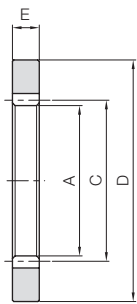




Specifications	
Precision grade	JIS grade N9 (JIS B1702-1: 1998)
Gear teeth	Standard full depth
Pressure angle	20°
Material	S45C
Heat treatment	—
Tooth hardness	(less than 194HB)
Surface treatment	Black oxide coating



T1

Catalog Number	Module	No. of teeth	Shape	Outside dia.	Pitch dia.	Outside dia.	Face width	Allowable torque (N·m)		Allowable torque (kgf·m)		Backlash (mm)	Weight (kg)
				A	C	D	E	Bending strength	Surface durability	Bending strength	Surface durability		
SIR2-120 SIR2-200	m2	120 200	T1	236 396	240 400	286 446	20	413 677	68.8 110	42.1 69.0	7.02 11.2	0.12~0.28	2.98 4.80
SIR2.5-120 SIR2.5-200	m2.5	120 200		295 495	300 500	355 555	25	807 1320	138 220	82.3 135	14.0 22.5	0.14~0.31	5.55 8.94
SIR3-120 SIR3-160	m3	120 160		354 474	360 480	424 544	30	1390 1840	244 315	142 188	24.9 32.1	0.15~0.35	9.28 12.1

- [Caution on Product Characteristics]
- ① The backlash values shown in the table are the theoretical values for the normal direction for the internal ring in mesh with an SS spur gear.
  - ② The allowable torques shown in the table are calculated values according to the assumed usage conditions. Please see Page 207 for more details.
  - ③ Please check for the involute interference, trochoid interference and trimming interference prior to using internal gears.
- [Caution on Secondary Operations]
- ① Please read “Cautions on Performing Secondary Operations” (Page 207) when performing modifications and/or secondary operations for safety concerns. KHK Quick-Mod Gears, the KHK system for quick modification of KHK stock gears, is also available.
  - ② Avoid performing secondary operations that narrow the tooth width, as it affects precision and strength.

Established equipment and technology  
Custom gears are also available.

Diameter  $\phi$  700mm maximum, Module 6.5 maximum,  
Cutting Stroke 170 mm



Gear cutting by CNC Gear Shaper



# Racks

MRGF/MRGFD Hardened Ground Racks	KRGF-H/KRGFD-H Hardened Ground Racks	KRG/KRGF/KRGFD Thermal Refined Ground Racks	SRG/SRGF/SRGFD/SRGFK Hardened Ground Racks	KRF-H/KRFD-H Hardened Racks	SRF-H/SRFD-H Hardened Racks	SRF-HL/SRFD-HL Laser Hardened Racks
Material: SCM415 m1.5~3 Page 224	Material: SCM440 m1.5~3 Page 226	Material: SCM440 m1~3 Page 228	Material: S45C m0.5~6 Page 230	Material: SCM440 m1.5~5 Page 232	Material: S45C m1.5~6 Page 234	Material: S45C m1.5~6 Page 236
KRF/KRFD Thermal Refined Racks	SRAF/SRAFD/SRAFK Square Racks	SR Racks	SRF Steel Racks with Machined Ends	SRFD/SRFK Steel Racks with Bolt Holes	SUR/SURF/SURFD Stainless Steel Racks	DRF/DRFD/DRFK Plastic Racks
Material: SCM440 m1.5~5 Page 238	Material: S45C m1.5~4 Page 240	Material: S45C m0.5~10 Page 242	Material: S45C m0.5~10 Page 243	Material: S45C m0.5~6 Page 244	Material: SUS304 m1~4 Page 246	Material: Polyacetal m1~3 Page 248
PR/PRF Plastic Racks	BSR Racks	SRO/SROS Round Racks	SURO Stainless Steel Round Racks	DR Molded Flexible Racks	SSDR/ARL/SRS Rack Clamps for Pinions/Rack Guide Rails For Molded Flexible Racks	KRHG/KRHGF/KRHGFD Ground Helical Racks
Material: MC901 m1~3 Page 250	Material: Free cutting brass (C3604) m0.5~1 Page 251	Material: S45C m1~5 Page 252	Material: SUS303 m1~3 Page 253	Material: Duracon (R) (M25-44) m0.8~2 Page 254	Material: S45C, etc. Page 254	Material: SCM440 m1~3 Page 256
SRH/SRHF/SRHFD Helical Racks	SRHEF Helical Racks	SHE Helical Gears	ZST/ZSTD Hardened Ground Helical Racks	ZSTP Ground Helical Gears	ZST-GL Assembly Gauges	
Material: S45C m2, 3 Page 258	Material: S45C m1.5~6 Page 260	Material: S45C m1.5~6 Page 260	Material: DIN C45 (S45C equivalent) m2~6 Page 262	Material: SCM440 m2~6 Page 262	Material: S45C m1.5~6 Page 264	

Includes Made to Order

## Catalog Number of KHK Stock Gears

The Catalog Number for KHK stock gears is based on the simple formula listed below. Please order KHK gears by specifying the Catalog Numbers.

(Example) Racks

K R G F 2 - 500 H

Gear teeth induction hardened  
Total Length (500mm)  
Module (2)  
Other Products (End Machined)  
Other Products (Ground Gears)  
Type (Rack)  
Material (SCM440)

**Material**  
M SCM415  
K SCM440  
S S45C  
SU Stainless Steel  
BS Brass  
P MC901  
D Polyacetal

**Type**  
R Racks  
RH Helical Racks  
RO Round Racks  
S Spur Gears  
H Helical Gears

**Other Information**  
F Racks with Machined Ends  
D Racks with Bolt Holes  
K Racks with Drill Holes  
G Ground Gears  
H Gear teeth induction hardened  
HL Laser hardened  
ZST #####



## Features



KHK stock racks are made for high precision linear motion applications. We offer a large selection of racks ranging from module 0.5 to 10 and lengths up to 2000 mm. The following table lists the main features.

### ■ Racks

Catalog Number <small>Note 1</small>	Module	Total Length mm Parentheses show no. of teeth	Material	Heat Treatment	Tooth Surface Finish	Gear accuracy <small>KHK R 001 Note 3 Parentheses show JIS B 1702-1</small>	Features
<b>MRGF/MRGFD</b>	1.5~3	500	SCM415	Tooth area carburized	Ground	1	Racks that have been carburized and ground that have excellent accuracy, strength and wear resistance. Secondary operations are possible except for tooth.
<b>KRGF-H KRGFD-H</b>	1.5~3	500, 1000	SCM440	Thermal refined, gear teeth induction hardened	Ground	1	Racks that have been tempered, hardened and ground that have excellent accuracy, strength and wear resistance. Secondary operations are possible except for tooth.
<b>KRG/KRGF/ KRGFD</b>	1~3	100, 500, 1000	SCM440	Thermal refined	Ground	1	Racks that have been tempered and ground that have excellent accuracy and strength.
<b>SRG/SRGF SRGFD/SRGFK</b>	0.5~6	100, 300, 500, 1000	S45C	Gear teeth induction hardened <small>NOTE 2</small>	Ground	3	Racks that have been hardened and ground with a good balance of accuracy, wear resistance and cost. Secondary operations are possible except for tooth.
<b>KRF-H/KRFD-H</b>	1.5~5	1000	SCM440	Thermal refined, gear teeth induction hardened	Cut	5	Racks that have been tempered and hardened that have excellent strength and wear resistance. Secondary operations are possible except for tooth.
<b>SRF-H SRFD-H</b>	1.5~6	1000	S45C	Gear teeth induction hardened	Cut	5	Racks that have been hardened with excellent wear resistance. Secondary operations are possible except for tooth.
<b>SRF-HL SRFD-HL</b>	1.5~6	1000, 1500, 2000	S45C	Gear teeth laser hardened	Cut	4	Racks that have been laser hardened with a good balance of wear resistance and cost. Secondary operations are possible except for tooth.
<b>KRF/KRFD</b>	1.5~5	500, 1000	SCM440	Thermal refined	Cut	4	Racks that have been tempered with excellent strength.
<b>SRAF/SRAFD SRAFK</b>	1.5~4	1000, 2000	S45C	—	Cut	4	These racks have smaller tooth height in comparison to SRF Racks.
<b>SR/SRF SRFD/SRFK</b>	0.5~10	100, 300, 500, 1000, 1500, 2000	S45C	—	Cut	4	Many lineups are available at a low price and excellent usability.
<b>SUR/SURF SURFD</b>	1~4	500, 1000	SUS304	Solution treated	Cut	5	Stainless steel racks with rust resistance.
<b>DRF/DRFD DRFK</b>	1~3	500, 1000	Polyacetal	—	Cut	5	Racks made of polyacetal with shorter overall length than nylon, making them suitable for joining together.
<b>PR/PRF</b>	1~3	500, 1000	MC901	—	Cut	5	Nylon racks can be used with no lubrication.
<b>BSR</b>	0.5~1	300	Free-cutting Brass (C3604)	—	Cut	4	Brass racks with excellent machinability.
<b>SRO/SROS</b>	1~5	500, 1000	S45C	—	Cut	4	Round racks that are suitable when the rack side moves.
<b>SURO</b>	1~3	500, 1000	SUS303	—	Cut	5	Round racks made of stainless steel. Suitable when the rack side moves.
<b>DR</b>	0.8~2	2000	Duracon (R) (M25-44) <small>NOTE 4</small>	—	Injection Molded	8	Thin plastic racks that can be bent.
<b>KRHG/KRHGF KRHGF</b>	1~3	100, 500, 1000	SCM440	Thermal refined	Ground	1	Helical racks that have been tempered and ground with excellent accuracy that have higher strength and quietness as compared with KRGF.
<b>SRH/SRHF SRHFD</b>	2~3	100, 500, 1000	S45C	—	Cut	5	As they are helical racks, they have higher strength and quietness as compared with SRF.
<b>SRHEF</b>	1.5~6	1000	S45C	—	Cut	4	As they are helical racks, they have higher strength and quietness as compared with SRF. They can be used like CP racks.
<b>ZST/ZSTD</b>	2~6	1000, 2000	DIN C45 (JIS Grade S45C equivalent)	Gear teeth induction hardened	Ground	Grade 2 equivalent	Helical racks that have been hardened and ground that have excellent accuracy, wear resistance and quietness. They can be used like CP racks. Secondary operations are possible except for tooth.

### ■ Pinion

<b>SHE</b>	1.5~6	(18~30)	S45C	—	Cut	(N8)	SRHEF pinions that have excellent strength and quietness as compared with SS due to its helix.
<b>ZSTP</b>	2~6	(18~30)	SCM440	Thermal refined, gear teeth induction hardened	Ground	(N6)	ZST pinions with high accuracy that have excellent strength, wear resistance and quietness due to its helix. Secondary operations are possible except for tooth.

[NOTE 1] The catalog numbers of the above racks with (F) suffix have both ends machined so that they can be butted against each other. The items with (D) have mounting screw holes for immediate assembly.

[NOTE 2] Products with module under 1 are thermal refined, without their gear teeth being induction hardened.

[NOTE 3] Precision grade standard of racks are set by KHK. Please see "Precision of Racks" in Selection Hints section for details.

[NOTE 4] "Duracon (R)" is a registered trademark of Polyplastics Co., Ltd. in Japan as well as other countries.

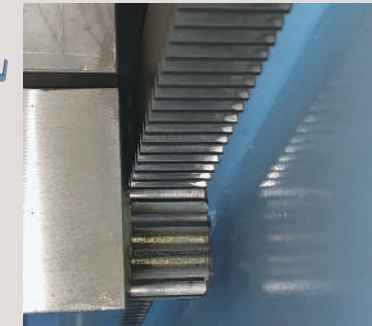
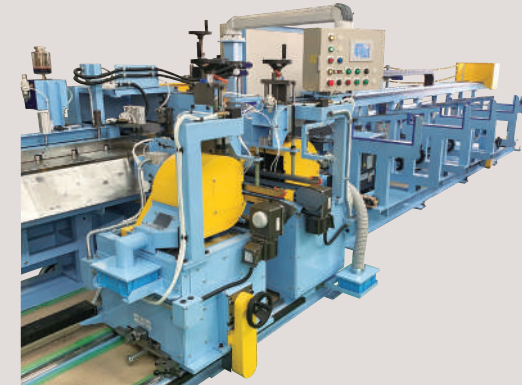
- KHK stock racks have round semi-topping at the corners of the top land of the gear tooth.
- Black products are KHK stock gears that have an applied black oxide coating for rust resistance.

## Application Examples



KHK stock racks & pinions are adopted in driving devices for all kinds of linear motion systems, including transport devices.

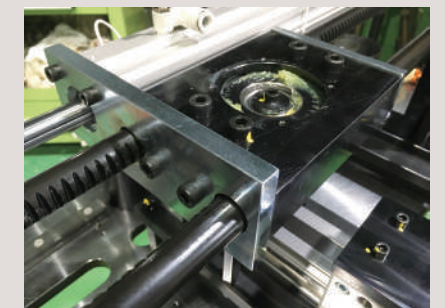
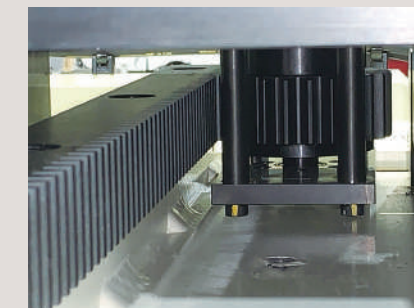
### ■ Circular saw cutting machine HS-400 manufactured by Kooki Co., Ltd.



SRFD racks and SSG spur gears used for automatic and manual drive for cutting, machining of both ends and deburring

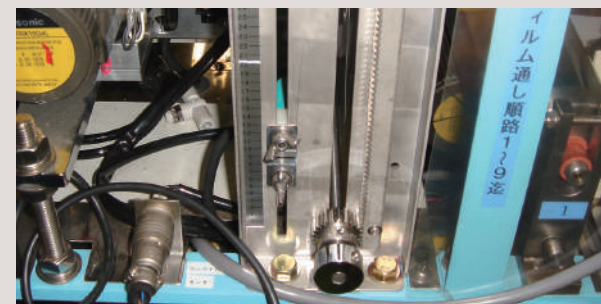


### ■ Clamp Seamer Welder



The SRCPFD racks and SSCP spur gears used to drive weld torches at constant speed, and the SRO round racks and SS spur gears used to position workpieces

### ■ Automatic packaging machine manufactured by Toyota Machinery Co., Ltd.



SUR stainless steel rack used for film winding tension part

### ■ Dremax Long Strip Cutter



PR plastic rack used for feeding Long Strip Cutter

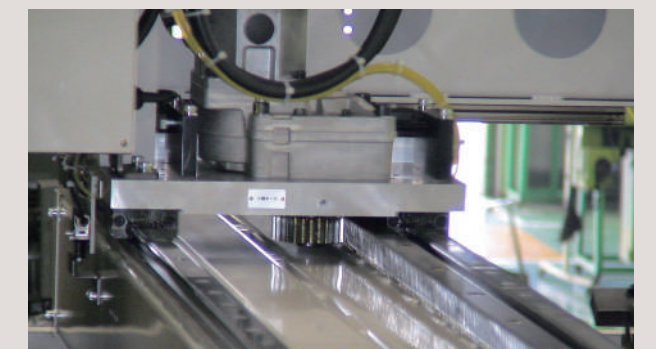


### ■ Lathe Auto Loader



SRO Round Rack used as a workpiece storage device (lifting/lowering table)

### ■ Lathe Gantry Loader



KRG Ground Rack used as a workpiece conveying device



## Selection Hints

Please select the most suitable products by carefully considering the characteristics of items and contents of the product tables. It is also important to read all applicable "CAUTION" notes shown below before the final selection.

### 1. Caution in Selecting the Mating Gears

- With the exception of helical racks, KHK stock racks can mate with any spur gears of the same module. Products with different tooth width can also be mated as a pinion.
- See the table on the right for the mating gears of the helical racks.  
Be sure to check the combination of helix direction (right or left) when selecting.

### 2. Caution in Selecting Gears Based on Gear Strength

The gear strength values shown in the product pages were computed by assuming the application environment in the table below. Therefore, they should be used as reference only. We recommend that each user computes their own values by applying the actual usage conditions.

### ■ Calculation of Bending Strength of Gears

Item	Racks					Pinion					Racks		
	Catalog Number	MRGF	KRGF-H	KRGF	SRGF/SRGF	SRF-HL	SRAF/SRAF	SRAF/SRAF	SUR	BSR	SHE	ZSTP	DRF
		MRGFD	KRGFD-H	KRGFD	SRGF/SRGF	SRF-HL	SRAF/SRAF	SRAF/SRAF	SUR	BSR	SHE	ZSTP	DRF
Formula NOTE 1	Formula of spur and helical gears on bending strength (JGMA401-01)										The Lewis formula		
No. of teeth of mating gears	30 Note 2										(30)		
Rotational Speed of Pinion	100rpm										(100rpm)		
Design Life (Durability)	Over 10 <sup>7</sup> cycles										Allowable bending stress (kgf/mm <sup>2</sup> )		
Impact from motor	Uniform load												
Impact from load	Uniform load												
Direction of load	Bidirectional load (calculated with allowable bending stress of 2/3)												
Allowable bending stress at root $\sigma_{Hlim}$ (kgf/mm <sup>2</sup> )	47		32		20 NOTE 3		10.5	4	19	30			
Safety factor $S_F$	1.2												

### ■ Calculation of Surface Durability (Except where it is common with bending strength)

Formula NOTE 1	Formula of spur and helical gears on surface durability (JGMA402-01)												
Kinematic viscosity of lubricant	100cSt(50°C)												
Gear support	Supported on one end.												
Allowable Hertz stress $\sigma_{Hlim}$ (kgf/mm <sup>2</sup> )	166	112	79	90 NOTE 3	80	52.5	41.3	-	49	112			
Safety factor $S_H$	1.15												

- [NOTE 1] The gear strength formula is based on JGMA (Japanese Gear Manufacturers Association) specifications, "MC Nylon Technical Data" by Mitsubishi Chemical Advanced Materials and "Duracon (R) Gear" by Polyplastics Co. The units for the rotational speed (rpm) and the stress (kgf/mm<sup>2</sup>) are adjusted to the units needed in the formula.
- [NOTE 2] No. of mating teeth in the ZST and ZSTD racks is the "minimum number of teeth" of the ZSTP pinion. The No. of mating teeth in the SRHEF racks is also calculated by the "minimum number of teeth" of the SHE pinion.
- [NOTE 3] For SRG, or SRGF Ground Racks, with a module less than m0.8, the allowable bending stress and allowable hertz stress are respectively 24.5 (kgf/mm<sup>2</sup>) and 62.5 (kgf/mm<sup>2</sup>).
- [NOTE 4] The values for DR m 1.5 racks were assumed by KHK. Usage conditions for SSCR (DR Rack Pinion) are the same for the SSCP Pinion, shown on Page 269.

When selecting KHK standard gears, glance over the Cautions on Product Characteristics and Cautions on Performing Secondary Operations on Page 216.

- Products not listed in this catalog or materials, modules, number of teeth and the like not listed in the dimensional tables can be manufactured as custom items. Please see Page 26 for more details about custom-made orders.
- The color and shape of the product images listed on the dimension table page of each product may differ from the actual product. Be sure to confirm the shape in the dimension table before selection.
- The details (specifications, dimensions, etc.) listed in the catalog may be changed without prior notice. Changes are announced on the KHK website.  
Website URL: <https://khkgears.net/new/>  
Overseas Sales Department: Phone: +81-48-254-1744 Fax: +81-48-254-1765 E-mail: [info@khkgears.net](mailto:info@khkgears.net)

### ■ Mating Helical Gear Selection Chart (○ Allowable × Not allowable)

Catalog Number and Direction of Helix		KRHG KRHGF		ZST ZSTD	SRHEF	SRH/SRHF SRHFD
		RH	LH	RH	RH	RH
KHG	LH	○	×	×	×	×
	RH	×	○	×	×	×
ZSTP	LH	×	×	○	○	×
SHE	LH	×	×	○	○	×
SH	LH	×	×	×	×	○
	RH	×	×	×	×	○



## Selecting the Gears

### Step 1

Determine the calculated load torque applied to the gear and the gear type suitable for the purpose.

### Step 2

Select provisionally from the allowable torque table in this catalog based on the load torque.

■ For provisional selection from this catalog

Catalog Number	Module	No. of teeth	Shape	Total Length	Face width	Height	Height to pitch line	Allowable torque (kgf)	Allowable torque (kgf)
KRG1-100	m1	20	R1	98	10	15	14	1330	641
KRG1.5-100	m1.5	20	R1	101	15	20	18.5	1440	352
KRG2-100	m2	11	R1	100	25	30	27.5	6130	2560
KRG3-100	m3	9	R1	101	30	35	32	9580	4010
KRG1-500	m1	159	RF	499.51	10	15	14	1530	641
KRG1.5-500	m1.5	109	RF	499.51	15	20	18.5	1440	352
KRG2-500	m2	80	RF	502.65	20	25	23	6130	2560
KRG2.5-500	m2.5	64	RF	502.65	25	30	27.5	9580	4010
KRG3-500	m3	53	RF	502.65	30	35	32	13800	5770

### Step 3

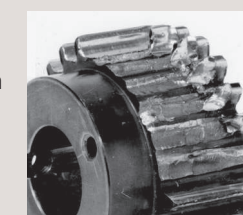
Calculate the strength under the actual usage conditions.

Calculate the strength formally using the various gear strength formulas. Please see our separate technical reference book for more details. We recommend using the Website that allows the strength to be easily calculated.

■ Use the strength calculation function on our website.

### ■ Bending strength

Calculated values of the strength at which the gear teeth do not break due to fatigue.



Example of failure due to insufficient bending strength

### ■ Surface durability

Calculated values of the strength at which the gear teeth do not wear due to surface fatigue damage.



Example of wear due to insufficient surface durability

## Product Precautions



### Common Notes

#### [Caution on Product Characteristics]

- (1) The allowable forces shown in the table are calculated values according to the assumed usage conditions. Please see Page 214 for more details.
- (2) The backlash values shown in the table are the theoretical values for the backlash in the circumferential direction of recommended pinions with the same pitch.
- (3) There is a decarburized layer on the surface, so 0.5mm or so will not be at the specified hardness.
- (4) After attaching the racks to the base, fasten with dowel pins. Clamping only with mounting screws could possibly cause the screws to be broken, due to a heavy load.

#### [Caution on Secondary Operations]

- (1) Please read "Cautions on Performing Secondary Operations" on Page 221 when performing modifications and/or secondary operations for safety concerns.
- (2) Due to the gear teeth being induction hardened, no secondary operations can be performed on tooth areas including the bottom land (approx. 2 to 3 mm).

#### [J Series]

- (1) Cancellation is not possible for made-to-order products. For lead time details, see Page 38.
- (2) Up to 20 units can be handled; for larger orders, please request a price and delivery quote.
- (3) Black oxide is not re-applied to parts undergoing secondary operations.

### MRGF Hardened Ground Racks

#### [Caution on Secondary Operations]

- (1) In the illustration, the area surrounded with ---- line is masked during the carburization process (max. HRC40 or so) and can be modified.

### KRF-H Hardened Racks

#### [Caution on Product Characteristics]

- (1) The dimensions may vary widely due to hardening. Therefore, the total composite error is excluded from the rack accuracy table on Page 219.

### SRF-H Hardened Racks

#### [Caution on Product Characteristics]

- (1) The dimensions may vary widely due to hardening. Therefore, the total composite error is excluded from the rack accuracy table on Page 219.

### SRF-HL Laser Hardened Racks

#### [Caution on Secondary Operations]

- (1) Due to the gear teeth being laser hardened, no secondary operations can be performed on tooth areas including the bottom land (approx. 1 mm).

### SRFD Steel Racks with Bolt Holes

#### [Caution on Secondary Operations]

- (1) Avoid hardening racks with bolt holes, due to mounting hole deformation.

### SUR(F,D) Stainless Steel Racks

#### [Caution on Product Characteristics]

- (1) The stainless steel material is given solution treatment and passivation.

### DRF(D,K) Plastic Racks

#### [Caution on Product Characteristics]

- (1) Boiling sterilization is not required when using this product in food machines. Note that POM plastic complies with the Food Sanitation Law of the US Food and Drug Administration (FDA), and boiling or exposing it to steam will cause the material to be damaged.

## Product Precautions



### PR(F) Plastic Racks

#### [Caution on Product Characteristics]

- (1) These plastic racks expand and contract depending on the temperature and humidity. The length per 1m changes by 0.45 mm when the temperature changes by 10°C, and about 5 mm with water absorption of 2%.The bending is 5 mm or less per 1 m, but may exceed 5 mm over time in products with total length 1000 mm. Mount for use while correcting along the gear cutting reference surface (bottom).

### SRO(S) Round Racks

#### [Caution on Product Characteristics]

- (1) Because this is extruded material, the outer diameter may be out of H9 tolerance in parts.

#### [Caution on Secondary Operations]

- (1) Avoid hardening round racks, due to twisting and deformation occurring and the difficulty of straightening the rack after hardening.

### SURO Stainless Steel Racks

#### [Caution on Product Characteristics]

- (1) Because this is extruded material, the outer diameter may be out of H9 tolerance in parts.

### DR Molded Flexible Racks

#### [Caution on Product Characteristics]

- (1) When using the DR flexible rack in an arc, the minimum bending radius (R) is 150 mm for both the external and internal teeth. This increases the pitch errors and tooth profile errors which prevent the teeth from meshing at the normal center distance, so be sure to make adjustments before use.
- (2) It cannot be used where positioning accuracy is required.
- (3) For the dimensional tolerance of each part, see the dimensional tolerance of molded items in the separate table.

### SRS Rack Clamps

#### [Caution on Product Characteristics]

- (1) M4 x 12 pan head machine screws with cross holes are included.
- (2) The set includes a rack clamp and 10 machine screws.

### KRHG(F,D) Ground Helical Racks

#### [Caution on Product Characteristics]

- (1) For the helical gear series combinations, see the Mating Gear Selection Chart on Page 190.
- (2) These bevel gears produce axial thrust forces. Please see Page 193 for more details.

### SRH(F) Helical Racks

#### [Caution on Product Characteristics]

- (1) For the helical gear series combinations, see the Mating Gear Selection Chart on Page 190.
- (2) These bevel gears produce axial thrust forces. Please see Page 193 for more details.

### SRHFD Helical Racks

#### [Caution on Product Characteristics]

- (1) For the helical gear series combinations, see the Mating Gear Selection Chart on Page 190.
- (2) These bevel gears produce axial thrust forces. Please see Page 193 for more details.

#### [Caution on Secondary Operations]

- (1) Avoid hardening racks with bolt holes, due to mounting hole deformation.

**SRHEF Helical Racks**
**[Caution on Product Characteristics]**

- (1) For the helical gear series combinations, see the Mating Gear Selection Chart on Page 190.
- (2) These bevel gears produce axial thrust forces. Please see Page 193 for more details.
- (3) For the assembly joining gauge, use ZST-GL on Page 264.

**SHE Helical Gears**
**[Caution on Product Characteristics]**

- (1) The backlash values shown in the table are the theoretical values for the backlash in the circumferential direction of SRHEF Helical Racks with the same pitch.

**ZST(D) Hardened Ground Helical Racks**
**[Caution on Product Characteristics]**

- (1) For the helical gear series combinations, see the Mating Gear Selection Chart on Page 190.
- (2) These bevel gears produce axial thrust forces. Please see Page 193 for more details.

**ZSTP Ground Helical Gears**
**[Caution on Product Characteristics]**

- (1) The backlash values shown in the table are the theoretical values for the backlash in the circumferential direction of ZST Helical Racks with the same pitch.

**[Caution on Secondary Operations]**

- (1) Because of the influence of hardening residual stress, avoid removing the entire boss, as it may cause the gears to deform.

**3. Cautions on Selecting Racks By Precision**

The precision standards of KHK stock racks are established by us.  
The table below indicates the tolerance ranges of our racks.

**① Pitch Errors of Racks (KHK R 001)**

Our precision grades for pitch errors are established by referring to old JIS Standards. The precision grades are set from 1 to 8, in accordance with the tolerance of a single pitch error (S.P.E.), adjacent tooth-to-tooth error (T.T.E.), and the total composite error (T.C.E.) for each module and length.

**■ Precision Grades of Racks**

Unit:  $\mu\text{m}$ 

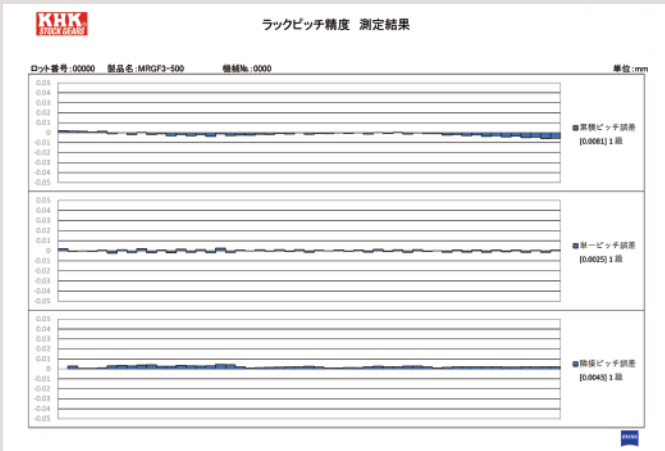
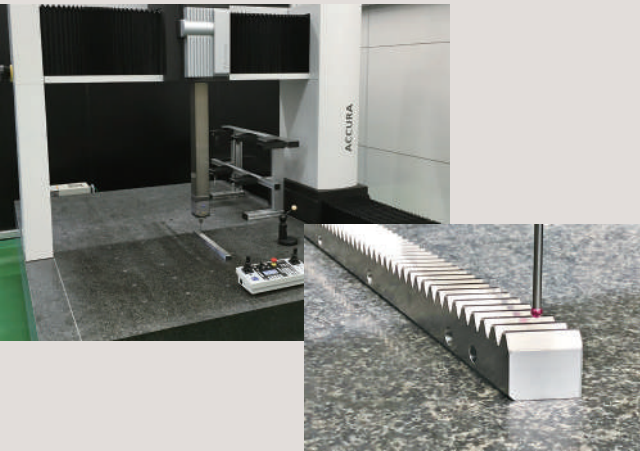
Grade	Pitch Error	Over $m0.4$ to 1 CP2.5		Over $m1$ to 1.6 CP5		Over $m1.6$ to 2.5 -		Over $m2.5$ to 4 CP10		Over $m4$ to 6 CP15		Over $m6$ to 10 CP20	
		Rack Length (nominal)											
		1000 or less	1001 up to 2000	1000 or less	1001 up to 2000	1000 or less	1001 up to 2000	1000 or less	1001 up to 2000	1000 or less	1001 up to 2000	1000 or less	1001 up to 2000
1	S.P.E.	10	-	10	12	11	12	11	13	13	14	14	16
	T.C.E.	28	-	29	33	30	35	32	37	35	40	40	45
2	S.P.E.	14	-	14	17	15	17	16	18	18	20	20	23
	T.C.E.	39	-	41	48	43	49	46	53	50	57	58	64
3	S.P.E.	20	-	20	24	21	25	23	26	25	29	29	32
	T.C.E.	56	-	57	67	60	70	64	74	71	80	81	91
4	S.P.E.	28	-	29	33	30	35	32	37	35	40	40	45
	T.C.E.	79	-	81	95	85	99	91	105	100	115	115	130
5	S.P.E.	39	-	41	48	43	49	46	53	50	57	58	64
	T.C.E.	110	-	115	135	120	140	130	145	140	160	160	180
8	S.P.E.	206	206	212	212	219	219	-	-	-	-	-	-

**[NOTE]** ① Since the pitch accuracy of racks may vary due to humidity, the precision grades are evaluated at the bottom surface of the product, at the temperature of 20°C. The dimensions of the KHK PR Plastic Racks may vary widely due to humidity. Therefore, the total composite error is assumed to be excluded from this accuracy standard.  
② For the accuracy of CP Rack, convert CP to  $m$  (module) when reference is made to the data in the table. ( $m = \text{CP} / \pi$ ).

**■ Comparison Table of Precision Grades of Racks**

KHK R001	1	2	3	4	5	6	7	8
DIN 3962	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12

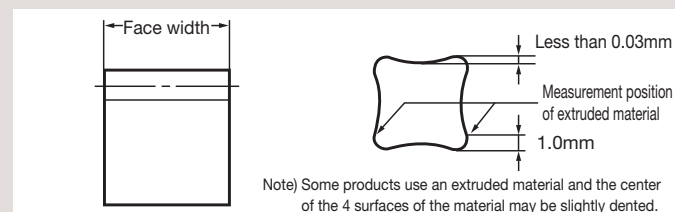
\* Values in the table are guidelines only and not guaranteed values.  
\* In the gray area, there are no equivalent products for stock gears.

**■ Pitch inspection and a sample report using Karl Zeiss ACCURA Coordinate Measuring Machine. (KHK R 001 Grade 1)**




## ② Precision of Rack Blanks

### ■ Tolerances for Face Width and Height

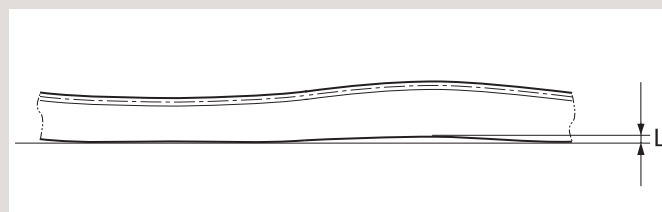


Unit: mm

Precision grade (KHK R 001)	Grade 1	Grade 2	Grades 3 to 5
Face width			
8 or less	0 -0.05	0 -0.10	0 -0.22
9 to 10		0 -0.10	0 -0.27
11 to 18		0 -0.10	0 -0.33
19 to 30		0 -0.15	0 -0.39
31 to 50		0 -0.15	0 -0.46
51 to 90		0 -0.15	0 -0.46

[NOTE] Dimensional tolerance of hardened products is that prior to hardening. Dimensional tolerance for plastic racks is the value obtained when machining is performed, and may increase slightly due to aging.  
\* BSR products are not applicable.

### ■ Maximum Curvature Values (Flatness Tolerance L)



Unit: mm

Precision grade (KHK R 001)	Grade 1 & 2	Grade 3	Grade 4 & 5
Length (nominal)			
500	0.05	0.1	0.2
1000	0.1	0.2	0.3
1500	—	—	0.3
2000	—	—	0.4

[NOTE] The straightness tolerances of round racks are 0.15/500 mm and 0.2/1000 mm.  
Plastic racks change over time so are excluded from this precision standard.

### ■ Tolerance on Total Length

Unit: mm

Product Type	Module	Dimensional Tolerance
F Type End Machined Product	m0.5	(-0.1 -0.3)
	m0.8(CP2.5)	(-0.1 -0.5)
	m1 up to 2.5	(-0.2 -0.6)
	m2.5 or more	(-0.2 -0.8)
FRCP and DR Flexible Racks	Uniform	±10
Products other than the above	Uniform	+3 -2

[NOTE] For Type-F racks with machined ends, the dimensional tolerance is a calculated value according to assumed usage conditions, without consideration of pitch errors and aged deterioration.

## ③ Backlash of Racks & Pinions

### ■ Backlash of Racks & Pinions (Circumferential)

Unit: mm

Module	CP	Precision Grade (KHK R 001)												
		Grade 1		Grade 2	Grade 3	Grade 4		Stainless Steel	Grade 5		Hardened	Thermal Refined + Hardened	MC nylon	POM * Excludes
		Straight	Helical			Excludes thermal refined racks	Includes thermal refined racks		Helical	SRHF				
m0.5	-	-	-	-	0.11 0.00	0.13 0.00	-	-	-	-	-	-	-	-
m0.8	CP2.5	-	-	-	0.12 0.00	0.14 0.00	-	-	-	-	-	-	-	-
m1	-	-	-	-	0.19 0.04	0.21 0.04	-	0.23 0.04	-	-	-	-	0.39 0.18	0.36 0.15
m1.5	CP5	0.14 0.04	0.15 0.05	0.14 0.04	0.19 0.04	0.25 0.09	0.27 0.09	0.27 0.09	-	0.28 0.10	0.29 0.05	0.31 0.05	0.42 0.21	0.39 0.18
m2	-	0.16 0.05	0.17 0.06	0.16 0.05	0.21 0.05	0.28 0.11	0.30 0.11	0.30 0.11	0.31 0.12	0.32 0.12	0.32 0.07	0.34 0.07	0.45 0.24	0.42 0.21
m2.5	-	0.16 0.05	0.17 0.06	0.16 0.05	0.21 0.05	0.31 0.13	0.33 0.13	0.33 0.13	-	0.35 0.14	0.35 0.09	0.37 0.09	0.49 0.26	0.46 0.23
m3	CP10	0.16 0.05	0.17 0.06	0.16 0.05	0.21 0.05	0.35 0.14	0.37 0.14	0.37 0.14	0.38 0.15	0.39 0.15	0.39 0.10	0.41 0.10	0.56 0.32	0.52 0.28
m4	-	-	-	0.16 0.05	0.21 0.05	0.42 0.18	0.44 0.18	0.44 0.18	-	0.47 0.19	0.46 0.14	0.48 0.14	-	-
m5	CP15	-	-	0.17 0.05	0.22 0.05	0.47 0.20	0.49 0.20	-	-	0.52 0.21	0.51 0.16	0.53 0.16	-	-
m6	CP20	-	-	0.17 0.05	0.22 0.05	0.54 0.22	-	-	-	0.57 0.23	0.58 0.18	-	-	-
m8	-	-	-	-	-	0.63 0.28	-	-	-	-	-	-	-	-
m10	-	-	-	-	-	0.70 0.33	-	-	-	-	-	-	-	-

## Application Hints



In order to use KHK stock racks safely, carefully read the Application Hints before proceeding. If there are questions or you require clarifications, please contact our technical department or your nearest distributor.

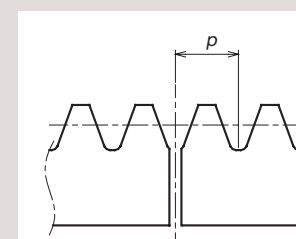
E-mail info@khkgears.net

### 1. Cautions on Handling

- KHK products are packaged one by one to prevent scratches and dents, but if you find issues such as rust, scratches, or dents when the product is removed from the box after purchase, please contact the supplier.
- Depending on the handling method, the product may become deformed or damaged. Long racks and plastic racks deform particularly easily, so please handle with care.

### 2. Caution on Performing Secondary Operations

- Secondary operations can be performed on all KHK stock racks except for the racks with their gear teeth induction hardened. To avoid problems of gear precision, do not reduce the face width.
- Height of pitch lines of racks are controlled by measuring the bottom surface as the reference datum and over-pin measurements on tooth thickness. If you machine the bottom surfaces, the precision of the racks may be affected.
- When connecting two racks, the machining of the mating ends requires careful consideration in terms of the pitch ( $p$ ) accuracy. The meshing will be poor if the pitch straddling the connection has a positive tolerance. We recommend a minus tolerance on pitch of at the connection.  
The below is an indication of pitch tolerance for each module.



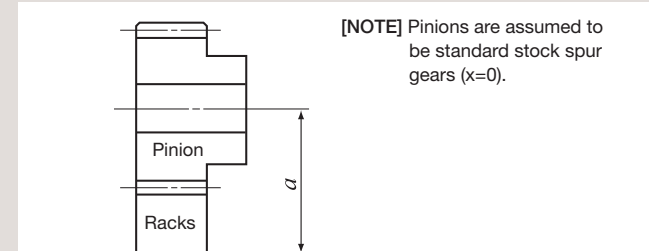
Module	Pitch (p)	Tolerance
m0.5	1.57	-0.05 -0.15
m0.8	2.51	-0.05 -0.25
m1	3.14	-0.1 -0.3
m1.5	4.71	
m2	6.28	
m2.5	7.85	
m3	9.42	-0.1 -0.4
m4	12.57	
m5	15.71	
m6	18.85	
m8	25.13	
m10	31.42	

- To use dowel pins to secure racks, attach the racks to the base and drill both simultaneously.
- Products made of S45C and SCM440 can be induction hardened. However, the precision is decreased. There is a decarburized layer (about 0.5 mm) on the block surface. The hardness of the decarburized layer does not increase even if it is quenched.
- To be able to handle parts safely, all burrs and sharp corners should be removed after the secondary operations are done.
- If you are going to modify the gear by gripping the teeth, please exercise caution not to crush the teeth by applying too much pressure.

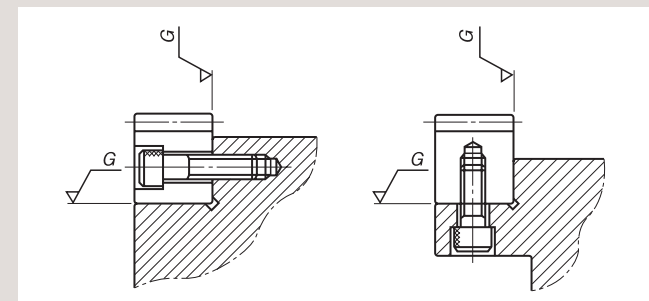
### 3. Points of Caution during Assembly

- The recommended assembly distance tolerance of KHK stock racks is H7 for ground racks and H8 for cut racks. Flexible racks need to be adjusted by the customer. The backlash values are given in the table on Page 220. Make sure that the mounting distance stays constant for the length of the rack.

Mounting distance  $a$  = Height of pitch line of rack + Pitch radius of pinion

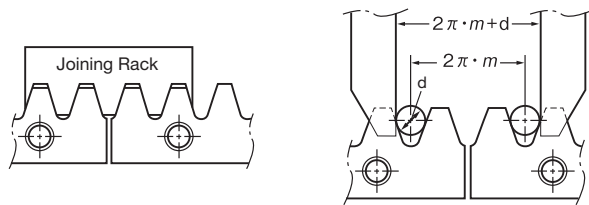


- The recommended flatness and squareness of the mounting surface of KHK stock racks is 0.01 mm for ground racks and 0.05 mm for cut racks.



- If the racks are not secured properly to the base, they could shift during operation and cause unexpected problems. It is very important to insure firm mounting by the use of dowel pins or similar devices.
- Machined end type racks such as SRF and SRFD series have smaller pitch tolerance at the end face. If you try to connect the racks without any space, the pitch at the connection will be too small and will cause problems. Please follow the diagrams for assembly on the next page.
- With SRFD etc., if using more than 10 racks connected together to form a rack with mounting holes machined along a length of 1 meter, the pitch precision and machining precision may cause the rack and base mounting holes to deviate, leading to set screw interference with the counterbored hole and preventing mounting. When using a rack for long lengths such as 10 meters or 20 meters, have the mounting holes additionally machined into long holes.

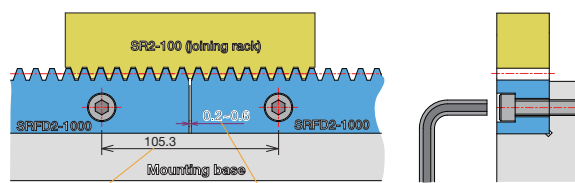
As an example of Rack Joining, we recommend the following method.



**[NOTE]** Joining gauge racks for helical racks must have the opposite hand from the racks. Please use 100 mm short racks as a joining gauge rack, or alternatively the rack of the same specifications on hand.

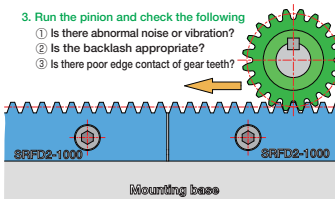
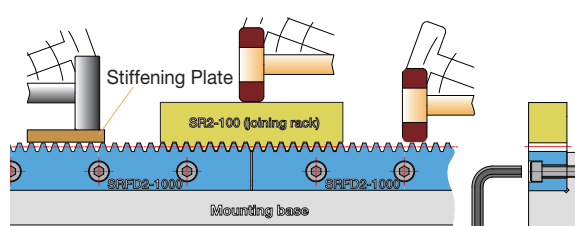
### How to mount racks on a mounting base (For SRFD2-1000)

**1. Pitch alignment**  
Place SRFD2-1000 on the mounting base, align SR2-100 and temporarily tighten the bolt.

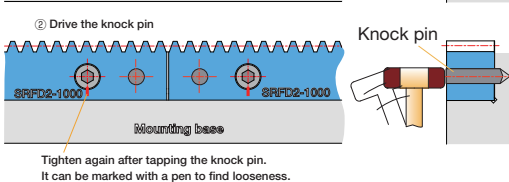
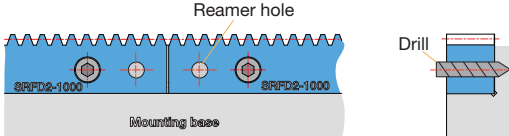


Dimensions Table F Value x 2  
SRFD2-1000 is designed to have a gap of 0.2 to 0.6 mm.

**2. Securing to the mounting base**  
Tap with a plastic hammer, bring it into close contact with the mounting base, and further tighten the bolt.  
(When using a metal hammer, be careful not to damage the gear teeth by using a stiffening plate, etc.)



**3. Run the pinion and check the following**  
① Is there abnormal noise or vibration?  
② Is the backlash appropriate?  
③ Is there poor edge contact of gear teeth?



### 4. Cautions on Starting

- Check the following items before starting.
  - Are the gears installed securely?
  - Is there uneven tooth contact?
  - Is there adequate backlash?  
(Be sure to avoid zero-backlash.)
  - Has proper lubrication been supplied?
- If gears are exposed, be sure to attach a safety cover to ensure safety. Also, be careful not to touch rotating gears.
- If there is any abnormality such as noise or vibration during startup, stop the operation immediately and check the assembly condition such as tooth contact, eccentricity and looseness.

KHK considers safety a priority in the use of our products.

When handling, adding secondary operations, assembling, and operating KHK products, please be aware of the following issues in order to prevent accidents.

#### Warning: Precautions for preventing physical and property damage

- When using KHK products, follow relevant safety regulations (Occupational Safety and Health Regulations, etc.).
- Pay attention to the following items when installing, removing, or performing maintenance and inspection of the product.
  - Turn off the power switch.
  - Do not reach or crawl under the product.
  - Wear appropriate clothing and protective equipment for the work.

#### Caution Cautions in Preventing Accidents

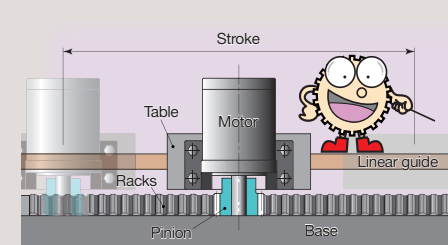
- Before using a KHK product, read the precautions in the catalog carefully in order to use it correctly.
- Avoid use in environments that may adversely affect the product.
- Our products are manufactured under a superior quality control system based on the ISO9000 quality management system; if you notice any malfunctions upon purchasing a product, please contact the supplier.

### Comparison of Racks & Pinions and Ball Screws

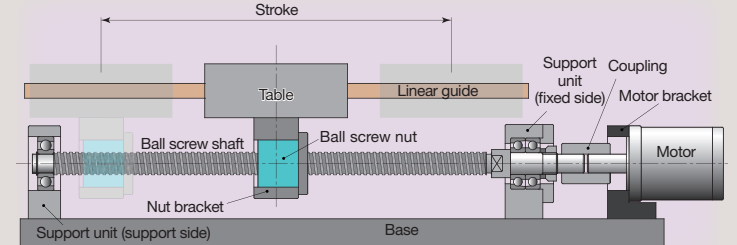
Since racks have a simple mechanism, the material, hardening, strength and precision can be designed according to the environment. They are also inexpensive, with parts that can be purchased separately for replacement.

In the designing process, please refer to Features of Racks & Pinions and Ball Screws in the table below.

#### Racks & Pinions



#### Ball screw



#### Features of Racks & Pinions

Advantages	Details
Few component parts	Since it does not have parts such as balls and retainers, there is less risk of accidentally falling apart during assembly and disassembly.
Supports heavy loads	Racks with large module can be used for heavy loads.
High transmission efficiency	High transmission efficiency of about 98% (excluding lubrication oil stirring resistance and bearing resistance).
High transport speed	The transport speed can be increased.
No length limit	The racks can be connected and used for a long period of time.
Flexible production is available	Materials, hardening, shapes and the like can be designed flexibly, allowing easy adjustment to the machine.
High-precision products can be manufactured	Gear grinding can be provided to minimize pitch error.
Can be used for food-related machinery	MC nylon and stainless steel products can be manufactured.

#### Disadvantages

Disadvantages	Details
Backlash is present	Backlash is required for smooth rotation. Backlash may become a problem in forward/reverse rotation positioning.
Lubrication is required	Metal racks require lubrication. Plastic racks do not require lubrication at light loads, but their precision is lower.

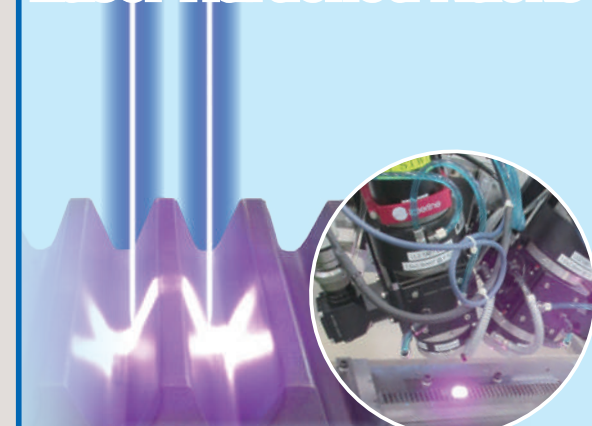
#### Features of Ball Screws

Advantages	Details
High transmission efficiency	Transmission efficiency of 90% or higher.
High-precision products can be manufactured	High-precision ball screws can be manufactured by grinding.
No backlash	The use of pressure eliminates backlash.

#### Disadvantages

Disadvantages	Details
Length is limited	There is a limit to the length due to the deflection of the screws.
Hard to manufacture special products	Since it is hard to manufacture special products, machines must be adjusted to the shape of the ball screw.

### Laser Hardened Racks



#### Lasers used for hardening gear teeth

In this environmentally friendly hardening method, powerful light provides instantaneous hardening and cooling water is not required due to diffusion of heat.

#### Can be hardened on surfaces other than the teeth

Lasers excel at spot hardening. As long as the laser can be irradiated, even the inside of bores can be hardened.

#### Less distortion due to burning during hardening

As the laser hardens necessary areas in spots, distortion due to burning can be minimized.

Lasers enable hardening that barely changes the precision grade.

\* Please see Page 236 for products.

