

# Internal Gears

Spur Gears

Helical Gears

Internal Gears

Racks

CP Racks & Pinions

Miter Gears



Bevel Gears

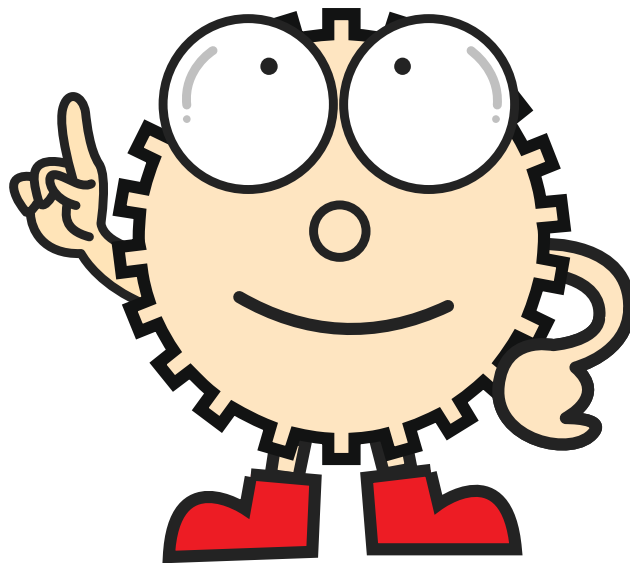
Screw Gears

Worm Gear Pairs

Bevel Gearboxes

Other Products

SI Steel Internal Gears	SIR Steel Ring Gears (Spur Gears)
	
Precision: N8 Material: S45C	Precision: N9 Material: S45C
m0.5 ~ 3 Page 184	m2 ~ 3 Page 186

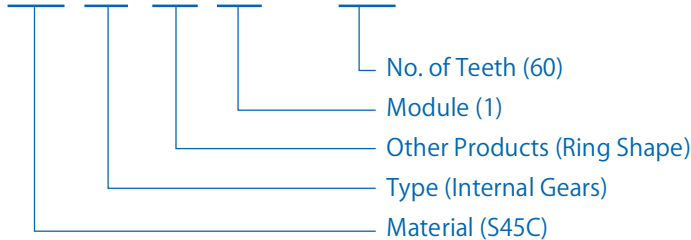


## Catalog Number of KHK Stock Gears

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 1 - 60**



**Material**  
S S45C

**Type**  
I Internal Gears

**Other Information**  
R Ring Gears

### Features



KHK stock internal gears are offered in modules 0.5 to 3 in 50 to 200 teeth. They can be used in many applications including planetary gear drives.

Catalog Number	SI	SIR
Module	0.5 to 3	2 to 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; low cost and suitable for many applications.	Ring gear large in size / number of teeth. It can be cut to make segment gears and corner racks.

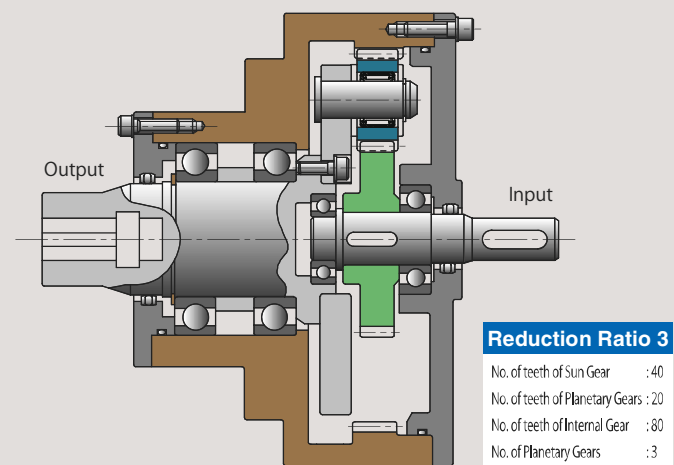
[Note 1] The product accuracy class having a module less than 0.8 corresponds to 'equivalent' as shown in the table.

### Application Examples

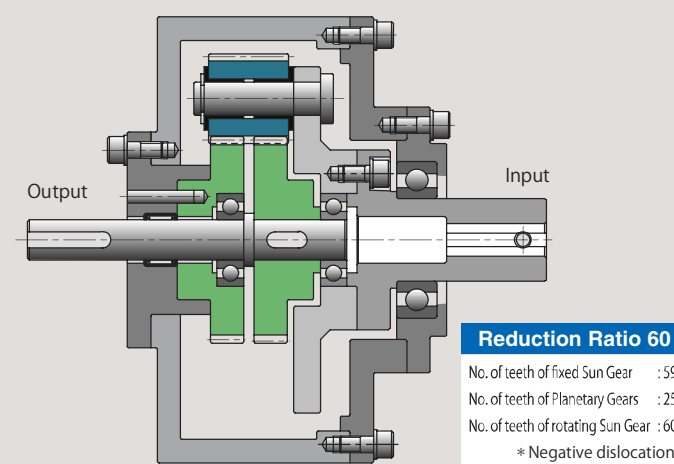


KHK stock internal gears are used to reduce the size of various equipment, such as reduction gears.

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



Planetary Gear Mechanism used in a reduction gear

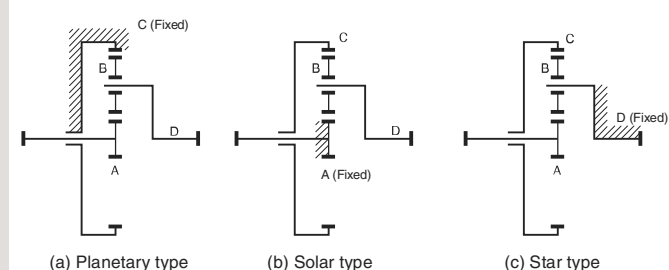


Mechanical Paradox Gear Mechanism used in a large reduction gear

### 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 reduction 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 involute, trochoid and trimming interference occurrences, 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
50	22	41	33
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 a certain application environment. 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	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	
Allowable bending stress at root $\sigma_{Flim}$ (kgf/mm <sup>2</sup> ) NOTE 2	19	
Safety factor $S_F$	1.2	

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

Item	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 $S_{H1}$	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.

[NOTE 2] The allowable bending stress at the root  $\sigma_{Flim}$  is calculated from JGMA401-01, and set to 2/3 of the value in the consideration of the use of planetary-, idler-, or other gear systems, loaded in both directions.

### Application Hints



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

Please refer to Page 26 for "Cautions on Handling" and Page 27 for "Cautions on Starting".

### 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 apply too much pressure when chucking the outer diameter. Gear precision may deteriorate and cause trouble.
- ③ To avoid problems of reduced gear precision and other manufacturing difficulties, do not attempt to machine the gears to reduce face widths.

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 ISO9000 quality management system; if you notice any malfunctions upon purchasing a product, please contact the supplier.

### 2. Points of Caution during Assembly

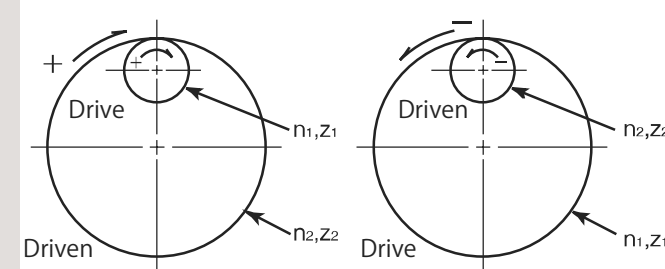
- ① KHK stock internal gears are designed to give the proper normal direction backlash when assembled using the center distance given by the formula below. The amount of backlash is given in the product table for each gear.

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

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

- ② Note that the direction of rotation of the internal gear is different from that of two spur gears in mesh.

### Gear Ratio and Direction of Rotation



(a) Internal gear is driven (b) Internal gear drives

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

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

### Gear tooth conditions for planetary gear mechanisms

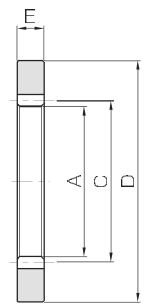
- Condition 1:  $z_c = z_a + 2z_b$
  - Condition 2:  $\frac{z_a + z_c}{N} = \text{Integer}$
  - Condition 3:  $z_b + 2 < (z_a + z_b) \sin \frac{180^\circ}{N}$
- $z_a$  : No. of teeth of Sun Gear  
 $z_b$  : No. of teeth of Planetary Gears  
 $z_c$  : No. of teeth of Internal Gear  
 $N$  : No. of Planetary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

Internal 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.				Pitch 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						
SI0.5-60 SI0.5-80 SI0.5-100	m0.5	60	T1	29	30	50	5	3.75	0.67	0.38	0.07	0.04~0.15	0.049				
		80		39	40	60		4.85	0.75	0.49	0.08						
		100		49	50	70		5.97	0.87	0.61	0.09						
SI0.8-60 SI0.8-80 SI0.8-100	m0.8	60		46.4	48	75	15.4	2.87	1.57	0.29	0.05~0.16	0.16					
		80		62.4	64	90	19.9	3.24	2.03	0.33							
		100		78.4	80	105	24.5	3.75	2.50	0.38							
SI1-60 SI1-80 SI1-100	m1	60		58	60	90	30.0	5.95	3.06	0.61	0.10~0.22	0.28					
		80		78	80	110	38.8	6.59	3.96	0.67							
		100		98	100	130	47.8	7.64	4.87	0.78							
SI1.5-50 SI1.5-60 SI1.5-80 SI1.5-100	m1.5	50		72	75	115	87.1	20.9	8.88	2.13	0.13~0.29	0.70					
		60	87	90	130	101	20.6	10.3	2.10								
		80	117	120	160	131	23.3	13.4	2.38								
SI2-50 SI2-60 SI2-80 SI2-100	m2	50	96	100	150	206	50.3	21.0	5.13	0.16~0.33	1.54						
		60	116	120	170	240	50.5	24.5	5.15								
		80	156	160	210	311	57.0	31.7	5.81								
SI2.5-50 SI2.5-60 SI2.5-80	m2.5	50	120	125	185	403	101	41.1	10.3	0.17~0.37	2.87						
		60	145	150	210	469	101	47.8	10.3								
		80	195	200	260	607	114	61.9	11.6								
SI3-50 SI3-60	m3	50	144	150	220	697	178	71.0	18.1	0.19~0.41	4.79						
		60	174	180	250	811	178	82.7	18.2								

[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 a 30 tooth SS spur gear.

② The allowable torques shown in the table are calculated values according to the assumed usage conditions. Please see Page 183 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 "Caution on Performing Secondary Operations" (Page 183) 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.

Ground internal gears are available.

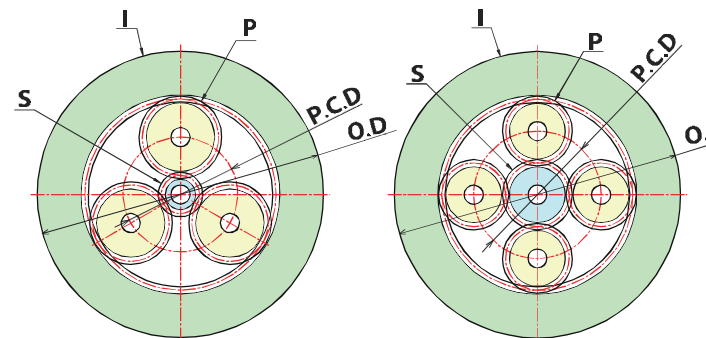
Please see Page 16 for more details.



Klingelberg 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)

Planetary Gear Systems created by using KHK Stock Gears



3 planetary gears are used

4 planetary gears are used

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

The velocity ratios <sup>Note 1</sup> in the table 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

Velocity ratio Note 1	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	50	SI0.5-60	60	SS0.5-24A	24	3	18	120°	SSS0.5-12	12	0.072	0.0003	0.43	0.013	0.10
	75	SI0.8-60		SS0.8-24A			28.8		SSS0.8-12		0.30	0.0011	1.78	0.057	0.30
	90	SI1-60		SSA1-24			36		SSS1-12		0.58	0.0023	3.47	0.11	0.48
	130	SI1.5-60	SSA1.5-24	24	3	54	120°	SS1.5-12	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	
	250	SI3-60	SSA3-24			108		SS3-12		14.2	0.070	85.2	3.49	8.57	
	60	SI0.5-80	SS0.5-32A			32		3		24	120°	SS0.5-16A	16	0.12	0.0005
	90	SI0.8-80	SS0.8-32A	38.4	SS0.8-16A		0.51		0.0024	3.05		0.12		0.38	
	110	SI1-80	SSA1-32	48	SS1-16		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					
	5	70	SI0.5-100	SS0.5-40A	40	4	30	90°	SS0.5-20A	20	0.23	0.0019	1.39	0.10	0.18
		105	SI0.8-100	SS0.8-40A			48		SS0.8-20A		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	
60		SI0.5-80	SS0.5-30A	30			4		25		90°	SS0.5-20A	20	0.23	0.0012
90	SI0.8-80	SS0.8-30A	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	SS0.5-20A	20	4	30	90°	SS0.5-40A	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	25	3	37.5	120°	SS0.5-50A	50	0.47	0.0020	1.42	0.12	0.16	
	105	SI0.8-100	SS0.8-25A			60		SS0.8-50A		1.94	0.0084	5.83	0.51	0.43	
	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.

$$T1 = Ts \cdot Z_p \cdot \eta \quad \text{..... (1)}$$

$$T2 = Ts \cdot Z_p \cdot u \cdot \eta \quad \text{..... (2)}$$

Where

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 : Velocity 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%.

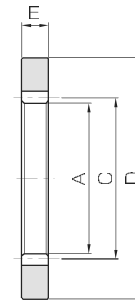




### Internal Ring Gears



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.				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	m2	120	T1	236	240	286	20	413	68.8	42.1	7.02	0.17~0.37	2.98		
SIR2-200		200		396	400	446		677	110	69.0	11.2	0.20~0.41	4.80		
SIR2.5-120	m2.5	120		295	300	355	25	807	138	82.3	14.0	0.19~0.41	5.55		
SIR2.5-200		200		495	500	555		1320	220	135	22.5	0.22~0.46	8.94		
SIR3-120	m3	120		354	360	424	30	1390	244	142	24.9	0.22~0.45	9.28		
SIR3-160		160		474	480	544		1840	315	188	32.1	0.22~0.45	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 a 30 tooth SS spur gear.
  - ② The allowable torques shown in the table are calculated values according to the assumed usage conditions. Please see Page 183 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 "Caution on Performing Secondary Operations" (Page 183) 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

- Spur Gears
- Helical Gears
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