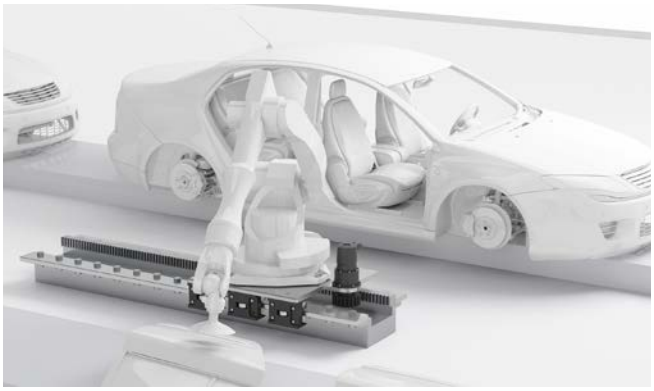
SCHNEEBERGER
LINEAR TECHNOLOGY

Gear Racks: The Economical Solution When Machine Components with Large Axial Forces Require Long Linear Movement

INTRODUCTION

In large machine building, there are times when the design engineer must transfer components with very large axial forces across long linear ranges of travel. These requirements are typically found in applications such as automation and robotics, machine tool, and packaging.

While there are several movement options the design engineer can choose – ball screws, linear motors, and drive belts to name a few – gear racks are extremely economical when the needed stroke is more than 4 meters. They permit linear movement that can extend along almost limitless stretches, making them well suited for large machines and systems. Gear racks' simplicity and strength enable easy customization, giving the engineer attractive flexibility in designing a linear movement system.



A robotic application for the automotive industry.

What is a gear rack?

Gear racks are among the more inexpensive linear drive elements that are frequently utilized when rail stretches cover a distance of more than 4 meters.

The technology uses a rack and pinion system where a slideway is driven by the pinion running on a fixed gear rack. A major advantage is the rack's high level of rigidity, which remains constant across the entire length of movement. This feature enables a gear rack to transfer an almost unlimited amount of axial force across its range of motion.

The gear rack is a highly economical drive element, especially when long strokes are required. A combination of two functions is possible: guiding and driving. The maximum one-piece length is 3 meters. However, connecting two rails with their butt joints make it easy to design longer lengths.

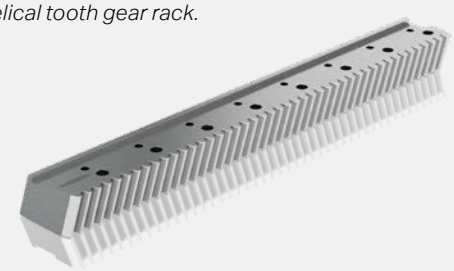
A standard straight-tooth gear rack.

Why use a gear rack?

There are four reasons why the design engineer would choose a gear rack for linear motion in a machine.

1. They are preferred for moving components or systems with large axial forces. Gear racks retain the same level of stiffness at each position of travel. The reason: the pinion is always in contact with the fixed rack!
2. The technology offers exceptional movement accuracy over long lengths of travel.
3. There is a high degree of flexibility and customization that makes it easy to fulfill a specific design. The gear rack's teeth can be milled or ground to the customer's specifications. Surface quality is available in ranges from Q11 to Q4, with Q4 corresponding to an individual pitch deviation of 3 µm from tooth to tooth. Typical surface quality ratings for common applications include automation-Q7, machine tools-Q6, and high-end machine tools-Q5. Different hardening processes are available including soft, tempered, inductive hardened, case hardened, through hardened, and nitrified. The hardening requirement is driven by the load capacity of the application.
4. Gear racks are the most economical form of machine motion when travel over long distances (greater than 4 meters) is required.

A helical tooth gear rack.

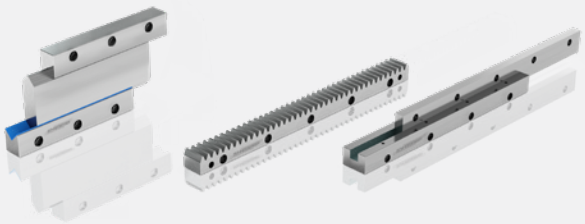


Standard or customized gear racks: what is the need?

Gear racks are available in standard or customized versions, depending on the design engineer's requirements.

Standard products come in straight-toothed and helical-toothed versions and are available in industrial dimensions from module 2 to module 12. The material, accuracy, and hardness (i.e. soft, induction, case hardened, nitride hardened, etc.) can be specified according to the required loads. Extremely high quality options are available. Gear racks with a Q4 rating have an individual adjacent pitch error of 3 µm and a cumulative pitch error of 15 µm per 1000 mm. The maximum single piece length is 3 meters. Connection with the rail's butt joints permits longer ranges of travel.

Custom gear racks.



Customized gear racks are a logical choice if a standard product does not fit the machine builder's design. About 70% of all gear racks are specifically built to customers' requirements. Customization is a collaborative process that demands a supplier with technical performance, knowledge of metallurgy, exceptional quality processes, and raw material access. A vendor with strong engineering resources and a history of successful partnerships can help the OEM reduce costs and improve performance, even if small product volumes are involved. Customized gear racks can be produced in dimensions up to module 20 and in lengths up to 3 meters. The design engineer can choose from different materials, hardness levels, and fastening options (i.e. lateral, vertical, dead-end, and flange type).

Synchronized gear racks (gantry machines) are also available. These devices consist of two rows of racks that are ground together in parallel. The tolerance between the two racks is 1 to 2 microns – providing smooth motion and movement.

Who needs gear racks?

Gear racks provide competitive advantages to machine builders designing systems requiring component travel over long ranges of motion. These applications include automation and robotics (7th axis); machine tools such as lathes, presses, and stamps; machining centers; medical devices; material handling and flow systems; packaging machines; and printing presses. In these products, OEMs want greater movement accuracy at lower cost.

End users that need existing machines to accelerate quicker and handle higher loads can replace their motion systems with case-hardened gear racks and avoid the purchase of a new design.

This custom gear rack is available up to 3000 mm in a single piece.

Conclusion

Machine builders frequently design products that must move components or systems with strong axial forces across long ranges of travel. While faced with several linear motion choices, gear rack technology offers the best combination of accurate movement and economical cost. It retains a consistent level of stiffness across the entire range of motion and offers an individual pitch deviation of up to 3 µm from tooth to tooth. With both standard and customized products offering a wide range of lengths, quality ratings, and material hardness, OEMs can design motion systems that maximize the performance of their products.

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