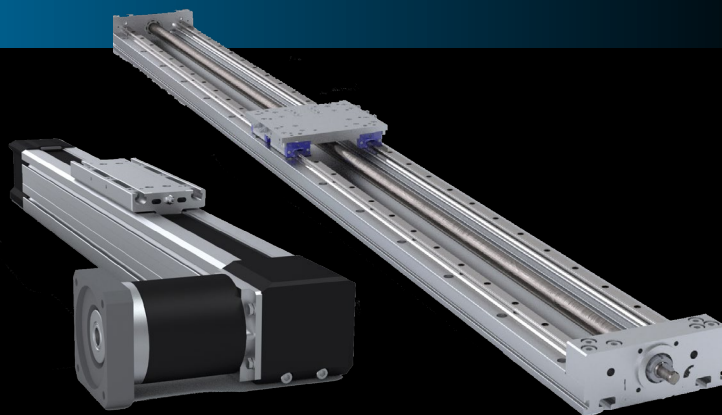


Modular Linear Actuator Comparison: Toothed Belt vs. Screw Driven



Modular actuators are available in four basic drive types. Three of the four produce the desired movement by converting rotary motion into linear travel. We will be discussing and comparing the two most popular of the four drive types - belt drives and ball screw drives. The pros and cons of each typically allow the customer, integrator, distributor, or manufacturer to quickly arrive at a selection for the actuator along with other factors such as guidance.

Screw-Driven Actuators

Screw-driven actuators are available in ball screw or trapezoidal/acme types. Ball screws have recirculating tubes or paths that allow the balls to loop back to the beginning of the ball nut. Trapezoidal screws are a plain thread in frictional contact with a brass or plastic nut. They are lower cost but not as popular as ball screws or belt drives due to the frictional wear and resulting loss of accuracy over time that occurs much more rapidly than the two drive types we are focusing on. Trapezoidal screws can be self-locking therefore, no brake is needed to hold the load. Vertical applications should have brakes no matter what screw type is used because machine vibration can cause an acme screw to creep.



Screw drive

Ball screw drives are accurate, repeatable and very efficient, making them capable of applying high force with a relatively small motor and no gearbox. This is due to the rolling friction efficiency of the bearing balls in the nut and the fact that the nut is essentially a gearbox in itself with optional thread pitches (ratios). Not a show-stopping limitation usually, but, screw drives also offer a slender, inline form factor compared to the right-angle projection required from a belt drive motor and gearbox that usually results in much more machine mounting real estate being consumed.

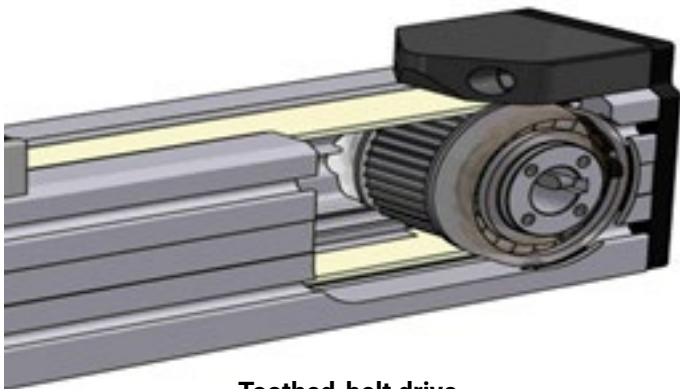
Ball screws also have their own limitations and downsides. Their length and speed is limited due to whipping deflection of the screw at higher speeds. Some manufacturers like NTN-SNR offer unique, mid-stroke, traveling supports to prevent this problem. However, the critical speed limitation cannot be overcome. A steeper pitch is needed but still cannot match the speeds that belt actuators can reach. Belt drive systems typically require relubrication of the guidance system but the belt is maintenance-free in comparison to lubrication requirements of the ball nut. Ball nut failures due to lack of this maintenance are costly and result in large amounts of machine downtime, particularly if the screw is damaged as well. Belts are low cost to keep a spare on the shelf and changing the belt out is not as involved as a ball screw.

(continued on next page)

Toothed-Belt Drive Actuators

The belts used in modular actuators have teeth on the inside for positive driving of the traveling carriage without slippage by the use of toothed pulleys with rotary ball bearings. This ensures the carriage (and load) travel to the intended position commanded by the controller and prevents the carriage from drifting downward if it is oriented vertically. The belts are able to be tightened to a tension level high enough that there is no further stretch of the belt which can cause problems in the smoothness and accuracy of the motion and positioning. This rigid tensioning is due to steel or Kevlar cords inside the belt. Belt drives can travel very fast, have long travel capability and are maintenance free - until they break that is. And if, or when, that occurs, the cost of a belt is a fraction of that of a ball screw drive.

Belt drives seem the ideal solution but they have some disadvantages when compared to ball screws. They are not as accurate or repeatable and they do not have high stiffness or the ability to be "preloaded" in the traditional sense. This means they also cannot apply or resist rigid force as a ball screw can. A belt drive often requires a gear box as both a speed reducer and torque booster to be able to match the inertia of the of motor and load. This prevents the need to far oversize the motor.



Toothed-belt drive

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