SCHNEEBERGER
LINEAR TECHNOLOGY

Breakthrough in Motion Control Enables Micron-Level Positioning Over Long Spans of Movement

INTRODUCTION

Customers are driving machine builders to develop systems that can produce large products with highly precise dimensions. To fulfill these demands, new positioning and motion technologies are required that can reliably achieve micron-level accuracy over long spans of movement.

The solution to this need is a breakthrough motion control technology called telescopic actuation. The technology enables a machine to smoothly position with up to 8 micron accuracy per stage, over a 4.85 meter range. Telescopic actuation is comprised of proven components that operate reliably and consistently over the machine's lifetime. It is ideal for special applications such as large 3D metal printers used in additive manufacturing or for positioning immense aerospace components that require ultra-precise dimensional accuracy.

This technical brief describes the makeup and operation of the telescopic actuator, its benefits to the machine builder, and a case study of its application.

What is a Telescopic Actuator?

The telescopic actuator was developed by A.MANNESMANN, a member of SCHNEEBERGER Linear Technology Group, to perform challenging drive and positioning tasks requiring extreme infeed accuracy and smooth operation. These tasks include displacement movements of components with complex, path-dependent processes as well as pressing and joining tasks with direct force-path evaluation.

The telescopic actuator comes in two-stage and four-stage versions and can operate in vertical and horizontal positions. Their compact designs produce micron-exact positioning, backlash-free movement, and constant torque.

Double 2-stage telescopic actuator.

Two-Stage Actuator Ideal for Long Travel with Limited Spatial Requirements

The two-stage telescope actuator is a linear drive system designed for applications with long movement range and limited space requirements. It achieves ultra-precise motion control plus the higher power transmission required in press and jig construction.

The patented actuator converts the central rotatory drive motion of its motor into an axial translation movement through two nested telescopic ball screws. The resulting partial movements split according to the thread pitches and occur synchronously. The highest precision positioning and repeat accuracies are achieved through backlash-free, preloaded double nuts and ball screw spindles with ground precision in the accuracy quality IT 3.

The device's torque and higher than 90% efficiency of the telescopic levels are constant across the entire length of travel. As a result, the actuator experiences minimal power losses and low operating temperatures.

The two-stage actuator handles large axial loads with extreme precision. With a retracted height of 1.85 meters, the actuator extends to 4.85 meters – a ratio of 1:2.62.

Double two-stage actuator when extended.

As found in the two-stage actuator, the patented four-stage device converts the central rotatory drive motion of the motor into two counter-running axial translational movements through two nested precision telescopic ball screws. The resulting partial movements split according to the thread pitches and occur synchronously. Positioning and repeat accuracies are achieved through backlash-free, preloaded double nuts and ball-screw spindles.

The telescopic, multi-stage ability of the ball-screw spindles makes it possible for the actuator to achieve a large extension with the shortest-possible retracted block length. Complex machine movements can be numerically controlled and safely monitored with this very compact unit. The preloaded ball-screw nuts guarantee freedom from backlash, even with high-tensile and compressive loads.

The ready-to-install device has a maximum retracted size of 1.0 meter and extends to 3.0 meters – providing a ratio of 1:3.86. The actuator's torque and higher than 80% efficiency of the telescopic levels are consistent across the entire range of motion. In this way, minimal power loss and low operating temperatures are experienced. The four-stage telescopic actuator is designed for high-precision, jerk-free positioning and movement in horizontal or vertical positions, and has one-way or two-way load-bearing capacity.

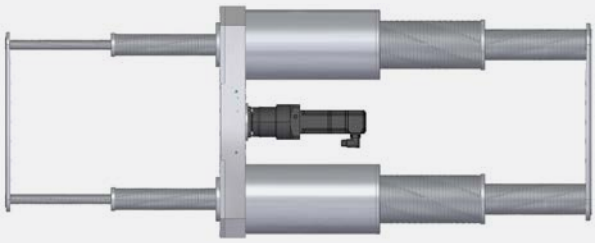
Model of 4-stage actuator in the retracted and extended state.

Compact Four-Stage Actuator Designed for Space-Saving Applications

The four-stage telescopic actuator combines the smallest possible structural dimensions with the greatest movement accuracy and large travel range. Its compact design and high-precision positioning make it suitable for a wide variety of machine tool, power transmission, and press and jig applications.

Dual-System Actuators Support Heavier Loads

For applications requiring heavier axial loads, two-stage and four-stage actuators are available as dual systems. In these configurations, the parallel-arranged actuators are driven by a joint motor for highly-accurate synchronous extension and retraction.



Model of double 4 stage actuator when extended.

Telescopic Actuation: Features and Benefits

Telescopic actuation brings both cost and technical benefits to the machine builder.

- Ultra-precise position capability over very large travel (up to 386%)
- High power transmission rates with up to 98% efficiency
- Compact construction and small block dimensions allow for mechanical engineering solutions in small spaces.
- Built-in durability and rigidity, with features such as nitride spindles, ensure greater wear resistance, maximum machine availability, and long life.
- Operates in all positions for installation flexibility.
- Actuation positions are storable in CNC control systems.

When Ultra-Precise Movement over Long Ranges of Motion Are Essential

Telescopic actuation solves a wide range of applications that require highly-precise motion control over large ranges of travel.

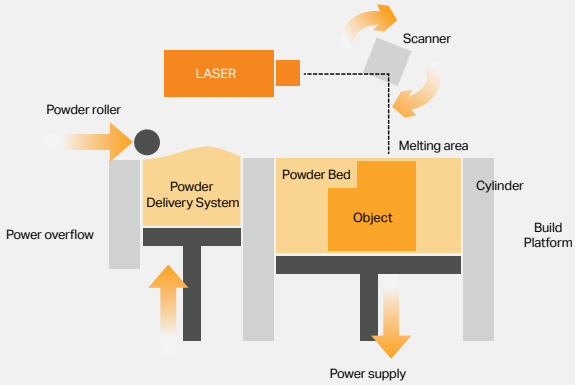
Two-stage actuators are ideal for machines and plant equipment where space is not a major concern. These applications include additive manufacturing, aerospace, special machine construction, or process engineering. (See additive manufacturing case study below.)

The compact design of four-stage telescopic actuators make them desirable for applications in confined spaces. These include flexible aerospace and automotive machining and clamping systems that process large parts and assemblies.

Case Study: 3D Metal Printers Incorporate Telescopic Actuation to Enable Large-Scale Additive Manufacturing

A 3D metal printer provider was designing a new system for the additive manufacturing market. The printer would enable manufacturers to produce specially shaped work pieces that could not be constructed by conventional methods. Using 3D metal printing, these components would be lighter weight and could be fabricated in one piece instead of assembled from multiple parts.

The printer used powder bed fusion technology to perform directed energy deposition. Two highly accurate vertical movements were required to position the powder supply and powder overfill systems. This up-and-down travel had to be soft, smooth, and backlash-free, with the two stages running at the same time.



Schematic display for possible areas of application of telescopic actuators in 3D metal printers.

The printer manufacturer selected SCHNEEBERGER's telescopic actuation to control the printer's movement. No other motion control technology could provide the positional accuracy and repeatability demanded by the machine builder's application.

In the first application, a two-stage telescopic actuator controlled the stepwise upward movement of the powder chamber for exact layer deposition. This stage required lower than 0.020 mm accuracy.

In the second application, a dual-system two-stage telescopic actuator positioned the stepwise downward movement of the powder overfill cylinder's build platform. A 600 mm stroke was required to optimize the accuracy and surface quality of the printed object.

With the actuator's preloaded double nuts, backlash-free up and down movements under push/pull load enabled a best-quality working piece for the 3D printer user.

Conclusion

With manufacturers demanding the capability to build larger, more specialized components, machine builders are faced with a host of new challenges. Many of these requirements involve fabrication and movement of large components with extreme levels of dimensional and positional accuracy.

A breakthrough motion control technology developed by SCHNEEBERGER, telescopic actuation, enables machine builders to provide equipment that can manufacture these hard-to-build products. The technology enables a machine to incorporate smooth motion control with micron-level accuracy across an almost 5 meter movement area – and do it reliably and consistently over the machine's lifetime. This exciting capability opens up a new frontier for machine builders and manufacturers developing innovative products that generate unique competitive advantage.

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