

Insider's Guide to Selecting Linear Guideways: Six Things You Must Know

INTRODUCTION

Linear guideways are the unsung workhorses in products requiring highly precise movement. From machining centers to wire bonding systems to medical imaging equipment, these components provide the motion control when micron-level accuracy is needed.

Linear guideways come in three major types: slideways with slide bearings, cross roller guideways with roller-contact bearings, and linear guideways with recirculating bearings. The broad range of these products gives original equipment manufacturers (OEMs) considerable leeway in designing their systems and instruments.

This paper reviews the wide variety of linear guideway applications. It explores why many of these components must be customised, and offers insight into the factors that ensure cost-effective and successful component selection.

Applications

Linear guideways are found in the movement systems of a myriad of industrial and medical/laboratory applications. These carefully machined components are installed when precise, repeatable motion is essential. Linear guideways are primarily utilized in the following equipment:

Microtome instruments used for cutting less than 100 μm slices of tissue for pathology or microscopic preparations.

Machining centers and dimension measurement machines for metal cutting on XYZ axes.

Wire bonding machines for making 15 μm thin-wire bonds between integrated circuits and printed circuit boards (PCB).

Pick-and-place machines for securing electronic components on PCBs.

Laboratory instruments including liquid-handling systems and DNA plate readers.

Automatic patient tables used in computer tomography and magnetic resonance tomography systems.



Type R bearing with Balls, Type R bearing with Rollers, Type RN Formula S with anti-cage creep mechanism.

Six Things You Must Know

Selecting the appropriate linear motion supplier and products can be a difficult experience. Incorporating incorrectly sized or lower-quality components will compromise the OEM products' performance. Machine movement will be slower and less accurate, causing lower throughput, incorrect component placement, and potential end-use product damage. Machine stops and failures will be more frequent. Slide lifetimes will decline and maintenance costs will rise.

To mitigate these issues, there are six key things design engineers must know to ensure successful outcomes.

1. Understand the types of products and the applications for which they are designed.

Cross roller guideways handle heavier loads, are more accurate, and are less expensive. They are ideal all-round products with well-balanced characteristics. Cage-guided roller guideways offer the best results in terms of load-bearing capacity and rigidity. Both components are pre-assembled and pre-loaded for simple OEM installation.

Slideways handle smaller loads. They also are pre-assembled and pre-loaded for easy installation. In addition, SCHNEEBERGER offers a slide with an integrated measurement system.

Linear guideways with recirculating bearings allow for unlimited stroke.

Ball-bearing mounted guideways yield excellent results for applications requiring smooth movement (but do not need high load-bearing capacity and rigidity).

Needle bearing-mounted guideways with cage assist meet the requirements for extremely high-load bearing capacity, rigidity, and precision (but less smooth operation). The cage optimises running performance by reliably preventing movement pulsations.

Overall, OEMs should look for the following desirable attributes when selecting linear guideway products:

- Exceptionally smooth operation
- Consistent accuracy of movement



Preload Wedge type NRV,
Recirculating unit type NRT,
Type SK recirculating bearing with balls.

- No stick-slip effect
- Rapid travelling speeds
- Minimal wear
- High reliability and rigidity
- High load-carrying capacity
- Vacuum and clean room compliance.



Type N/O needle bearing,
Type M/V needle bearing.

2. Define your linear motion requirements.

The load, accuracy, force, speed, and acceleration required of the motion system are the most important factors in specifying a linear guideway. They must be calculated first to determine the type and size of the product.

To meet the specifications of the guideway's travel, the customer must choose the length of the rails. Rails are sized by number: 1, 2, 4, and 6. The formula for calculating the rail's correct length is available in SCHNEEBERGER's linear guideway product guide.

In addition, a knowledgeable supplier will perform calculations to help determine the anticipated lifetime of the linear guideway component.

3. Surround assembly and machining must be precise.

The assembly and machining of the surround that holds the motion system must be exceptionally precise. Flatness, straightness, and angularity all must be correct. Out-of-spec machining can cause cage movement, inaccurate machine operation, and system error.

4. Eliminate cage creep.

OEMs must be aware of the potential for cage movement or “creep.” The cage is a set of roller or ball bearings that fit in a housing in the middle of the rails. In every linear guideway, the cage can be shifted from the center along the longitudinal axis. Cage creep reduces the optimal load distribution and requires a correct stroke to return the cage to a centered position.

Cage creep can occur for the following reasons:

- Surround not properly machined
- High accelerations and speeds
- Vertical installation of the guideway
- Uneven load distribution
- Protruding cage
- Different heat expansion coefficients
- Design and installation (lacking rigidity and/or accuracy of the connecting structure).

Cage creep will affect the accuracy of the machine and must be curtailed. Fortunately, cage control technology, such as SCHNEEBERGER’S Formula S system, has been developed to eliminate cage movement.

If the OEM’s product has a heavier load and accuracy is important, then they should choose a cage with roller bearings. If the load is not heavy, but smooth operating movement is required, then a cage with ball bearings should be selected.

Cage control provides a variety of important benefits:

- No cage slipping results in consistent load conditions
- Correction strokes are avoided
- No force is required for cage reset
- The device continues running with accelerations up to 300 m/s² (30 g)
- Speed of 1 m/s
- Easy installation and/or removal
- Extended service life
- Vacuum-compatible up to 10⁻⁷ mbar.



Type RN Formula S with anti-cage creep mechanism.

5. Pre-load the linear guideway bearings.

The anticipated load must be put on the guideway bearings before they are installed to ensure correct functionality. The slides should be pre-assembled and pre-loaded by the supplier before shipment to the OEM. This procedure is essential to ensure micron tolerance and accuracy.

6. Customise the product for competitive advantage.

More than 50% of all linear motions products are customized. Why? Because OEMs want to build products with unique competitive advantages. This quest requires components with lighter weight, smaller size, and the capability to handle greater forces, speeds, and loads. It may call for cage modifications, special coatings, or corrosion-resistant materials.

When customisation is required, look for suppliers that specialize in working with OEMs to create new and unique products. These suppliers typically offer two levels of customized components.

- Modified standard products involve minor changes to the supplier’s existing products:
- Totally customised products are built to customer-specific designs and may specify unique geometries; special greasing for cleanroom, vacuum, and extraordinary temperature range applications; and one-of-a-kind packaging.

A supplier that specialises in customised linear motion products will employ a collaborative design and development process. The process should begin with rapid decision making by the supplier’s management to invest in customised products that require new capabilities. Then, the following steps should occur:

- OEM provides product need, application, and specifications to supplier
- Supplier drafts a product solution
- Customer reviews draft and ideas are shared
- Design revisions are made by supplier
- Supplier builds component prototype while OEM builds machine prototype
- Linear motion prototypes are tested in the machine prototype to generate data that supports and validates the component design
- After revisions are made, supplier delivers final component to OEM for testing and evaluation.

Conclusion

Linear guideways play a critical role in the operation of the OEMs' products. Many of these OEM systems involve applications that can affect patient health or impact military, aerospace, and communications performance.

Selecting the correct linear guideway components requires an in-depth understanding of the product type best suited for the OEM application. For example, if cage creep is anticipated, choosing a proven cage control system is crucial. Guideway bearings should be preloaded to ensure the required accuracy and precision. Plus, motion system surrounds must be machined to exceptionally accurate tolerances.

If a customised product is desired, a motion control specialist with a collaborative development process is preferred for their knowledge and flexible engineering and manufacturing capabilities. These specialists should be co-located with other companies that provide additional precision machining technologies.

Understanding these six key issues will assure the selection of linear guideways that provide the required accuracy, repeatability, and operating lifetime.