Rack and Pinions

The GAM Helical Rack and Pinion series, along with our broad gearbox offering, provide a complete linear solution. Simply select the rack and pinion needed then match it with the right gearbox for your application.

- High-precision helical rack for smooth, quiet operation
- Pinions can be mounted to SureGear® gearboxes
- Pinions are hardened and work with ISO 10 hardened rack

What is Rack & Pinion?

A linear actuator that converts the rotary motion of the (circular) pinion to linear motion at the (linear) rack.

Why use a Rack & Pinion System?

A rack and pinion system is the most cost-effective installation for linear movements greater than 2 meters.

Why use a GAM Rack & Pinion System?

GAM matches their high-quality rack and pinion with the best precision gearboxes for your application.

GAM Pinions

Part Number	Price	Module	Teeth	Mounting	Pitch Diameter	Travel per Rotation	Max Feed Force	Mounting Distance	Fits	Drawing Links
84010001	$409.00	1.5	20	set screw	31.831mm	100mm	1.3 kN	31.4mm	SureGear PGCN23 series gearboxes	PDF
84010002	$409.00	2	18	keyed shaft	38.197mm	120mm	2.8 kN	41.1mm	SureGear PGCN34 series gearboxes	PDF
84010003	$409.00	2	18	keyed shaft	38.2mm	120mm	12.88 kN	41.1mm	SureGear PGA070 and PGB070 series gearboxes	PDF
84010004	$415.00	2	20	keyed shaft	42.44mm	133.33mm	13.37 kN	43.22mm	SureGear PGA090 and PGB090 series gearboxes	PDF
84010005	$526.00	2	30	keyed shaft	63.66mm	200mm	15.02 kN	53.83mm	SureGear PGA120 and PGB120 series gearboxes	PDF
84010006	$655.00	3	22	keyed shaft	70.03mm	220mm	20.05 kN	61.01mm	SureGear PGA155 and PGB155 series gearboxes	PDF
84010007	$649.00	2	26	bolt-through	55.174mm	173.334mm	13.4 kN	50.4mm	SureGear PGD064 series gearboxes	PDF
84010008	$752.00	2	33	bolt-through	70.028mm	220mm	18.4 kN	57.8mm	SureGear PGD090 series gearboxes	PDF
84010009	$799.00	2	40	bolt-through	84.883mm	266.667mm	14.8 kN	65.2mm	SureGear PGD110 series gearboxes	PDF

NOTE: Shaft Key is not included with Pinions

Set Screw Pinion
84010001

Keyed Pinion
84010002

Bolt Through Pinion
84010007

GAM Pinion General Specifications

Quality	ISO Q06
Material	4140 carbon steel
Helix Angle	Left Hand 19° 31'42"
Pressure Angle	20 degrees
Induction Hardened	55 - 60 HRC

One inspection pin included for use with rack height adjustments

Rack and Pinion

GAM Racks			
Part Number	***Price***	***Description***	***Drawing Links***
74020012	$208.00	GAM helical rack, Module 1.5, 200 tooth, 1m length. For use with Module 1.5 pinions.	PDF
74020004	$208.00	GAM helical rack, Module 2, 150 tooth, 1m length. For use with Module 2.0 pinions.	PDF
74020005	$233.00	GAM helical rack, Module 3, 100 tooth, 1m length. For use with Module 3.0 pinions.	PDF

Rack
74020012

GAM Rack General Specifications			
Module	***1.5***	***2.0***	***3.0***
Quality	ISO Q10		
Material	1045 carbon steel		
Helix Angle	Right Hand 19° 31'42"		
Pressure Angle	20 degrees		
Induction Hardened	50 - 55 HRC		
Tooth Thickness Tolerance (µm)	-124	-124	-124
Single Pitch Error (µm)	≤37	≤37	≤39
Total Pitch Error (µm)	≤148	≤148	≤162

Rack Installation

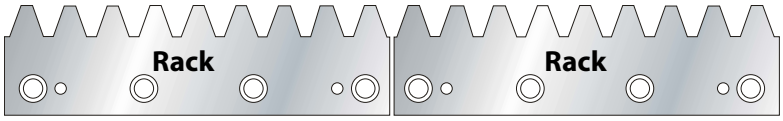
These are the three main steps to installing a GAM rack. Installation of multiple rack pieces end-to-end requires an opposite tooth installation gauge:

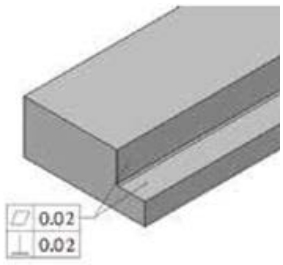
GAM Gauges			
Part Number	***Price***	***Description***	***Drawing Links***
74030010	$59.00	GAM helical rack installation gauge, for use with Module 1.5 racks.	PDF
74030001	$59.00	GAM helical rack installation gauge, for use with Module 2.0 racks.	PDF
74030002	$71.00	GAM helical rack installation gauge, for use with Module 3.0 racks.	PDF

Step 1

Put the racks on the base, end to end, loosely installing the screws

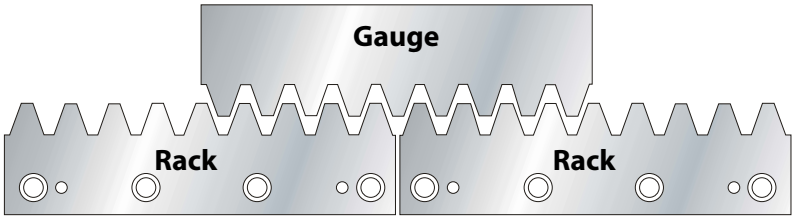
NOTE: Ensure the mounting surface of installation is clean and clear of debris and within tolerance (Perpendicularity and Flatness≤0.02mm)





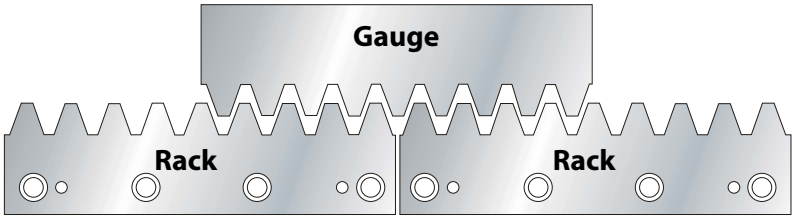
Step 2

Put the Rack Gauge across the ends of the joined racks and adjust the pitch. The ends of the racks each form half a tooth



Step 3

Bolt the racks to the base in sequence. Install dowel pins

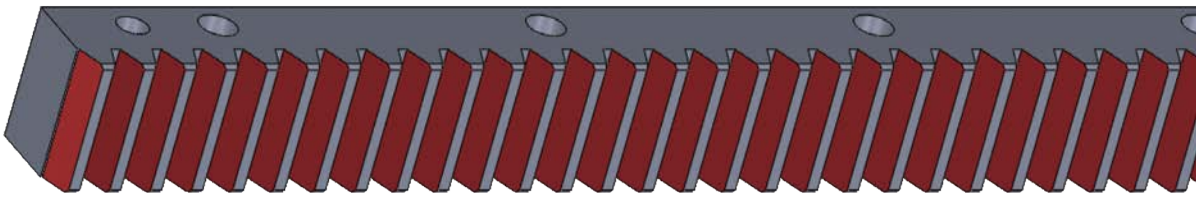


Rack and Pinion Alignment

For best performance, the rack and pinion must be installed with proper tooth engagement. To perform this check, apply the Gear Marking Compound to the Pinion and drive the pinion along the rack UNDER LOAD CONDITIONS.

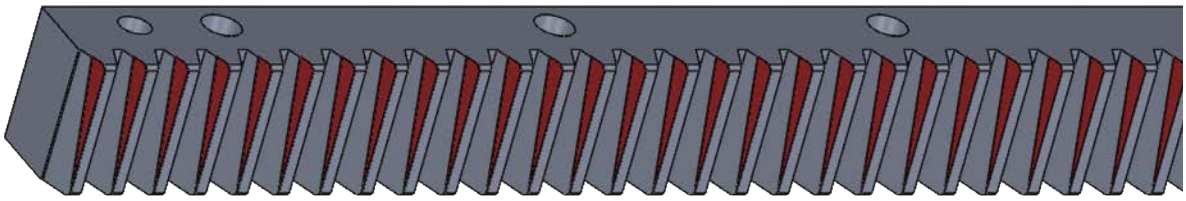
Correct

The Gear Marking Compound is consistently deposited across most the face of the tooth



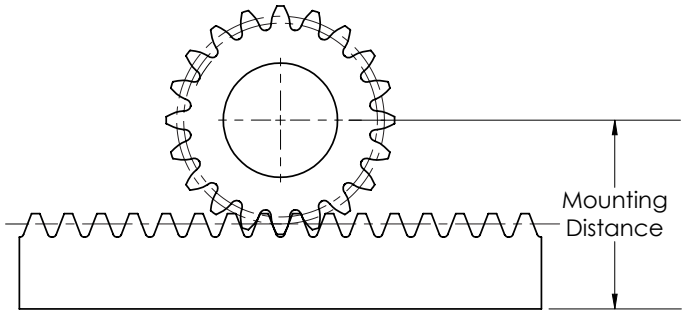
Pinion is Not Parallel to Rack

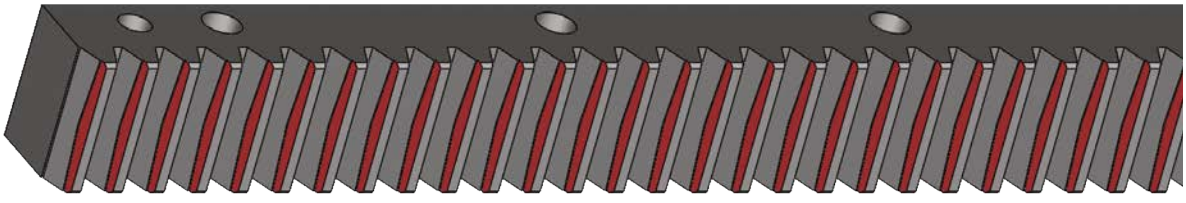
If the Gear Marking Compound forms a triangular shape across the face of the tooth, then the pinion and rack are not parallel. Adjust the pinion so the face of the pinion and the side of the rack are parallel. the axis of the pinion should be perpendicular to the rack.



Incorrect Mounting Distance

If the Gear Marking Compound appears only on the top half across the face of the tooth, then there is insufficient tooth contact between the rack and pinion. Adjust the center distance between the rack and the pinion. The pinion specification tables include the center distance for each size pinion.





Rack and Pinion Terminology

Module

The module is the relative size of the rack and pinion as described by the pinion. It is the ratio of the diameter of a gear to the number of teeth on the gear. The module and number of teeth give the reference pitch diameter:

$$\text{Module (M)} = \frac{\text{Pitch Diameter}}{\text{Number of Teeth (z)}}$$

Reference Pitch Diameter = Module (M) x Number of Teeth (z)

NOTE: The rack and pinion must have the same module.

ISO Quality Number

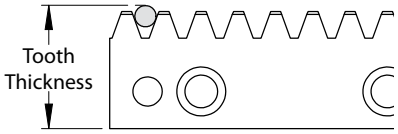
The ISO Quality Number describes the accuracy of the gear including the tooth alignment and profile, spacing variation, and radial runout among other things. AutomationDirect.com stocks Q6 and Q10 racks along with Q6 pinions.

ISO	DIN	AGMA	JIS
6	6	12	2
10	10	8	6

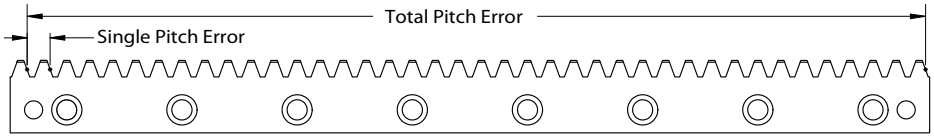
Tooth Thickness Tolerance

Tooth Thickness Tolerance is the relationship between tooth thickness and a measuring pin measurement.

- The tooth thickness of racks is usually measured via the pin measurement as tooth thickness can not be measured directly.
- A measuring pin is put into the teeth and measured to the back of the rack.



Pitch Error



Pitch: Distance between teeth as measured from a point on one rack tooth to the corresponding point on the next gear tooth.

Single Pitch Error: Error in the pitch between two teeth relative to the ideal.

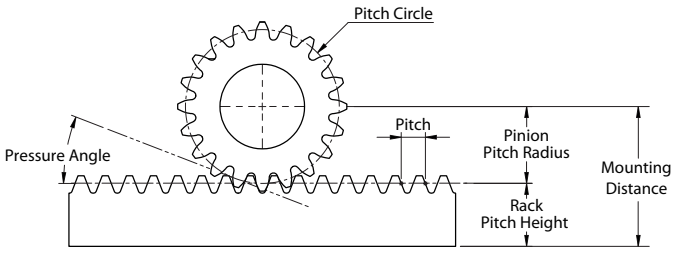
Total Pitch Error: Cumulative pitch error over the length of the rack

Circular Pitch: The distance from a point on one gear tooth to the corresponding point on the next gear tooth, measured along the pitch circle.

Pitch Circle: A circle transcribing the contact point on the teeth where the rack and pinion mesh correctly

Pitch Diameter: The diameter of the pinion's pitch circle.

Pressure Angle: The angle made by the sides of the tooth as it angles towards the top of the tooth. Mating gears and racks must have the same pressure angle.

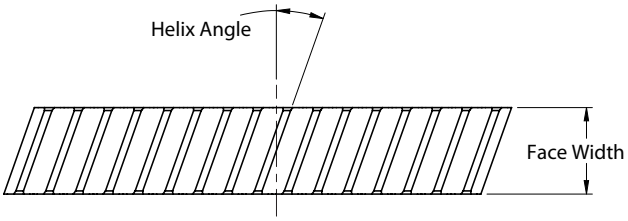


Mounting Distance: Distance between the center of the pinion and the bottom of the rack that ensures proper mesh. The Mounting distance should stay consistent for the length of the rack.

Mounting Distance = Pitch Height of Rack + Pitch Radius of Pinion

Rack and Pinion Terminology (Cont'd)

Helix Angle: Angle of the rack or gear tooth. GAM racks and pinions use a common helix angle of 19°31'42"



Gear Strength and Durability

Gear strength and durability depends on transmitted forces and power.

$$\text{Power } (P_{kW}) = \text{Force } (F_N) \times \text{Linear Velocity } (V_{mm/s})$$

$$\text{Force } (F_N) = \frac{1000 \times \text{Torque } (T_{Nm})}{\text{Pitch Radius } (r_{mm})}$$

$$\text{Linear Velocity } (V_{mm/s}) = \frac{\pi r_{mm} \times N_{RPM}}{60}$$

$$\text{Power } (P_{kW}) = \frac{T_{Nm} \times N_{RPM}}{9550}$$

The feed force required by the application should be less than the feed force capacity of the pinion or gearbox-pinion system as listed in this catalog. The feed force rating should be derated by the Overload Factor (K_a) and the Life Factor (K_L)

$$\text{Application Feed Force (F)} < \frac{K_L}{K_a} \times \text{Rated Feed Force (F)}$$

Overload Factor (K_a)

Impact from Prime Mover	*Impact from Load Side*		
	Uniform Load	*Medium Impact*	*Heavy Impact*
Uniform Load	1	1.25	1.75
Light Impact	1.25	1.5	2
Medium Impact	1.5	1.75	2.25

Life Factor (K_L)

Number of Cycles	*Hardness (HRC) ≥45*
Under 10,000	1.5
~10^5	1.5
~10^6	1.1
~10^7	1.0