



# CP Racks & Pinions

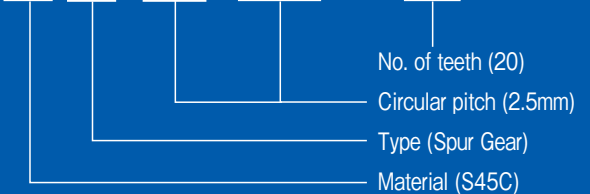
## Catalog Number of KHK Stock Gears

Catalog Numbers of KHK stock gears are based on simple principles as follows. Please order KHK gears by specifying their Catalog Numbers.

(Example) CP Racks & Pinions

Pinions

S S CP 2.5 - 20



### Material

S S45C  
SU SUS303, SUS304  
K SCM440

### Type

S Spur Gears  
TS Tapered Spur Gears

### Other Information

G Ground Gears  
S Pinion Shafts

### Racks

S R CP 5 - 100



### Material

S S45C  
K SCM440  
SU SUS304  
F SS400

### Other Information

F Racks with Machined Ends  
D Racks with Bolt Holes  
K Racks with Drill Holes  
G Ground Racks

### Type

R Racks  
RO Round Racks  
TR Tapered Racks

<b>KTSCP</b> CP Tapered Pinions  CP5, 10 Page 404 RoHS	<b>STRCPF · STRCPFD</b> CP Tapered Racks  CP5, 10 Page 404 RoHS	<b>SSCPGS</b> CP Ground Spur Pinion Shafts  CP5, 10 Page 406 RoHS
<b>SSCPG</b> CP Ground Spur Gears  CP5 ~ 20 Page 406 RoHS	<b>KRGCP · KRGCPF · KRGCPD</b> CP Ground Racks  CP5, 10 Page 408 RoHS	<b>SRGCP · SRGCPF · SRGCPD</b> CP Ground Racks  CP5 ~ 20 Page 410 RoHS <b>Newly added</b>
<b>SSCP</b> CP Steel Spur Gears  CP2.5 ~ 20 Page 412 RoHS	<b>KRCPF</b> CP Thermal Refined Racks  CP5, 10 Page 412 RoHS	<b>SRCP · SRCPF · SRCPFD</b> CP Racks  CP2.5 ~ 20 Page 414 RoHS
<b>SUSCP</b> CP Stainless Steel Spur Gears  CP5, 10 Page 416 RoHS	<b>SURCPF · SURCPFD</b> CP Stainless Steel Racks  CP5, 10 Page 416 RoHS	<b>SROCP</b> CP Round Racks  CP2.5 ~ 10 Page 418 RoHS
<b>FRCP</b> CP Metal Flexible Racks  CP5 Page 418 RoHS		

### Feature Icons

- |                        |                            |
|------------------------|----------------------------|
| RoHS Compliant Product | Stainless Product          |
| Re-machinable Product  | Resin Product              |
| Finished Product       | Copper Alloy Product       |
| Heat Treated Product   | Injection Molding Product  |
| Ground Gear            | Black Oxide coated Product |

Spur Gears

Helical Gears

Internal Gears

Racks

CP Racks & Pinions

Miter Gears

Bevel Gears

Screw Gears

Worm Gear Pair

Bevel Gearboxes

Other Products

## Characteristics



KHK stock CP racks and pinions are suitable in applications where very accurate positioning in linear motion is required. For your convenience, we offer circular pitches of 2.5 to 20 mm and in lengths of 100 to 2000 mm. (FRCP is available to 4000 mm)

### About CP Racks & Pinions

The reference pitch of a metric module is computed by multiplying the number of module by  $\pi$  (3.14159). For example, the reference pitch of  $m3$  rack is 9.425 mm ( $3 \times \pi$ ). When using a rack and a pinion in a linear motion application, the fact that the pitch is not an integral number presents a difficulty in accurate positioning. This problem is solved by CP racks and pinions where one rotation of a pinion moves it precisely 50, 100, 150, ... or 600 mm. The following table lists the main features. The following table lists the main features.

### Racks

Catalog No.	Pitch (mm)	Total Length (mm) ( ) No. of teeth	Material	Heat Treatment	Tooth Surface Finish	Precision KHK R 001 ( ) denotes JIS B 1702-1	Features
<b>STRCPF</b> · <b>STRCPFD</b> <small>Note 1</small>	5, 10	1000	S45C	Straightened & annealed	Cut	4	By pairing with KTSCP pinion, the backlash may be adjusted.
<b>KRGCP</b> · <b>KRGCPF</b> · <b>KRGCPD</b> <small>Note 1</small>	5, 10	100, 500, 1000	SCM440	Thermal Refined	Ground	1	High strength and abrasion-resistant for precision linear motion.
<b>SRGCP</b> · <b>SRGCPF</b> · <b>SRGCPFD</b> <small>Note 1</small>	5, 10, 15, 20	100, 500, 1000	S45C	Gear teeth induction hardened	Ground	3	Reasonably priced ground racks with abrasion-resistant characteristics. J Series products are also available.
<b>KRCPF</b>	5, 10	1000	SCM440	Thermal Refined	Cut	4	Increased strength with SCM440 material which is thermal refined.
<b>SRPC</b> · <b>SRCPF</b> · <b>SRCPFD</b> <small>Note 1</small>	2.5, 5, 10, 15, 20	100, 500, 1000, 1500, 2000	S45C	Straightened & annealed	Cut	4	Widely applicable due to low cost and large selection of pitches and lengths.
<b>SURCPF</b> · <b>SURCPFD</b> <small>Note 1</small>	5, 10	500, 1000	SUS304	Solution treated	Cut	5	Suitable for food machinery due to SUS304 material's rust-resistant quality.
<b>SROCP</b>	2.5, 5, 10	500	S45C	Straightened & annealed	Cut	4	Convenient in applications where the rack has reciprocal motion.
<b>FRCP</b>	5	2000, 3000, 4000	SS400	—	Cut	8	Cut continuously. Long length and bendable to a contour.

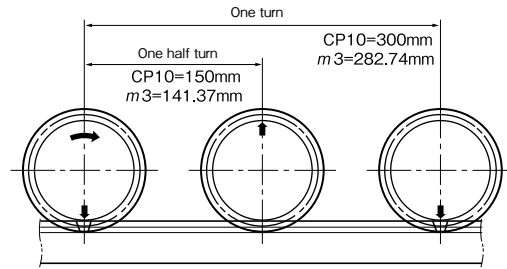
### Pinions

<b>KTSCP</b>	5, 10	(20 ~ 40)	SCM440	Thermal refined	Cut	(N8)	By pairing with STRCPF rack, the backlash may be adjusted.
<b>SSCPGS</b>	5, 10	(10 ~ 25)	S45C	Gear teeth induction hardened	Ground	(N7)	Ground Spur Gears with Pinions, can be directly assembled with the shaft bearing, by modifying the pinion.
<b>SSCPG</b>	5, 10, 15, 20	(20 ~ 40)	S45C	Gear teeth induction hardened	Ground	(N7)	Perform secondary operations to suit your requirement on these ground CP spur gears.
<b>SSCP</b>	2.5, 5, 10, 15, 20	(20 ~ 40)	S45C	—	Cut	(N8)	Low cost and widely applicable, with a large selection of pitches and numbers of teeth.
<b>SUSCP</b>	5, 10	(20 ~ 30)	SUS303	—	Cut	(N8)	Suitable for food machinery due to SUS303 material's rust-resistant quality.

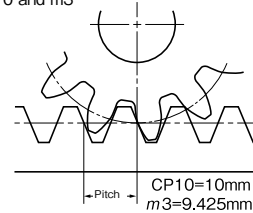
**(NOTE 1)** The catalog numbers in the above tables with a suffix of F have both ends machined so that they can be butted against each other to make any desired length. The items with (D) have mounting screw holes for easier assembly.

- For safer handling and to prevent damage such as deformation, KHK stock CP racks have round chamfering on the corners of the top land of the gear tooth. This rounded chamfered shape is patented by KHK. Because it is effective for reducing noise, all of KHK CP racks have this chamfering treatment.
- Black colored products are KHK stock gears that have an applied black oxide coating for rust resistance; this 'blackness' is a product characteristic of KHK stock gears.

Movement of one cycle of the CP10-30 pinion on a CP rack vs. SS3-30 (m3) on a m3 rack.



Difference between CP10 and m3



## 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 notes before the final selection.

### 1. Caution in Selecting the Mating Gears

- ① KHK stock CP racks are mated with CP spur gears having the same pitch. Since CP2.5 (m0.796), CP5 (m1.592) and CP10 (m3.183) are very close in size to m0.8, m1.5 and m3 respectively, the selecting the proper mating gear should be verified to make sure that the items are correct. Otherwise, complications could arise.
- ② STRCPF and STRCPFD Tapered Racks are mated with KTSCP Spur Gears having the same pitch. They can also be mated with other spur gears, however, they can not be used as parallel axis gears due to the setting angles.

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

The gear strength values shown in the product pages were computed by assuming a certain application environment. Therefore, they should be used as reference only. We recommend that each user computes his own values by applying the actual usage conditions. The table below contains the assumptions established for these products in order to compute gear strengths.

### Calculation assumptions for Bending Strength

Item	Catalog No.	Racks					Pinions			
		KRGCP KRGCPF KRGCPD KRCPF	SRGCP SRGCPF SRGCPFD	SRCP · SRCPF SRCPF SROCP STRCPF STRCPFD	SURCPF SURCPFD FRCP	SSCPGS	SSCPG	KTSCP	SSCP	SUSCP
Formula <small>NOTE 1</small>	Formula of spur and helical gears on bending strength (JGMA401-01)									
No. of teeth of mating gear	30				Same number of teeth					
Rotation	100rpm									
Durability	Over 10 <sup>7</sup> cycles									
Impact from motor	Uniform load									
Impact from load	Uniform load									
Direction of load	Bidirectional									
Allowable bending stress at root $\sigma_{lim}$ (kgf/mm <sup>2</sup> ) <small>NOTE 2</small>	32	20	20	10.5	24.5	19	28.5	19	10.5	
Safety factor $S_F$	1.2									

### Calculation assumptions for Surface Durability (Except those in common with bending strength)

Formula <small>NOTE 1</small>	Formula of spur and helical gears on surface durability (JGMA402-01)								
Kinematic viscosity of lubricant	100cSt (50°C)								
Gear support	Support on one end								
Allowable Hertz stress $\sigma_{Hlim}$ (kgf/mm <sup>2</sup> )	79	90	52.5	41.3	99	90	74.5	49	41.3
Safety factor $S_H$	1.15								

**(NOTE 1)** The gear strength formula is based on JGMA (Japanese Gear Manufacturers Association) specifications. The units for the number of rotations (rpm) and the stress (kgf/mm<sup>2</sup>) are adjusted to the units needed in the formula.

**(NOTE 2)** Since the load is bidirectional, the allowable bending stress at root  $\sigma_{lim}$  is set to 2/3 of the value.

#### Definition of bending strength by JGMA 401-01 (1974)

The allowable bending strength of a gear is defined as the allowable tangential force at the pitch circle based on the mutually allowable root stress of two meshing gears under load.



Example of the failure due to insufficient bending strength.

#### Definition of surface durability by JGMA 402-01 (1975)

The surface durability of a gear is defined as the allowable tangential force at the pitch circle, which permits the force to be transmitted safely without incurring surface failure.



Example of the defacement due to insufficient surface durability.

### 3. Selecting Racks By Precision

The precision standards of KHK stock racks are established by us. Please be sure to see the pages below when selecting.

- ① Pitch Error of Racks NOTE 2 (KHKR001) → page 374
- ② Precision of Rack Blanks (KHKR002) → page 375
- ③ Backlash of Rack Tooth (KHKR003) → page 375

**(NOTE 2)** Convert CP to m (module) when reference is made to the data in the table. ( $m=CP/\pi$ )

## Application Hints



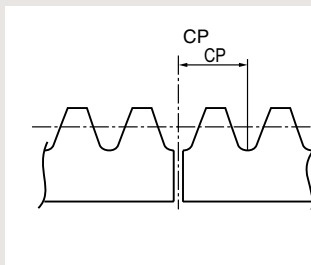
In order to use KHK stock gears safely, carefully read the Application Hints before proceeding.

If there are questions or if you require clarifications, please contact our technical department or your nearest distributor.

KHK CO., LTD.  
 PHONE: 81-48-254-1744 FAX: 81-48-254-1765  
 E-mail export@khkgears.co.jp

### 1. Caution on Performing Secondary Operations

- ① Secondary operations can be performed on all KHK stock CP racks except for the racks where the gear teeth are induction hardened. To avoid problems of gear precision, do not reduce the face width. The precision of ground racks and racks with mounting holes may drop if you do not exercise extreme caution during installation or while modifying.
- ② Pitch lines of racks are controlled by using 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.
- ③ When connecting two racks, the machining of the mating ends requires careful consideration. The meshing will be poor if the pitch (CP) 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.

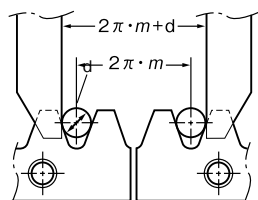
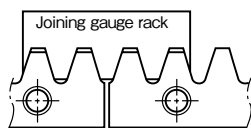


Unit : mm

CP	Tolerance
CP2.5	-0.05 -0.25
CP5	-0.1 -0.3
CP10	-0.1 -0.4
CP15	
CP20	

- ④ To use dowel pins to secure racks, attach the racks to the base and drill both simultaneously.
- ⑤ KHK stock CP racks made of S45C and SCM440 (except for ground racks) can be induction hardened. However, the precision of pitch is decreased.
- ⑥ To be able to handle parts safely, all burrs and sharp corners should be removed after the secondary operations are done.
- ⑦ 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. Any scarring will cause noise during operation.

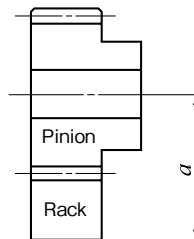
### An example of Rack Joining, we recommend the following method.



### 2. Points of Caution in Assembling

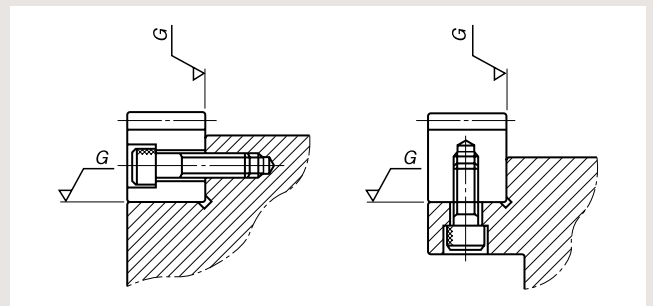
- ① KHK stock CP racks are designed to give the proper backlash when assembled using the mounting distance given by the formula below (mounting distance tolerance of H7 to H8 required). The backlash values are given in the table on page 375. Make sure that the mounting distance stays constant for the length of the rack.

Mounting distance  $a = \text{Height of pitch line of rack} + \text{Pitch radius of pinion}$



**(CAUTION)**  
 Pinions are assumed to be standard stock spur gears ( $x=0$ ).

- ② KRGCP type of KHK stock ground racks have four surfaces ground parallel to within  $10 \sim 15 \mu\text{m}$ . To maintain true angle, they should be mounted on high precision bases as shown below. It is even possible to correct for the angular errors of racks by compensating the mounting base. With recent increases in the requirement for zero backlash linear drives, such accurate assembly as shown is becoming more important.



- ③ 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.
- ④ Machined end type racks such as SRCPF and SRCPFD series have the pitch tolerance of  $-0.1/-0.3$  for modules less than Module 2.5, and  $-0.1/-0.4$  for larger modules. 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 following diagrams for assembly.



**(CAUTION)** Joining gauge racks for helical racks must have the opposite hand from the racks. Please use Module 1-10 100 racks as a joining gauge rack, or alternatively the rack of the same specifications on hand.



### ■ Features of KHK Tapered Racks and Pinions

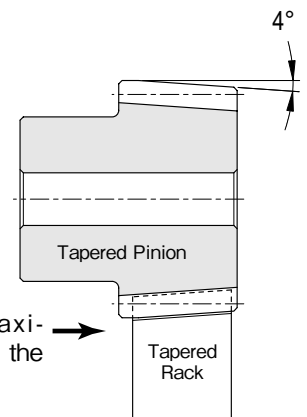
1. Easy adjustment of Backlash value  
 Generally, adjustment of backlash value is made by changing mounting distance (adjusting the height of the motor shaft). The backlash of KHK stock tapered racks and pinions are adjustable only by moving the pinion axially.
2. Reasonable Prices  
 The precision of KHK stock tapered racks and pinions are obtained by rationalization in the production process with our cutting-edge technologies. This enables us to offer quality tapered racks and pinions in the same price range as the CP racks and pinions. (SRCPF and SSC).



### ■ Example of Comparison

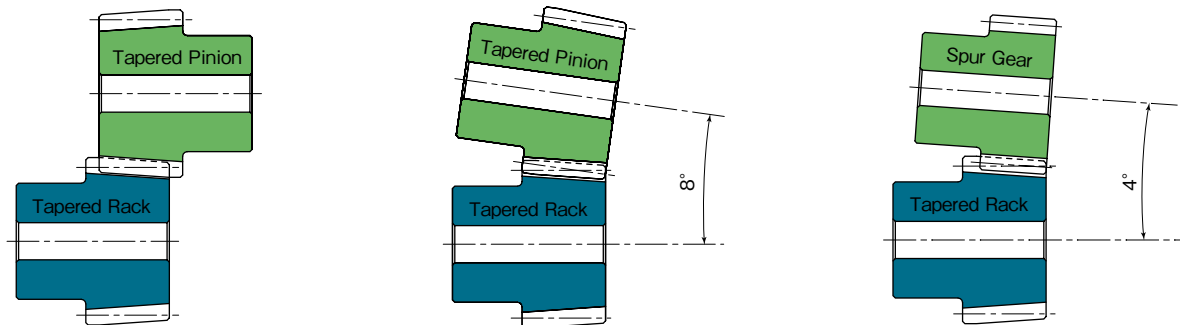
- SRCP5-1000 and SSCP5-30 combination produces a backlash value of 0.1 to 0.26.
- STRCPF5-1000 and KTSCP5-30 combination produces a backlash value of 0.05 or less. (Target value)

- ※ Note above backlash values are theoretical values when meshed under ideal conditions.
- ※ Tapered racks and pinions are not interchangeable with KHK stock CP racks and pinions.
- ※ Different modules, number of teeth, ground gear versions and custom-made items are available as special orders.



### ■ Examples of special applications of Tapered Rack & Pinions

(1) Mounting distance of Tapered Spur Gears and the Shaft Angle when mated with regular Spur Gears.

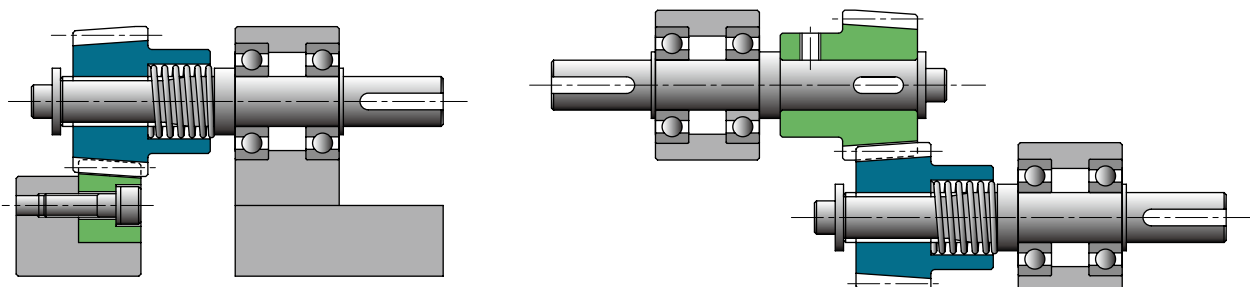


When mating a tapered rack and a tapered pinion, where each hub is set in opposite directions, a 0° shaft angle is obtained. (Axis Parallel).

When mating a tapered rack and a tapered pinion, where each hub is set in the same direction, an 8° shaft angle is obtained.

When mating a tapered rack and a spur gear, a 4° shaft angle is obtained.

(2) Example of an assembly with zero backlash (no backlash) for a spring device



An assembled tapered rack and the pinion with zero backlash. \*

An assembly of tapered pinions, as a pair, with zero backlash.\*

\* The illustration is a design example, not a design for machinery or a device in actual use.

- Spur Gears
- Helical Gears
- Internal Gears
- Racks
- CP Racks & Pinions
- Miter Gears
- Bevel Gears
- Screw Gears
- Worm Gear Pair
- Bevel Gearboxes
- Other Products