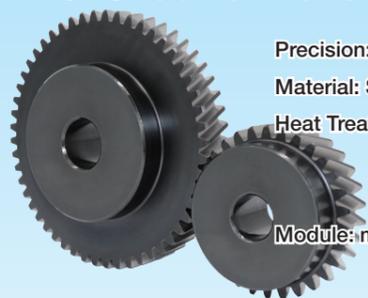


### KHG Ground Helical Gears

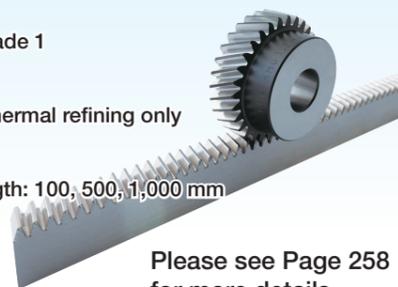


Precision: JIS Grade N6  
Material: SCM440  
Heat Treatment: Thermal refined / gear teeth induction hardened  
Module: m1 to 6

Please see Page 196 for more details.

### KRHG/KRHGF/KRHGFD Ground Helical Racks

Precision: KHK Grade 1  
Material: SCM440  
Heat Treatment: Thermal refining only  
Module: m1 to 3  
Nominal Total Length: 100, 500, 1,000 mm



Please see Page 258 for more details.

### SH Helical Gears



Precision: JIS Grade N8  
Material: S45C  
Heat Treatment: -  
Module: m2, 3

Please see Page 204 for more details.

### SRH·SRHF·SRHFD Helical Racks

Precision: KHK Grade 5  
Material: S45C  
Heat Treatment: -  
Module: m2, 3  
Nominal Total Length: 100, 1,000 mm



Please see Page 258 for more details.

### ZSTP Ground Helical Gears

**Dedicated for racks**



Precision: JIS Grade N6  
Material: SCM440  
Heat Treatment: Thermal refined / gear teeth induction hardened  
Module: m2 to 6

Please see Page 266 for more details.

### SHE Helical Gears

**Dedicated for racks**



Precision: JIS Grade N8  
Material: S45C  
Heat Treatment: -  
Module: m1.5 to 6

Please see Page 264 for more details.

### ZST/ZSTD

### Hardened Ground Helical Racks

Precision: DIN Grade 6 (KHK Grade 2 equivalent)  
Material: DIN C45 (JIS S45C equivalent)  
Heat Treatment: Gear teeth induction hardened  
Module: m2 to 6  
Nominal Total Length: 1,000, 2,000 mm



Please see Page 266 for more details.

### SRHEF Helical Racks

Precision: KHK Grade 4  
Material: S45C  
Heat Treatment: -  
Module: m1.5 to 6  
Nominal Total Length: 1,000 mm



Please see Page 264 for more details.

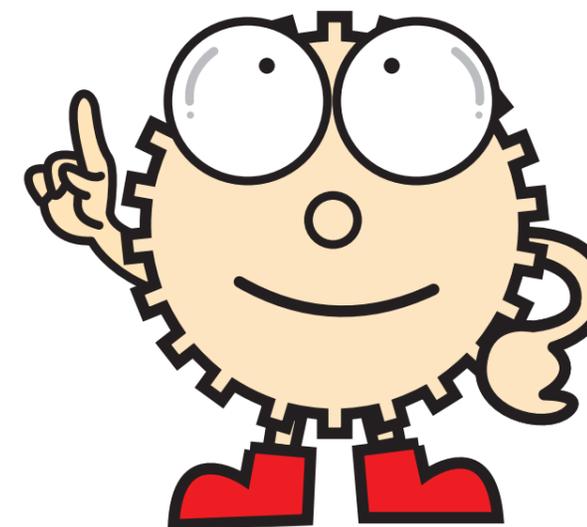


# Internal Gears

SI Steel Internal Gears	SIR Internal Ring Gears
	
Material: S45C m0.5-2.5 Page 210	Material: S45C m2-3 Page 212

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### 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) Internal Gears

**S I R 2 - 120**



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

### Features

KHK stock internal gears are offered in modules 0.5 to 3 in 60 to 200 teeth. They can be used in many applications including planetary gear drives.

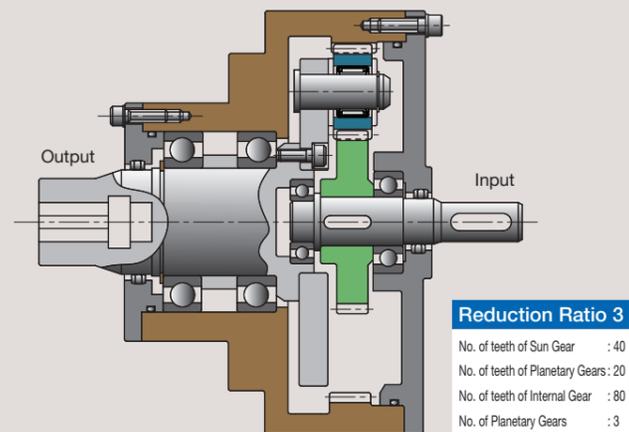
Catalog Number	SI	SIR
Module	0.5~2.5	2~3
Material	S45C	S45C
Heat Treatment	—	—
Tooth Surface Finish	Cut	Cut
Precision JIS B 1702-1:1998	N8 NOTE 1	N9
Secondary Operations	Possible	Possible
Features	A popular type of internal gear; Allows secondary operations.	They have a ring shape with a large number of teeth. Allows secondary operations.

[Note 1] The product accuracy class having a module less than 0.8 corresponds to 'equivalent' as shown in the table.

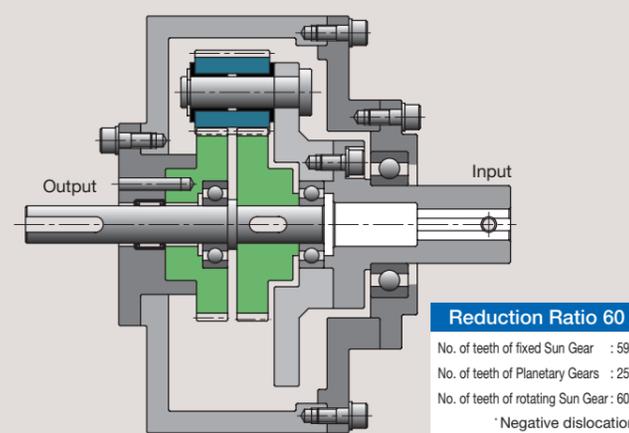
### Application Examples

KHK stock internal gears are used to reduce the size of various equipment, such as reduction gears.

■ Design example of reduction gear (not a design for machinery or a device in actual use)



Planetary Gear Mechanism used in a reduction gear

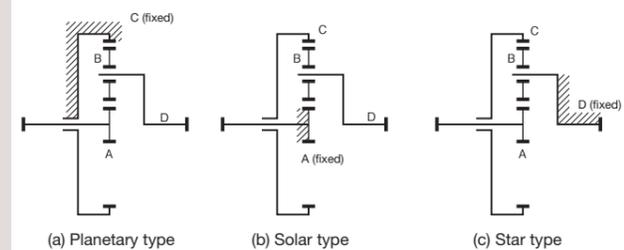


Mechanical Paradox Gear Mechanism used in a large reduction gear

### Example of combinations

No. of teeth of Internal Gear	No. of Planetary Gears	No. of teeth of sun gear	No. of teeth of Planetary Gears	Reduction ratio of planetary type	Reduction ratio of solar type	Reduction ratio of star type
60	3	18	21	4.333	1.3	-3.333
80	3	16	32	6	1.2	-5
80	3	40	20	3	1.5	-2
100	3	20	40	6	1.2	-5
100	3	50	25	3	1.5	-2

### Types of Planetary Gear Mechanism



### Selection Hints

Please select the most suitable products by carefully considering the characteristics of items and contents of the product tables.

#### 1. Caution in Selecting the Mating Gears

KHK stock internal gears can mate with any spur gears of the same module, however, there are cases of interference depending on the number of teeth of the mating gear. The table below contains the assumptions established for these products in order to compute gear strengths.

#### Interferences and the symptoms

Type	SYMPTOMS	CAUSES
Involute interference	The tip of the internal gear digs into the root of the pinion.	Too few teeth on the pinion.
Trochoid interference	The exiting pinion tooth contacts the internal gear tooth.	Too little difference in number of teeth of the two gears.
Trimming interference	Pinion can slide in or out axially but cannot move radially.	Too little difference in number of teeth of the two gears.

#### Allowable Mating Pinions and Number of Teeth

No. of teeth of Internal Gear	No. of teeth of Allowable Mating Pinions		
	Lower limit No. of teeth due to involute interference	Upper limit No. of teeth due to trochoid interference	Upper limit No. of teeth due to trimming interference
60	21	51	43
80	20	72	64
100	19	92	84
120	19	112	104
160	19	152	144
200	18	192	184



#### 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. The table below contains the assumptions established for various products in order to compute gear strengths.

#### Calculation of Bending Strength of Gears

Item	Catalog Number	SI	SIR
Formula NOTE 1		Formula of spur and helical gears on bending strength (JGMA401-01)	
No. of teeth of mating gears		30	
Rotational Speed		100rpm	
Design Life (Durability)		Over 10 <sup>7</sup> cycles	
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> )		19	
Safety factor $S_H$		1.2	

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

Item	Catalog Number	SI	SIR
Formula NOTE 1		Formula of spur and helical gears on surface durability (JGMA402-01)	
Kinematic viscosity of lubricant		100cSt (50°C)	
Gear support		Symmetric support by bearings	
Allowable Hertz stress $\sigma_{Hlim}$ (kgf/mm <sup>2</sup> )		49	
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 rotational speed (rpm) and the stress (kgf/mm<sup>2</sup>) are adjusted to the units needed in the formula.

### Application Hints

In order to use KHK stock internal gears safely, read the Application Hints carefully before proceeding. Please refer to Page 52 for "Cautions on Handling" and Page 53 for "Cautions on Starting". Please read "Cautions on Performing Secondary Operations" below when performing modifications and/or secondary operations for safety concerns. Avoid performing secondary operations that narrow the tooth width, as it affects precision and strength.

#### 1. Caution on Performing Secondary Operations

- ① If performing outer diameter machining, it is important to pay special attention to locating the center in order to avoid runout.
- ② Please exercise caution not to cause deformation when chucking the outer diameter. Gear precision may deteriorate and cause trouble.

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

1. When using KHK products, follow relevant safety regulations (Occupational Safety and Health Regulations, etc.).
2. Pay attention to the following items when installing, removing, or performing maintenance and inspection of the product.
  - ① Turn off the power switch.
  - ② Do not reach or crawl under the product.
  - ③ Wear appropriate clothing and protective equipment for the work.

#### Caution Cautions in Preventing Accidents

1. Before using a KHK product, read the precautions in the catalog carefully in order to use it correctly.
2. Avoid use in environments that may adversely affect the product.
3. Our products are manufactured under a superior quality control system based on the ISO9001 quality management system; if you notice any malfunctions upon purchasing a product, please contact the supplier.

#### 2. Points of Caution during Assembly

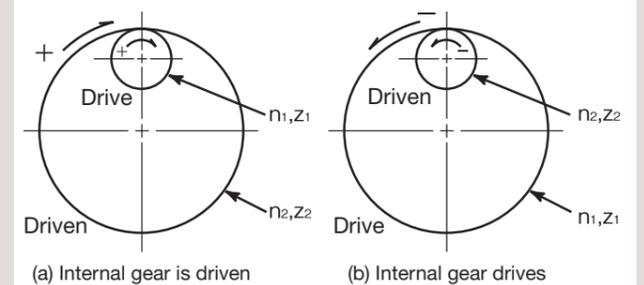
- ① KHK stock internal gears are designed to give the proper normal direction backlash when assembled using the center distance given by the formula below. The amount of backlash is given in the dimension table for each gear.

$$a = \frac{d_2 - d_1}{2}$$

Where  
 $a$  : Center distance  
 $d_1$  : Pitch diameter of pinion  
 $d_2$  : Pitch diameter of internal gear

- ② Refer to the figure below for the direction of rotation of internal gears.

#### Gear Ratio and Direction of Rotation



$$\text{Gear Ratio } i = \frac{z_2}{z_1} = \frac{n_1}{n_2} \quad \begin{matrix} z : \text{No. of teeth} \\ n : \text{Rotational speed} \end{matrix}$$

- ③ To use as a planetary gear drive, the following conditions must be satisfied.

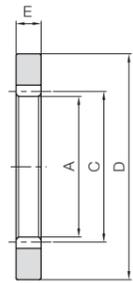
#### Gear tooth conditions for planetary gear mechanisms

- Condition 1:  $z_c = z_a + 2z_b$
  - Condition 2:  $\frac{z_a + z_c}{N} = \text{Integer}$
  - Condition 3:  $z_b + 2 < (z_a + z_b) \sin \frac{180^\circ}{N}$
- $z_a$  : No. of teeth of Sun Gear  
 $z_b$  : No. of teeth of Planetary Gears  
 $z_c$  : No. of teeth of Internal Gear  
 $N$  : No. of Planetary Gears



Specifications	
Precision grade	JIS grade N8 (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

\* The precision grade of products with a module of less than 0.8 is equivalent to the value shown in the table.

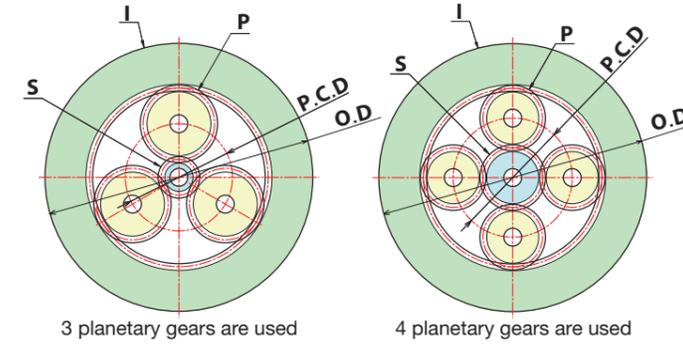


T1

Catalog Number	Module	No. of teeth	Shape	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				
<b>SI0.5-60</b>	<b>m0.5</b>	60	T1	29	30	50	5	3.75	0.67	0.38	0.068	0.04~0.15	0.049		
<b>SI0.5-80</b>		80		39	40	60	4.85	0.75	0.49	0.077	0.062				
<b>SI0.5-100</b>		100		49	50	70	5.97	0.87	0.61	0.089	0.074				
<b>SI0.8-60</b>	<b>m0.8</b>	60		46.4	48	75	15.4	2.87	1.57	0.29	0.16				
<b>SI0.8-80</b>		80		62.4	64	90	19.9	3.24	2.03	0.33	0.20				
<b>SI0.8-100</b>		100		78.4	80	105	24.5	3.75	2.50	0.38	0.23				
<b>SI1-60</b>	<b>m1</b>	60		58	60	90	30.0	5.95	3.06	0.61	0.28				
<b>SI1-80</b>		80		78	80	110	38.8	6.59	3.96	0.67	0.35				
<b>SI1-100</b>		100		98	100	130	47.8	7.64	4.87	0.78	0.43				
<b>SI1.5-60</b>	<b>m1.5</b>	60		87	90	130	101	20.6	10.3	2.10	0.81				
<b>SI1.5-80</b>		80		117	120	160	131	23.3	13.4	2.38	0.11~0.25				
<b>SI1.5-100</b>		100		147	150	190	161	27.0	16.5	2.75	1.04				
<b>SI2-60</b>	<b>m2</b>	60		116	120	170	240	50.5	24.5	5.15	1.79				
<b>SI2-80</b>		80		156	160	210	311	57.0	31.7	5.81	2.28				
<b>SI2-100</b>		100		196	200	250	382	65.7	39.0	6.70	2.77				
<b>SI2.5-60</b>	<b>m2.5</b>	60	145	150	210	469	101	47.8	10.3	3.33					
<b>SI2.5-80</b>		80	195	200	260	607	114	61.9	11.6	4.25					

- [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 209 for more details.  
 ③ Please check for the involute interference, trochoid interference and trimming interference prior to using internal gears.

### Planetary Gear Systems created by using KHK Stock Gears



KHK's stock internal and spur gears working together will allow you to create planetary gear devices. "In the table below, we introduce examples of planetary gear. Note 1 are for planetary gear systems created with a stationary internal gear. When used as speed reducers, the input is the sun gear and the output is the carrier. "Selection of the number of teeth also enables you to create various planetary gear devices with different transmission

Speed ratio	Stock gears used in the system										Allowable transmission torque (kgf·m)				Total weight (kg)	
	Internal gears (I)			Planetary gears (P)				Sun gear (S)			Sun gear_T1		Planetary carrier_T2			
	OD(mm)	Catalog Number	No. of teeth	Catalog Number	No. of teeth	Quantity	P.C.D.(mm)	Equal angles	Catalog Number	No. of teeth	Bending strength	Surface durability	Bending strength	Surface durability		
6	90	SI1-60	60	SSA1-24	24	3	36	120°	SSS1-12	12	0.58	0.0023	3.47	0.11	0.48	
	130	SI1.5-60		SSA1.5-24			54		SS1.5-12		1.77	0.0081	10.7	0.40	1.20	
	170	SI2-60		SSA2-24			72		SS2-12		4.21	0.020	25.2	0.99	2.66	
	210	SI2.5-60		SSA2.5-24			90		SS2.5-12		8.21	0.040	49.3	1.98	5.03	
	110	SI1-80	80	SSA1-32	32	3	48	120°	SS1-16	16	0.99	0.0047	5.96	0.24	0.57	
	160	SI1.5-80		SSA1.5-32			72		SS1.5-16		3.35	0.026	20.1	1.32	1.72	
	210	SI2-80		SSA2-32			96		SS2-16		7.95	0.064	47.7	3.22	3.85	
	260	SI2.5-80		SSA2.5-32			120		SS2.5-16		15.5	0.13	93.2	6.45	7.33	
	105	SI0.8-100	100	SS0.8-40A	40	4	48	90°	SS0.8-20A	20	0.95	0.0082	5.68	0.41	0.59	
	130	SI1-100		SSA1-40			60		SS1-20		1.85	0.016	11.1	0.82	0.84	
	190	SI1.5-100		SSA1.5-40			90		SS1.5-20		6.24	0.058	37.5	2.90	2.62	
	250	SI2-100		SSA2-40			120		SS2-20		14.8	0.14	88.8	7.09	6.01	
5	60	SI0.5-80	80	SS0.5-30B	30	4	25	90°	SS0.5-20A	20	0.23	0.0012	1.13	0.070	0.12	
	90	SI0.8-80		SS0.8-30C			40		SS0.8-20A		0.93	0.0050	4.65	0.30	0.40	
	110	SI1-80		SSA1-30			50		SS1-20		1.82	0.010	9.08	0.60	0.59	
	160	SI1.5-80		SSA1.5-30			75		SS1.5-20		6.13	0.035	30.63	2.13	1.86	
	210	SI2-80		SSA2-30			100		SS2-20		14.5	0.087	72.6	5.21	4.18	
	260	SI2.5-80		SSA2.5-30			125		SS2.5-20		28.4	0.17	142	10.4	7.97	
3	60	SI0.5-80	80	SS0.5-20A	20	4	30	90°	SSG0.5-40B	40	0.46	0.0016	1.39	0.10	0.13	
	90	SI0.8-80		SS0.8-20A			48		SS0.8-40A		1.89	0.0068	5.68	0.41	0.35	
	110	SI1-80		SSA1-20			60		SS1-40		3.70	0.014	11.1	0.82	0.60	
	160	SI1.5-80		SSA1.5-20			90		SS1.5-40		12.5	0.048	37.5	2.91	1.77	
	210	SI2-80		SSA2-20			120		SS2-40		29.6	0.12	88.8	7.12	3.93	
	260	SI2.5-80		SSA2.5-20			150		SS2.5-40		57.8	0.24	173	14.3	7.47	
	70	SI0.5-100		SS0.5-25B			37.5		SS0.5-50B		50	0.47	0.0020	1.42	0.12	0.16
	130	SI1-100		SSA1-25			75		SS1-50		3.79	0.017	11.4	1.01	0.75	
	190	SI1.5-100		SSA1.5-25			112.5		SS1.5-50		12.8	0.060	38.4	3.58	2.24	
	250	SI2-100		SSA2-25			150		SS2-50		30.4	0.15	91.1	8.79	5.02	

### Calculation of Allowable Transmission Torque

One advantage of a planetary gear system is that they share load burdens by grouping multiple planetary gears. This enables high torque capacity transmission. The following formula is the calculation method for T1 (Allowable transmission torque of Sun Gear) and T2 (Allowable transmission torque of Planetary Carrier), shown in the table.  
 $T1 = Ts \cdot Zp \cdot \eta$  (kgf·m) ..... (1)  
 $T2 = Ts \cdot Zp \cdot u \cdot \eta$  (kgf·m) ..... (2)  
 Here,  
 Ts : Allowable transmission torque for a Sun gear (kgf·m) on a meshed pair of sun gear and planetary gear.  
 For a sun gear meshed with a planetary gear, the number of revolutions is set to 100rpm.  
 Zp : Number of planetary gears used in the system  
 u : Speed ratio  
 η : Contact efficiency for torque transmission  
 In consideration of machining accuracy, variation in tooth thickness or other factors on the planetary carrier, the contact efficiency is set to 75%.

**Ground internal gears are available.**

**Klingelnberg Gear Grinding Machine VIPER 500W**

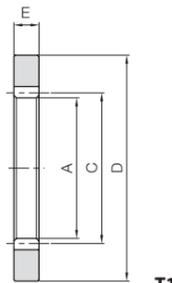
Internal ground gear machining range	
Maximum gear accuracy	JIS B 1702-1:1998 Grade N5 (former JIS Grade 1)
Maximum module	About m4 (DP6, CP12), special sizes available
Max. helix angle	27°, right/left helix direction available
Maximum outer diameter	φ 500mm
Minimum inner diameter	φ 150mm
Maximum weight	500 kgf (jig weight included)

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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



Catalog Number	Module	No. of teeth	Shape	Dimensions (mm)				Allowable torque (N-m)				Backlash (mm)	Weight (kg)
				A	C	D	E	Bending strength	Surface durability	Bending strength	Surface durability		
<b>SIR2-120</b> <b>SIR2-200</b>	<b>m2</b>	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
<b>SIR2.5-120</b> <b>SIR2.5-200</b>	<b>m2.5</b>	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
<b>SIR3-120</b> <b>SIR3-160</b>	<b>m3</b>	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]
- 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.
  - The allowable torques shown in the table are calculated values according to the assumed usage conditions. Please see Page 209 for more details.
  - Please check for the involute interference, trochoid interference and trimming interference prior to using internal gears.

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Established equipment and technology  
Custom gears are also available.

Module 0.5~4, Tooth diameter  $\phi$  150mm or more  
Outside diameter  $\phi$  700mm or less, weight 40kg or less



Gear cutting by CNC Gear Shaper



# Racks

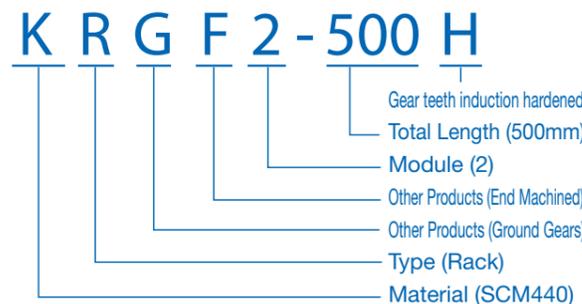
<b>MRGF/MRGFD</b> Hardened Ground Racks Material: SCM415 m1.5-3 Page 224	<b>KRGF-H/KRGFD-H</b> Hardened Ground Racks Material: SCM440 m1.5-3 Page 226	<b>KRG/KRGF/KRGFD</b> Thermal Refined Ground Racks Material: SCM440 m1-3 Page 228	<b>SRG/SRGF/SRGFD/SRGFK</b> Hardened Ground Racks Material: S45C m0.5-6 Page 230	<b>KRF-H/KRFD-H</b> Hardened Racks Material: SCM440 m1.5-5 Page 232	<b>SRF-H/SRFD-H</b> Hardened Racks Material: S45C m1.5-6 Page 234	<b>SRF-HL/SRFD-HL</b> Laser Hardened Racks Material: S45C m1.5-6 Page 236	<b>SRAF-HL/SRAF-D-HL/SRAF-K-HL</b> Laser Hardened Square Racks Material: S45C m1.5-4 Page 238
<b>KRF/KRFD</b> Thermal Refined Racks Material: SCM440 m1.5-5 Page 240	<b>SRAF/SRAF-D/SRAF-K</b> Square Racks Material: S45C m1.5-4 Page 242	<b>SR</b> Racks Material: S45C m0.5-10 Page 244	<b>SRF</b> Steel Racks with Machined Ends Material: S45C m0.5-10 Page 245	<b>SRFD/SRFK</b> Steel Racks with Bolt Holes Material: S45C m0.5-6 Page 246	<b>SUR/SURF/SURFD</b> Stainless Steel Racks Material: SUS304 m1-4 Page 248	<b>DRF/DRFD/DRFK</b> Plastic Racks Material: Polyacetal m1-3 Page 250	<b>PR/PRF</b> Plastic Racks Material: MC901 m1-3 Page 252
<b>BSR</b> Racks Material: Free cutting brass (C3604) m0.5-1 Page 253	<b>SRO/SROS</b> Round Racks Material: S45C m1-5 Page 254	<b>SURO</b> Stainless Steel Round Racks Material: SUS303 m1-3 Page 255	<b>DR</b> Molded Flexible Racks Material: Duracon (R) (M25-44) m0.8-2 Page 256	<b>SSDR/ARL/SRS</b> Rack Clamps for Pinions/Rack Guide Rails For Molded Flexible Racks Material: S45C, etc. Page 256	<b>KRHG/KRHGF/KRHGFD</b> Ground Helical Racks Material: SCM440 m1-3 Page 258	<b>SRHEF-HL</b> Laser Hardened Helical Racks Material: S45C m3-6 Page 260	<b>SRH/SRHF/SRHFD</b> Helical Racks Material: S45C m2, 3 Page 262
<b>SRHEF</b> Helical Racks Material: S45C m1.5-6 Page 264	<b>SHE-H</b> Hardened Helical Gears Material: S45C m1.5-6 Page 264	<b>SHE</b> Helical Gears Material: S45C m1.5-6 Page 264	<b>ZST/ZSTD</b> Hardened Ground Helical Racks Material: DIN C45 (S45C equivalent) m2-6 Page 266	<b>ZSTP</b> Ground Helical Gears Material: SCM440 m2-6 Page 266	<b>ZST-GL</b> Assembly Gauges Material: S45C m1.5-6 Page 268		

**M** 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



Material		Other Information	
M	SCM415	F	Racks with Machined Ends
K	SCM440	D	Racks with Bolt Holes
S	S45C	K	Racks with Drill Holes
SU	Stainless Steel	G	Ground Gears
BS	Brass	H	Gear teeth induction hardened
P	MC901	HL	Laser hardened
D	Polyacetal	ZST	Manufactured by Schneeberger
Type			
R	Racks		
RH	Helical Racks		
RO	Round Racks		
S	Spur Gears		
H	Helical Gears		