistent. Motors must deliver long-term reliability and accurate, repeatable positioning to ensure precise results throughout operational life. Compact size and high-power density are essential for fitting multiple actuators within tight mechanical environments. Cost considerations also play an important role, as POC devices must remain competitive in both clinical and consumer markets.

Each motion axis imposes unique performance demands. Some require high torque and strong holding capability to maintain position, while others need smooth, continuous rotation at elevated speeds. Certain axes operate intermittently; others run at high duty cycles. Because no single motor technology satisfies every requirement, selecting the right technology for each function is key to achieving an optimal device architecture.

Integrated Rotary and Linear Motion in POC Devices

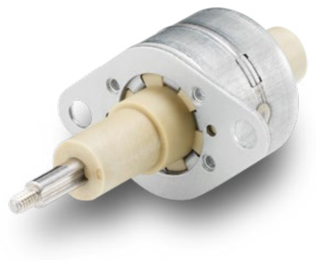
Growing sophistication in POC diagnostic systems demands that rotary and linear motion work in harmony to keep tests fast and accurate. Rotary motors drive functions like mixing, pumping, and rotational alignment, while linear actuators provide controlled force and displacement for blister activation, valve engagement, and cartridge positioning. Each motor technology contributes unique advantages, and successful platforms combine multiple actuation types to achieve the right balance of speed, precision, force, and energy efficiency.

The following motor technologies form the core building blocks for POC motion. Rather than identifying a single "best" option, engineers match each technology to the mechanical, electrical, and workflow demands of the application. In practice, most diagnostic systems integrate several actuation types, both rotary and linear, to meet diverse performance requirements across subsystems.

Stepper Motors

Stepper motors are well suited for POC diagnostic tasks requiring precise positioning, high torque at low speed, and strong unpowered holding torque. Their ability to maintain position without continuous power is especially valuable in battery powered systems or in applications such as cartridge alignment and valve actuation.

The straightforward mechanical design of stepper motors also supports cost effective scaling when many motors are integrated into a single device. Linear stepper actuators provide direct linear motion without requiring additional conversion components, simplifying assembly and improving repeatability in motion critical axes.

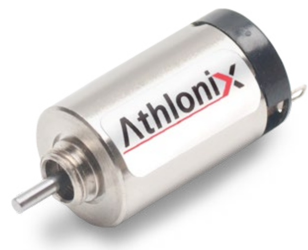


By pairing precision with inherent stability, Portecap's 20DAM linear actuator shows how stepper technology reinforces the accuracy and reliability of next generation POC analyzers.

Brush DC Motors

Brushed DC motors offer high efficiency, smooth rotation, and strong power density in compact packages. These characteristics make them ideal for motion tasks requiring continuous, high speed rotation, particularly fluid handling operations such as pumping and mixing. Their inherently simple velocity control helps reduce electronic complexity and supports cost efficient system design.

For handheld devices, the high efficiency of brush DC motors also supports longer battery life and reduced thermal buildup, both important for user experience and device reliability.

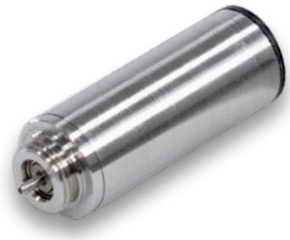


Portecap's high-efficiency 12GS88 Athlonix brush DC motor delivering smooth, continuous rotation — well suited for pumping, mixing, and other fluid-handling tasks.

Brushless DC Motors

While traditionally less common in POC devices due to cost and control complexity, modern BLDC motors have become increasingly accessible. Recent advances in manufacturing, magnetics, and drive electronics have significantly reduced system cost while improving efficiency and lifetime.

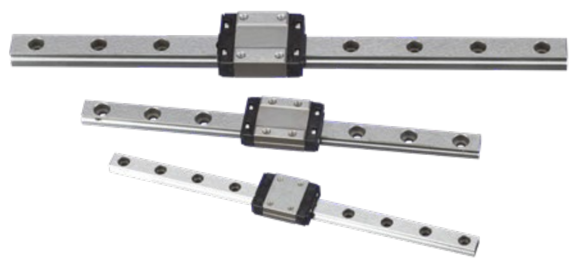
BLDC motors deliver excellent power density, superior energy efficiency, and long operational life, making them ideal for high duty cycle or precision critical axes. As bench top diagnostic systems continue to grow in sophistication, BLDC technology is becoming a valuable option for select motion requirements.

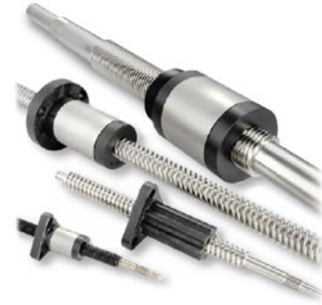


The 08ECP20 BLDC motor from Portescap is optimized for long-life, high-duty-cycle operation, enabling precise and energy-efficient motion in sophisticated diagnostic platforms.

Linear Motion Solutions

Linear motion solutions are commonly used to provide precise movement along the X, Y, and Z axes. These systems can also deliver enhanced precision and force when driving a rotary axis. By integrating miniature profile rail guides with miniature lead screws or ball screws, properly specified and assembled, designers can achieve high accuracy and load capacity within a compact form factor.





Integrated miniature linear motion system featuring Thomson's MicroGuide™ profile rail guides paired with miniature lead screws, delivering high-precision, high-force linear movement within compact point-of-care diagnostic architectures.

Motor Applications in Bench-Top POC Devices

Within a bench-top POC device, multiple coordinated motorized functions are required to execute the complete testing workflow. Here is an overview of key motion applications in bench top POC diagnostic devices and the motor technologies that support them.

Application	Motion Requirements	Recommended Technology	Example Products
Blister Bursting	Controlled force output; precise linear displacement; high repeatability	Linear Stepper Actuator	20DAM Digital Linear Actuator
Valve Actuation	Strong holding ability; repeatable linear movement; cost effective scaling across many valves	Linear Stepper Actuator	20DAM, Other Compact Linear Stepper Variants
Liquid Handling: Mixing & Pumping	Smooth, continuous rotation; efficient high speed operation; compact footprint	Brush DC Motor	12GS88 Athlonix™ Brush DC Motor
Sample Movement	Precise positioning; rotational or linear motion depending on design	Stepper Motor (rotational) or Linear Motion Solution	26M048 (rotary) Can Stack Stepper, Microguide and Miniature Lead Screw solution
Door Actuation & Locking	High holding force; safety critical reliability; secure latching	Can Stack Stepper Motor	26M048, 35L048D Can Stack Steppers

Conclusion

Continued advancements in Point-of-Care diagnostic devices make the integration of reliable rotary and linear motion systems increasingly essential. Every motion axis—whether for blister activation, valve control, sample positioning, or fluid handling—places unique demands on torque, speed, force, precision, and duty cycle. Optimizing each of these functions requires selecting the right combination of stepper motors, brush and brushless DC motors, linear actuators, and guided motion components.

A system level approach to motion design—one that evaluates how each axis interacts across the workflow—ensures consistent assay performance, a compact device footprint, and long term reliability. This is especially critical for benchtop POC platforms, where multiple coordinated axes must operate seamlessly to deliver rapid, accurate results.

Partnering with a comprehensive motion supplier such as Regal Rexnord accelerates development by providing access to integrated rotary and linear assemblies, optimized subsystems, and application expertise. Leveraging a single, trusted source for integrated motion solutions reduces design complexity, shortens development cycles, and supports the creation of next generation POC diagnostic devices that meet the industry's evolving performance and reliability expectations.

Dave Beckstoffer
Senior Industry Manager
Portescap

Portescap THOMSON

Regal Rexnord
portescap.com | regalrexnord.com
110 Westtown Road
West Chester, PA 19382 - USA

RegalRexnord™