

# Lab Test Comparison Proves Closed Loop Stepper Motor Systems Offer Greater Efficiency than Traditional Open Loop Versions

Eric Rice, Marketing Director, Applied Motion Products

*This white paper details a lab comparison of closed loop stepper motor systems vs. traditional open loop systems. The test monitors power consumption of both motors when turning a dynamometer at a fixed speed of 10 rev/sec (600 rpm). Results show that closed loop systems offer greater motor efficiency, cooler operations and lower energy consumption for greater operational savings.*

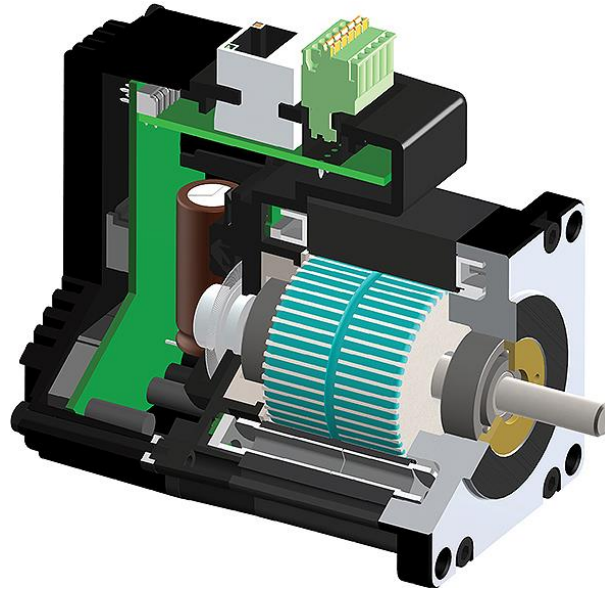
The simplicity, excellent positioning and low cost of step motors make them popular for use in automation applications such as indexing and positioning. Because traditional step motor systems run open loop, the drive electronics constantly supply current to the motor windings, regardless of torque demand from the load. Configured to provide the motor's rated current, the drive will do its best to power that rated current into the motor at all times, whether the motor needs it or not. Expending unnecessary energy during operation makes open loop step motor systems inefficient. Excessive power consumption wastes money and step motors operate "hot" due to this excess of power.

Closing the loop makes a more efficient step motor system. By employing a common feedback device such as an encoder to monitor actual shaft position versus commanded position, closed loop step motor systems automatically reduce current to the motor when torque is no longer demanded by the load. Only the amount of current needed to drive the load powers the motor. This saves energy, especially when the torque demand is low.

This simple change to the stepper system is extremely powerful and greatly improves the efficiency of the step motor. A closed loop stepper system will consume much less power than a traditional step motor system. Increasing motor efficiency while decreasing power consumption translates to lower energy bills and greener operations.

## Lab Comparison of Closed Loop vs. Open Loop Step Motors

This [video](https://www.youtube.com/watch?v=YquqQK4Y93o&feature=youtu.be) (<https://www.youtube.com/watch?v=YquqQK4Y93o&feature=youtu.be>) shows a side-by-side comparison of an open loop step motor system vs. a closed loop step motor system. In the open loop system, a step motor is driven open loop by a basic microstepping drive. The closed loop system is a StepSERVO™ Integrated Motor which combines the motor, encoder, drive and controller into a single package, as shown in Diagram 1.

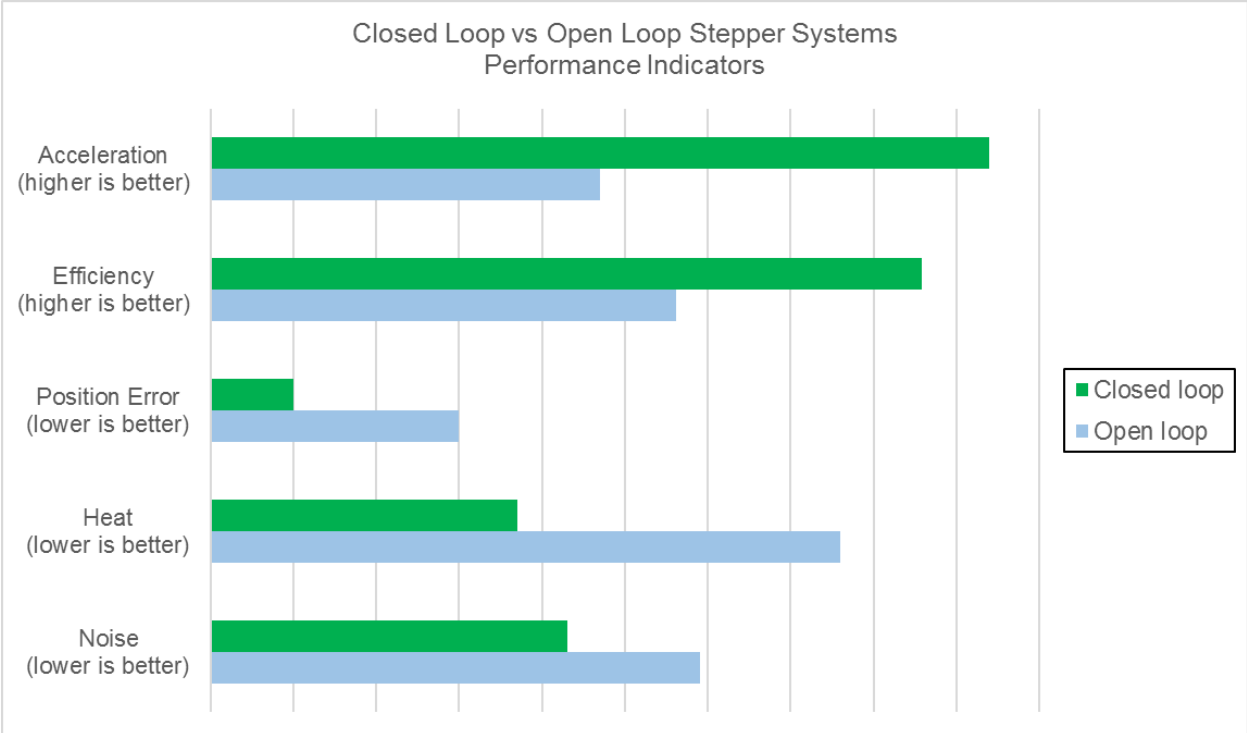


*Diagram 1: Shown is a cutaway of a closed loop StepSERVO™ Integrated Motor. It combines motor, drive and controller with a high-resolution incremental encoder and closed-loop servo firmware to operate cooler and more quietly than open loop motors, by drawing just enough current to control the load. Because motor power consumption is an issue for many machines, StepSERVO Integrated Motors provide the benefits of less power consumption and reduced operating costs.*

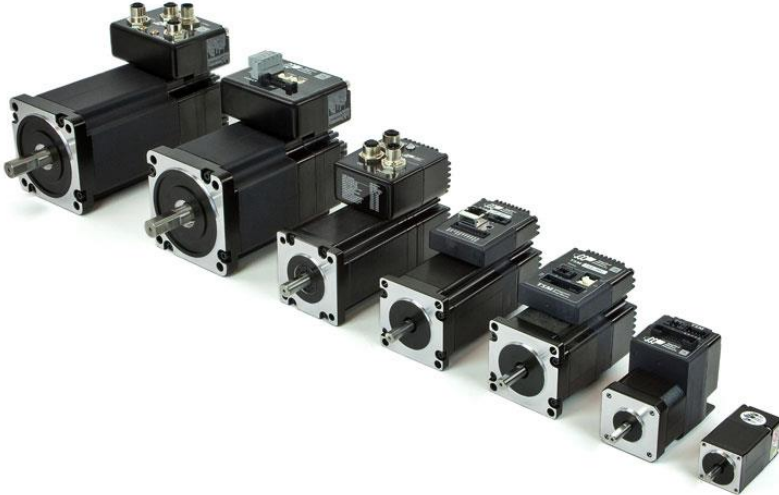
The test shown in the video monitors the power consumption of two equivalent step motors, one open loop and one closed loop, when turning a dynamometer at a fixed speed of 10 rev/sec (600 rpm). At a torque load of 50 oz-in, the open loop system draws 0.73 amps and consumes on average 87.2 Watts of power. The closed loop system draws 0.42 amps and consumes on average just 50.0 Watts of power. That's more than a 40% reduction in power consumption with the closed loop motor, which is doing the same amount of work as the open loop motor.

In addition to increasing motor efficiency, a closed loop stepper system operates more quietly. Step motors are known to make audible noise. This is due to the fact that open loop step motors operate at full rated current regardless of load. Because the closed loop stepper system runs with less current, it operates more quietly, especially at speeds in the range of 0 to 20 revs/sec (0 to 1200 rpm).

While closed loop step motor systems may cost more initially, reductions in energy consumption, heating and audible noise, along with increases in torque and accuracy justify the switch from open loop. The use of closed loop step motor systems will reduce energy consumption and provide other long-term benefits in many applications.



*Diagram 2: The application of low-cost, high-resolution feedback devices and advanced digital signal processing to close the loop on stepper motion results in an efficient and high-performance StepSERVO™ closed loop stepper system. This table compares the relative benefits of a StepSERVO™ closed loop stepper system compared to a traditional open loop stepper system.*



*Photo 1: Shown are StepSERVO™ Closed Loop Integrated Motors from Applied Motion Products that offer many advantages over traditional step motor systems, including higher torque and acceleration, higher machine throughput, better efficiency and quieter operation. With encoder*

*feedback and advanced control loops that incorporate servo control, StepSERVO Integrated Motors provide a cost-effective motion control system that operates faster and cooler than competitive technology.*

### **About Applied Motion Products**

*Applied Motion Products specializes in high-precision, cost-effective motion control products including stepper and servo motors, drives, controllers, gearheads, and power supplies. The company serves a diverse industrial and OEM customer base with both standard and customized products. With in-depth motor and control expertise, Applied Motion Products works with customers from initial concept and design through finished product and production to provide the best motion control solutions to a range of markets. Find out more at <https://www.applied-motion.com/>.*