Highlights of BSHP ball runner blocks

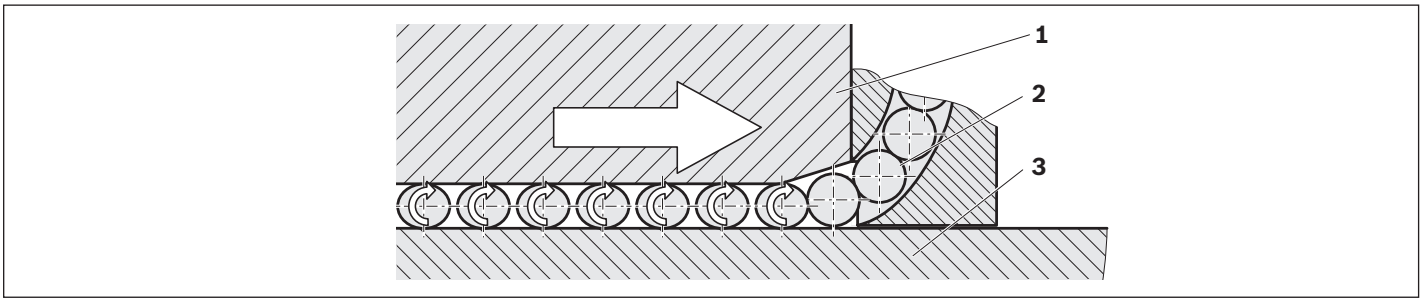
- Travel accuracy again further improved by a factor of up to six
- Significantly reduced frictional drag variations and low frictional drag, especially under an applied external load
- Highest precision
- Superior quality
- Minimum quantity preservation in accuracy classes XP; SP; UP.
  (Reduction in the negative effect on the environment due to anti-corrosion agents)
- Patented entry zone design enhances travel accuracy
- Plus all further advantages of Rexroth precision ball runner blocks

Comparison

Conventional ball runner blocks

If the ball runner block has a conventional entry zone, this can only be designed for a specific load point.

Entry zone geometry for conventional ball runner blocks



1) Ball runner block **2)** Ball **3)** Ball guide rail

Ball entry

- The balls are guided to the beginning of the entry zone by the ball recirculation track.
- When the distance between the ball runner block (1) and the ball guide rail (3) becomes smaller than the ball diameter, the ball (2) is subjected to loading (preload) in a series of pulses.
- The preload increases in the entry zone and reaches a maximum in the load-bearing zone. The ball transmits the force from the ball runner block to the rail.
- The kinematic and geometric conditions cause spaces to develop between the balls.

Entry zone

Conventional ball runner blocks have a fixed entry zone. The depth of the entry zone must be designed to withstand high loading, since smooth ball entry must be assured even under very high loads.

- On the one hand, there should be as many load-bearing balls in the ball runner block to achieve optimum load-bearing capacity.
  ⇒ As short an entry zone as possible
- On the other hand, the increase in loading of the balls upon entry should be as slow and smooth as possible, in order to maximize the geometrical travel accuracy.
  ⇒ As flat (long) an entry zone as possible

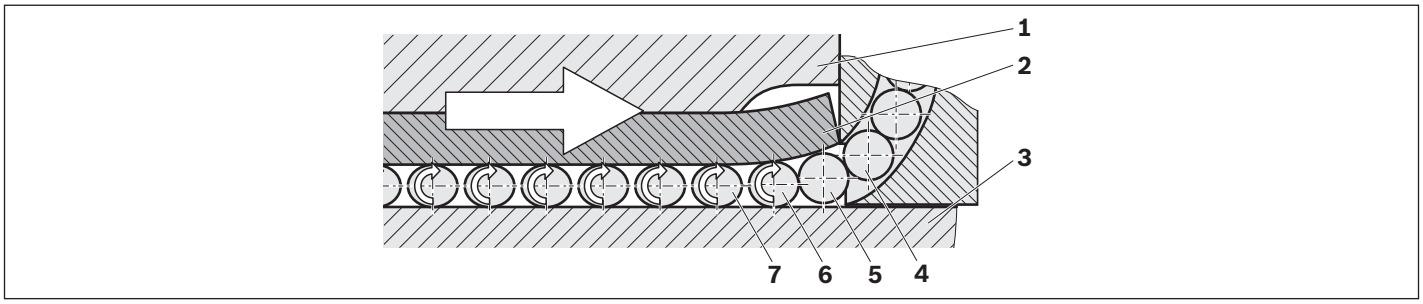
These are conflicting aims (short versus long entry zone).

Product description

High-precision steel ball runner blocks BSHP

New entry zone geometry for high precision ball runner blocks

High-precision ball runner blocks have an innovative entry zone. The ends of the steel segments are not supported by the ball runner block body and can therefore deflect elastically. This entry zone adjusts individually to the actual operating load of the ball runner block. The balls enter the load-bearing zone very smoothly, i.e. without any load pulsation.



1) Ball runner block
2) Steel segment
3) Ball guide rail
4) – **7)** Balls

Ball entry

- The balls (4) are guided to the beginning of the entry zone by the ball recirculation track.
- The ball (5) enters the zone load-free.
- The ball (6) deforms the end of the steel bearing plate (2) elastically. This deflection is the sum of the compliance of the ball itself and the compliance of the unsupported end of the steel segment.
- If the distance between the steel bearing plate and the ball guide rail (3) gets less than the ball diameter, the ball comes under load slowly and evenly (preload).
- The preload is thus smoothly increased until the ball (7) has reached its maximum preload.

Innovative solution from Rexroth:

The load-dependent entry zone

The crucial factor is the functionality of the entry zone. The steel segments are manufactured with such precision that they deflect to the right degree in response to the actual load. This results in especially smooth ball entry behavior. A ball deflects the precision-manufactured steel segment only as far as necessary to allow the following ball to enter load-free. The ball is no longer guided into the load-bearing zone in pulses by a rigid entry channel but by a very smooth flexing curve, which ideally transitions tangentially into the load-bearing zone. The extremely smooth ball entry behavior and the continuous adjustment of the entry zone in response to the actual load are the great advantages of these high precision ball runner blocks.

Characteristic features

1 Highest travel accuracy
2 Minimal frictional drag variation
3 The conflicting aims are resolved

Frictional drag variations

Definition

The total frictional drag of a ball runner block is composed of the following components:

1 Ball friction

2 Seal friction

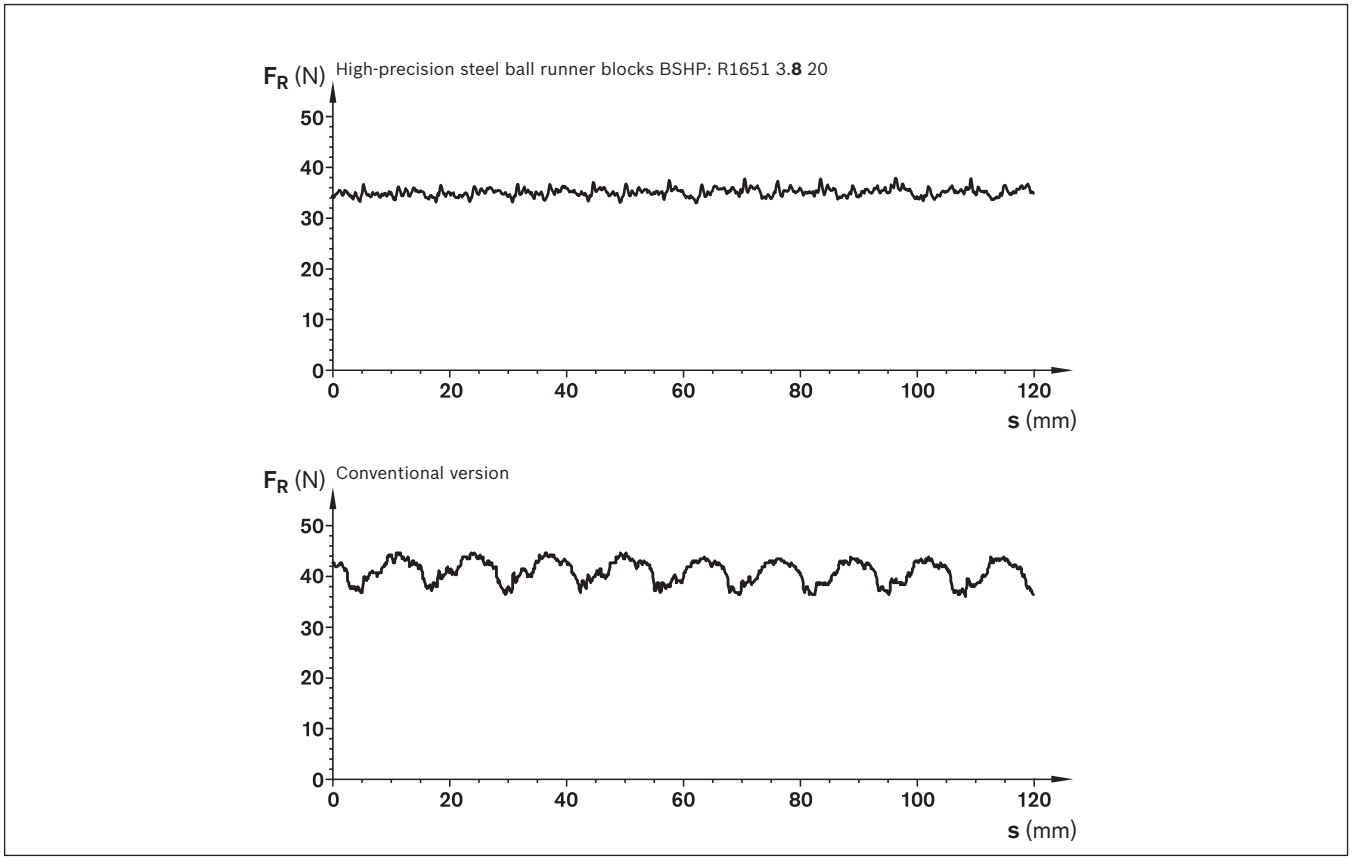
3 Friction in the ball recirculation elements and recirculation tracks

Variations in frictional drag can be especially troublesome in certain operating environments.

These variations are mainly due to the following fact:

The balls have to transition from the load-free zone to the load-bearing zone. Through its innovative design, the smooth ball entry zone minimizes the variations, which also permits better control of the linear drive.

Frictional drag comparison for a size 35 ball runner block with an external load of 10,000 N



⇒ Reduced frictional drag value

⇒ Considerably reduced frictional drag fluctuation

Product description

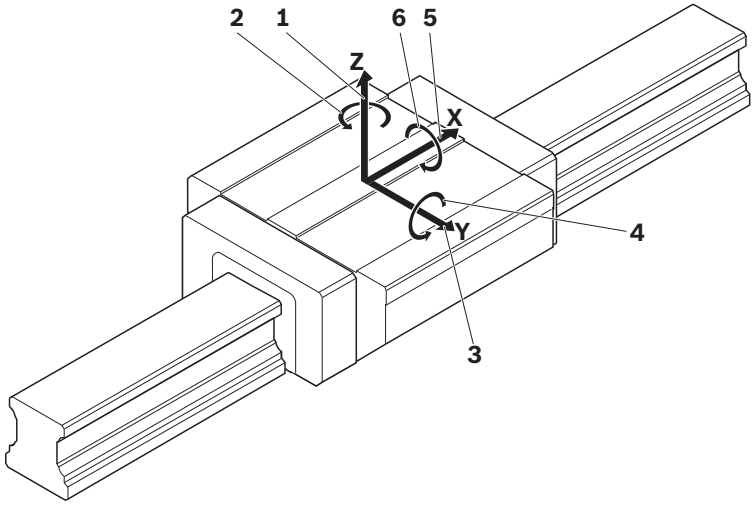
Travel accuracy

Definition

Ideally, the ball runner block should move in a straight line along the guide rail in the direction of the X-axis. In practice, however, deviations occur in all six degrees of freedom. Travel accuracy is the term used to describe the closeness of the movement to the ideal straight line.

The six different degrees of freedom

1 Vertical offset (linear deviation in Z)
2 Yawing (rotation about the Z-axis)
3 Vertical offset (linear deviation in Z)
4 Pitching (rotation about the Y-axis)
5 Translation (linear motion in X)
6 Rolling (rotation about the X-axis)



Causes of travel inaccuracy

Travel accuracy is influenced by the following parameters:
1. The finish of the mounting base to which the rail fastened.
2. Parallelism errors between the contact surfaces of the rail and the ball running tracks.
3. Elastic deformations of the rail under the mounting screws.
4. Variations in accuracy as balls enter and exit the load-bearing zone.

Optimization potential

For 1.: Machine the contact surfaces of the ball guide rail as precisely as possible (cannot be affected by Rexroth).
For 2.: Compensate by choosing the accuracy class of the ball guide rail.
For 3.: Reduce the tightening torque. The tightening torque for the fastening screws has a proportional effect. Reducing the torque will lessen the compression of the rail material.
⇒ Lower geometric travel fluctuations for 4.: The patented, innovative entry zone of Rexroth's high-precision ball runner blocks minimizes accuracy fluctuations.

⚠ This measure makes it possible to reduce the transferable forces and moments.

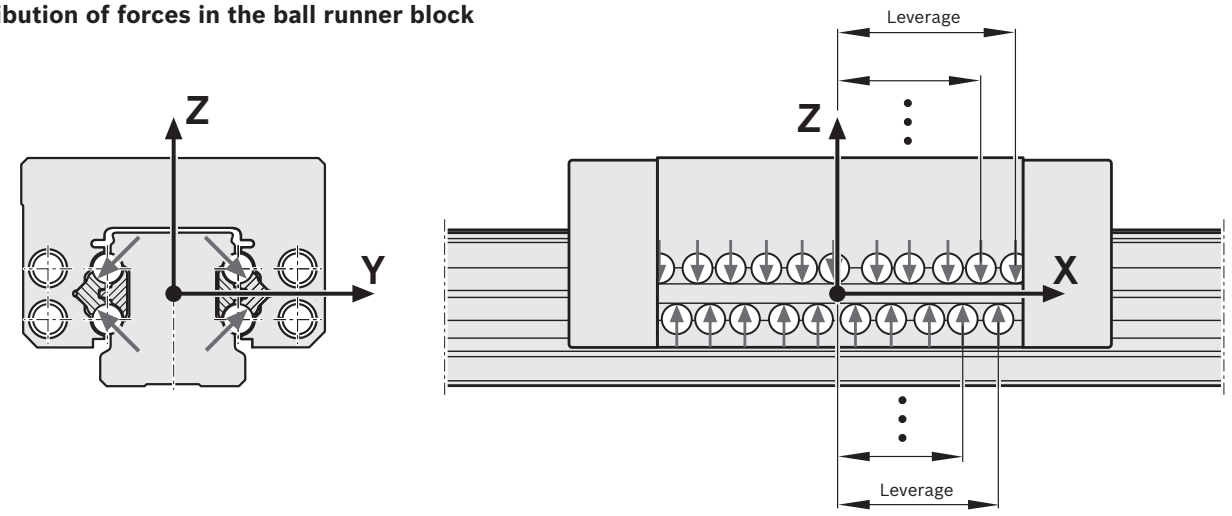
Further potential improvements:
- Use of long runner blocks
- Installation of additional runner blocks per rail

The deviations measured are due to the following phenomenon

A ball circuit contains a number n of load-bearing balls. When the ball runner block is moved in the direction of travel, a new ball engages in the entry zone. Now there are n+1 load-bearing balls. This creates an imbalance between the four rows of load-bearing balls. The ball runner block gets into a rotational movement, since the balls in the load-bearing rows of balls can involuntarily enter. To reestablish the balance, the ball runner block moves to a new balanced position. As the ball runner block moves further on, a ball leaves the load-bearing part of the circuit through the run-out zone. This again creates an imbalance between the four load-bearing ball circuits, which the ball runner block again attempts to correct by rotating.
You can clearly see this effect in the diagram on the next page.

As demonstrated in practical applications, the shortwave inaccuracies have a period equivalent to approximately twice the ball diameter.
The remaining long-wave deviation is the result of the causes 1, 2 and 3 described earlier (mounting base finish, parallelism error, and elastic deformation of the rail under the fastening screws).

Distribution of forces in the ball runner block



Product description

Direct comparison of the travel accuracy of two ball runner blocks

The graph clearly shows that the short-wave inaccuracies (dashed line) can be very significantly reduced by the new, innovative design of the entry zone (continuous line).