



Frameless Motor-Based Stages Offer Benefits to Machine Designers

When solving precision stage applications, machine designers are often faced with the contradictory goals of maximizing stage travel while minimizing footprint. Frameless servo motors offer designers an alternative to standard servo motors that provides the benefits of reduced settling times, improved performance and a smaller footprint, all at no extra cost. Primatics has pioneered the use of frameless motors across its entire line of standard and custom stage products.

What is a Frameless Motor?

A frameless motor is the term used to describe a rotor and stator that are not housed in a traditional motor housing. As such, it does not include any bearings or an output shaft. Operationally, a frameless motor is identical to a traditional motor: the rotor consists of rare-earth magnets and the stator windings are energized to create a rotating magnetic field. Sensors are included in the stator for commutating the motor. In the PLG series of linear positioning stages configured with frameless motors, the rotor is bonded directly to the ballscrew thus eliminating the need for a motor coupler. In effect, the ballscrew is the

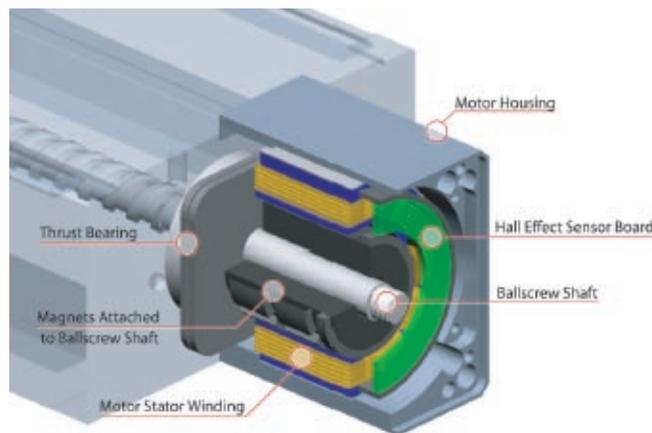


Figure 1: Primatics PLG110 linear stage with frameless motor option

motor output shaft. The stator is located at the end of the stages in a housing surrounding the rotor. This configuration is much shorter than the same stage used with a traditional motor and coupling (see Figure 2). Further, the PLG series of stages offer internally mounted rotary or linear encoders to complete the servo system.

Benefits of a Frameless Motor

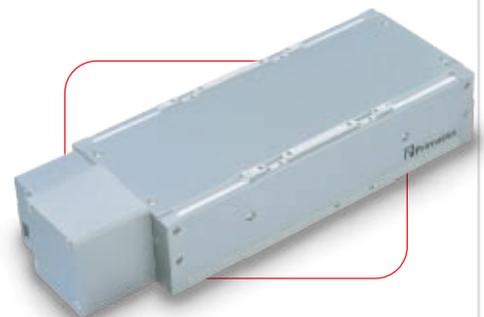
- **Smaller Footprint** - The absence of the motor coupling housing will reduce the length of a positioning stage. The PLG line of frameless motor based stages is typically 2.5 to 6 inches shorter than competitors positioning stages equipped with similarly sized framed motors. An additional 1 to 1.5 inches is gained with the PLG stage from internally mounted rotary encoder.
- **Better Dynamic Response** - The elimination of the motor coupler will also improve the dynamic response of a positioning stage. All motor couplers will exhibit windup to some degree, and this windup introduces phase delay into the servo loop. Windup also reduces the efficiency of the transmission of power from the motor. By eliminating the coupler, servo tuning gains can be significantly increased, allowing frameless motor based stages to achieve shorter settling times while using less power.
- **Improved Positioning Performance** - Windup in a stage coupler introduces uncertainty into the positioning performance of a stage. Both the repeatability and accuracy capabilities of a stage will degrade to varying degrees, depending on the characteristics of the coupler. With both the feedback device and motor attached directly to the ballscrew, only the windup of the ballscrew itself will be present. The windup of a 16-25mm steel shaft is orders of magnitude less than a flexible coupler, all but eliminating windup as a concern, which in turn tightens both the repeatability and accuracy performance of the stage. In addition, the inaccuracy of the positioning stage in this configuration

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More About the PLG Family Linear Positioning Stage

The Primatics PLG Family Linear Positioning Stage features the a frameless motor in action. Available in three cross sectional sizes and lengths from 50-1200 mm, the PLG Family is a versatile solution to a variety of Precision Motion applications. And depending on your cost and stage protection requirements the PLG can be customized from the inside out to meet stringent environmental requirements and price targets.

- Up to +/- 3 μm of positional accuracy over total table travel
- Up to +/- 0.5 μm of positional repeatability over total table travel
- Supports loads to 100 kg
- All stages individually tested for accuracy, repeatability, straightness & flatness
- Multi-axis configurations available
- Class 10 Cleanroom option
- 4 motor drivetrain options





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is tightly correlated with the lead error of the drivetrain. Since the lead error does not change as the screw wears, two point slope correction can be employed to drastically improve the stage accuracy. In many cases, the PLG frameless motor stage with two-point slope correction will have superior accuracy performance to even a linear encoder based systems at a significantly lower cost.

o **More Robust** - Improper alignment of the coupler between the ballscrew and motor shafts will lead to premature coupler failure. Small misalignments or runout between the shafts can create forces on a flexible coupler that will cause failure in a matter of hours. Because this alignment is so critical and difficult to achieve, motor coupler failures are the most common type of failure in positioning stages. The PLG frameless motor driven stages eliminate this type of failure, making frameless motor stages far more robust. Moving the encoder to the interior of the positioning stage also eliminates a

source of failure. Optical encoders are fragile devices that can be easily knocked out of alignment or broken if they experience an impact. These design improvements have made the PLG frameless motor stages a standard in dozens of 24/7 production fabs all over the world where downtime can cost millions of dollars per day.

Conclusion

Positioning stages incorporating frameless motors offer advantages over traditional framed servo motor configurations. The Primatics PLG Series of frameless motor based stages provide an example of the frameless motor's improved performance, ruggedness, and reduced footprint over traditional servo motor stages for no additional cost.

-Kyle Tomson
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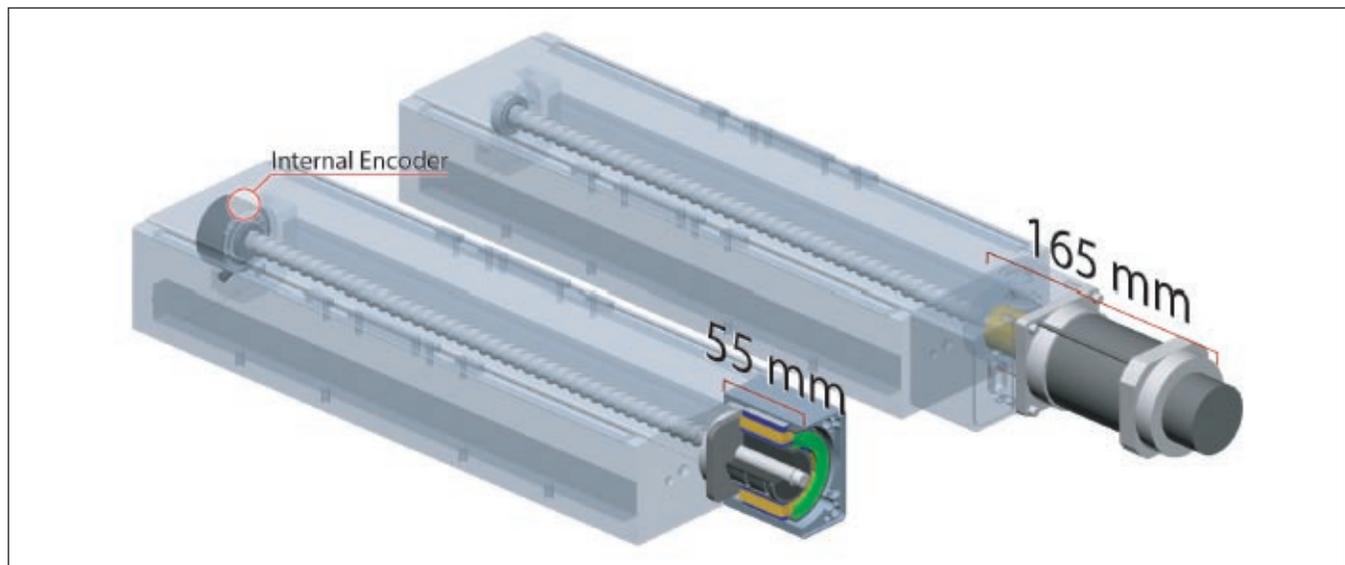


Figure 2: Footprint differences in a Primatics PLG Stage with a frameless motor (left) and an in-line servo motor (right)

About Primatics, Inc.

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Comprised of individuals from many corners of the automation field, the Primatics team draws from years of experience in the automation and precision positioning stage market continually creating solutions to satisfy a variety of applications. We offer a range of linear and rotary positioning stages, motion controls, and a variety of accessories and services. We are also an engineering partner of specialty products for OEMs and short time-to-market projects. Contact us or visit our web-site at www.primatics.com.

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Linear Positioning



Rotary Positioning



Motion Controls



Engineered Solutions