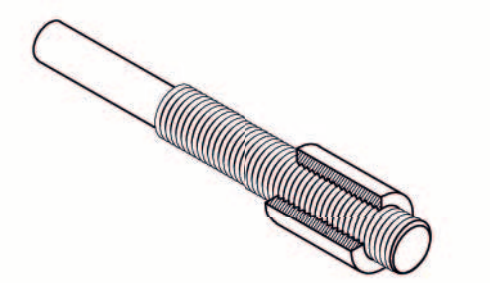
Drive Train Elements

Gearhead

Gearheads are used between motor and drive screw; they improve position resolution and torque. Most models use preloaded gearheads to eliminate backlash.

Leadscrews

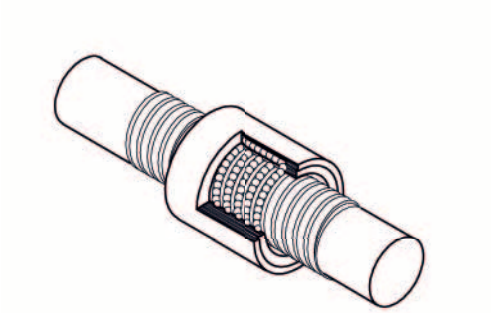
Leadscrews can provide very high resolutions and very smooth motion. A leadscrew drive consists of a motor-driven screw with a nut coupled to the moving platform of the stage. The nut can be spring-preloaded to reduce backlash. They have higher friction than recirculating ball screws so that they are self-locking; on the other hand, however, this has an effect on velocity, motor power and lifetime. Typical leadscrews have a pitch between 0.4 and 0.5 mm/revolution, up to 1 mm/revolution for longer travel ranges.



Recirculating Ball Screws

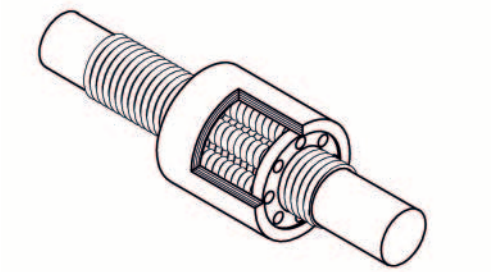
Recirculating ball screws have significantly less friction than leadscrews because they replace sliding friction with rolling friction.

A recirculating ball screw drive consists of a motor-driven screw with a nut coupled to the moving platform of the stage. Balls in a closed circuit are located between nut (ball case) and drive screw. Backlash can be minimized by selecting the proper ball-to-thread-diameter ratio. Recirculating ball screws are not self-locking but very efficient and offer high velocities and long lifetime in continuous operation. PI uses pitches of 0.5, 1 or 2 mm/revolution.



Threaded Spindle Drives

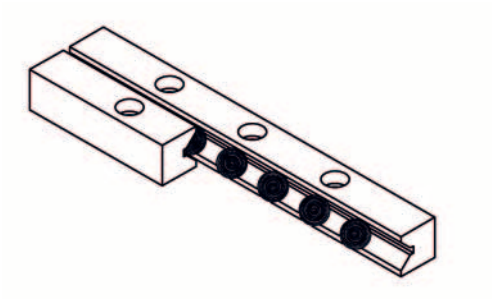
Threaded spindle drives use rolls instead of balls as rolling bodies so that a higher load rating, higher velocity and considerably longer lifetime are achieved.



Guidings and Bearings

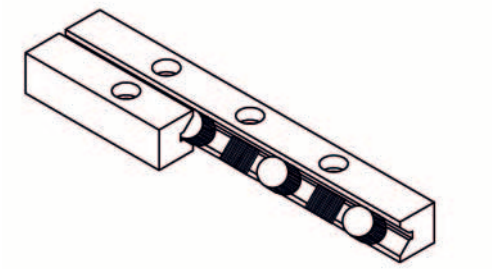
Linear Ball Bearing

The balls run in a brass cage and are preloaded with regard to the hardened precision guiding shafts. Exact tolerances between guiding and bearing are necessary for zero backlash and low friction. Load capacity is limited.



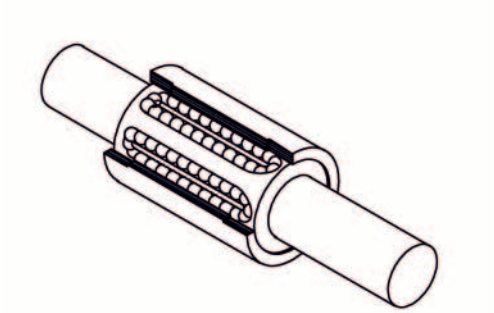
Crossed Roller Bearings

In crossed roller bearings, the point contact of the balls in ball bearings is replaced by a line contact of the hardened rollers. Consequently, they are considerably stiffer and need less preload so that friction is reduced and a smooth run is possible. Crossed roller bearings are also characterized by high guiding accuracy and high load capacity. Permanent guiding of the rolling body cages avoids migration of the crossed roller bearings.



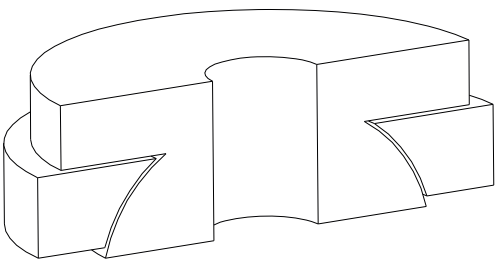
Recirculating Ball Bearings

High-precision stages are equipped with precision double linear rails. Precision assembly allows these bearings to yield excellent results in terms of load capacity, lifetime, low maintenance and guiding accuracy. The moving part of the stages is supported by a total of four preloaded linear bearings with two rows of recirculating balls each. They are also immune to the cage migration as occur with crossed roller bearings (can be an issue where small ranges are scanned repeatedly).



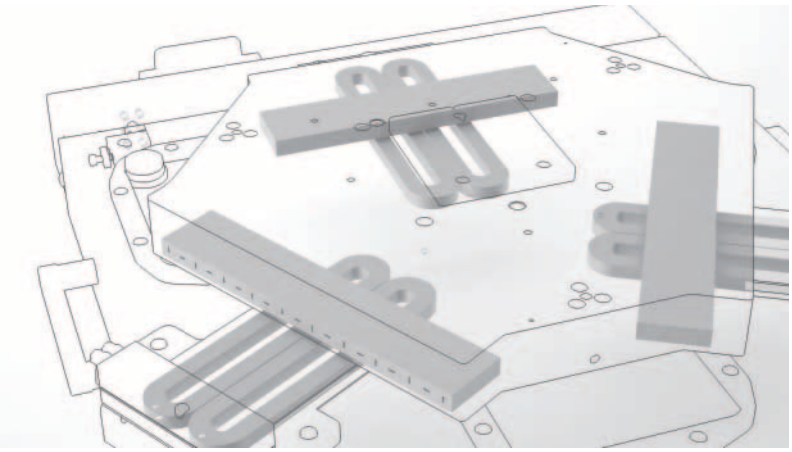
Air Bearings

An air film of a few micrometers is used as bearing. Therefore, air bearings are friction-free and have a tenfold better guiding accuracy than mechanical bearings. PI miCos uses air bearings in ultra-precion, and high-velocity stages.



Magnetic Bearings

Magnetic levitation ensures excellent guiding accuracy in a plane, both linear and rotational: The passive platform levitates on a magnetic field and is actively guided by it. Sequence errors are measured and compensated by very accurate noncontact sensors. Contrary to air bearings, which are also very accurate, magnetic bearings can also be used in vacuum.

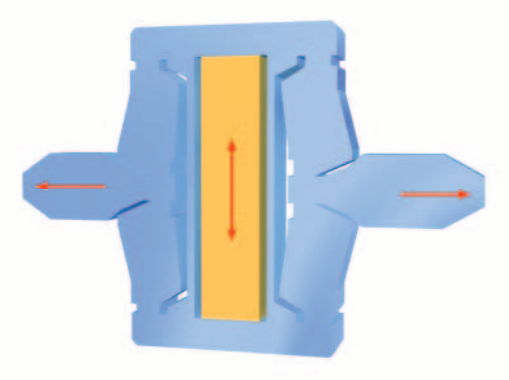


The platform levitates on a magnetic field generated by only six planar coils in the stator

Flexure Guides

The motion of a flexure joint is based on the elastic deformation of a solid. Therefore, there is no static, rolling or sliding friction. Flexure elements have a high stiffness and load capacity and are very insensitive to shocks and vibrations. Flexure guides are free from maintenance and wear. They are 100% vacuum compatible, function in a wide temperature range and do not require any lubricants.

Flexure guides from PI have proven their worth in nanopositioning. They guide the piezo actuator and ensure a straight motion without tilting or lateral offset. A solid is elastically deformed by a device (flexure) free from static and sliding friction – completely without rolling or sliding parts. This deformation is sufficient to guide the actuator over travel ranges from several 10 to several 100 µm.



Flexure joints extend the travel range, can re-direct the motion and offer excellent guiding accuracy without friction. The lever mechanism shown above with flexure guides transforms the actuator travel range (vertical) to an even, straight motion (horizontal)

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