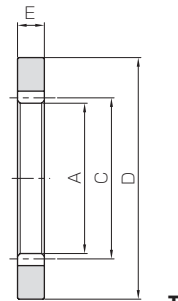


Internal Gears



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. 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		
KSI0.5-60 KSI0.5-80 KSI0.5-100	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		0.062
		100		49	50	70		5.97	0.87	0.61	0.09		0.074
KSI0.8-60 KSI0.8-80 KSI0.8-100	m0.8	60	T1	46.4	48	75	8	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		0.20
		100		78.4	80	105		24.5	3.75	2.50	0.38		0.23
KSI1-60 KSI1-80 KSI1-100	m1	60	T1	58	60	90	10	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		0.35
		100		98	100	130		47.8	7.64	4.87	0.78		0.43
KSI1.5-50 KSI1.5-60 KSI1.5-80 KSI1.5-100	m1.5	50	T1	72	75	115	15	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		0.81
		80		117	120	160		131	23.3	13.4	2.38		1.04
KSI2-50 KSI2-60 KSI2-80 KSI2-100	m2	50	T1	147	150	190	20	161	27.0	16.5	2.75	0.15~0.32	1.26
		60		96	100	150		206	50.3	21.0	5.13		1.54
		80		116	120	170		240	50.5	24.5	5.15		1.79
KSI2.5-50 KSI2.5-60 KSI2.5-80	m2.5	50	T1	196	200	250	25	382	65.7	39.0	6.70	0.17~0.37	2.77
		60		120	125	185		403	101	41.1	10.3		2.87
		80		145	150	210		469	101	47.8	10.3		3.33
KSI3-50 KSI3-60	m3	50	T1	195	200	260	30	607	114	61.9	11.6	0.19~0.41	4.25
		60		144	150	220		697	178	71.0	18.1		4.79
								811	178	82.7	18.2		5.57

[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 KSS 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.

② Avoid performing secondary operations that narrow the tooth width, as it affects precision and strength.

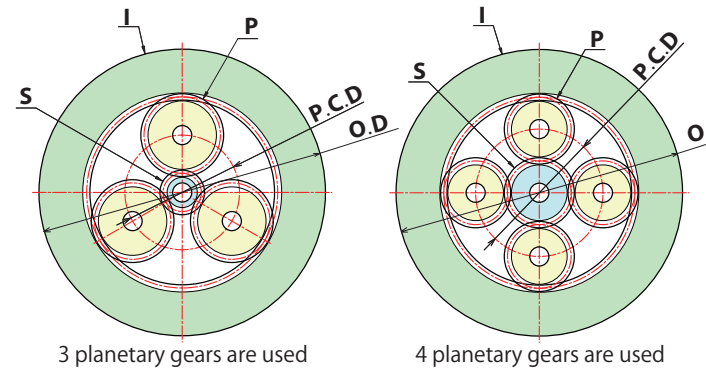
Ground internal gears are available.



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

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 T <sub>1</sub>		Planetary carrier T <sub>2</sub>				
	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			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	
	250	SI3-60	SSA3-24	108	SS3-12	14.2	0.070	85.2	3.49	8.57						
	5	60	SI0.5-80	80	SS0.5-32A	32	3	24	120°	SS0.5-16A	16	0.12	0.0005	0.75	0.027	0.11
		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	
70		SI0.5-100	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	
3		60		SI0.5-80			80		SS0.5-30A		30	4	25	90°	SS0.5-20A	20
	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			
	60	SI0.5-80	100	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	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 · Zp · η (kgf-m) ..... (1)

T2 = Ts · Zp · u · η (kgf-m) ..... (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%.

### Features

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.

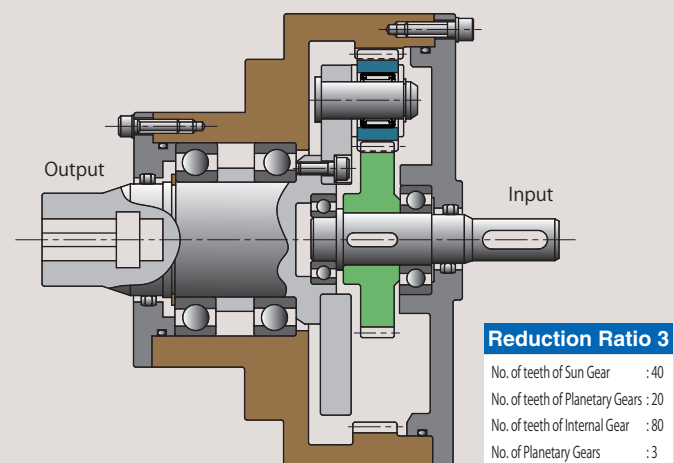
Catalog Number	KSI	KSIR
Module	0.5 to 3	2 to 3
Material	S45C	S45C
Heat Treatment	-	-
Tooth Surface Finish	Cut	Cut
Precision JIS B 1702-1:1998	N8 NOTE 1	N9
Secondary Operations	Possible	Possible
Features	A popular type of internal gear; low cost and suitable for many applications.	Ring gear large in size / 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.

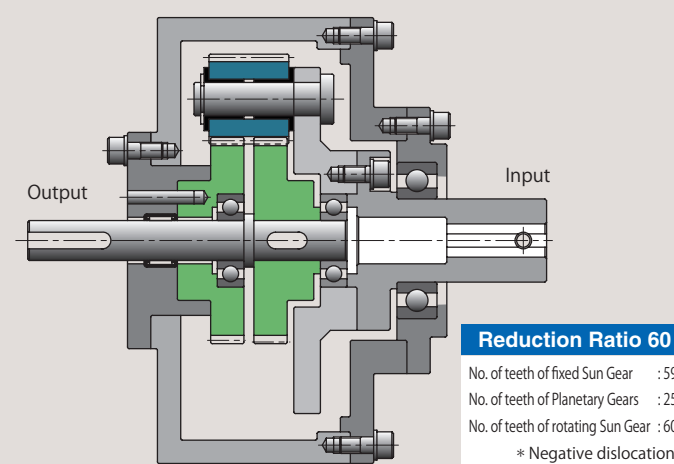
### Application Examples

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

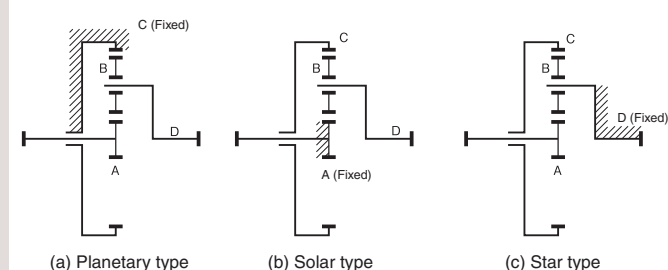


Mechanical Paradox Gear Mechanism used in a large reduction gear

### 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

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	Catalog Number	KSI	KSIR
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 $\sigma_{Fim}$ (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	Catalog Number	KSI	KSIR
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 $\sigma_{Him}$ (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.

[NOTE 2] The allowable bending stress at the root  $\sigma_{Fim}$  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.

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

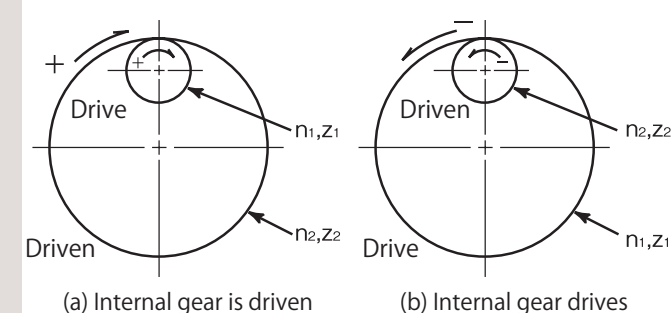
- ① Internal gears are designed to give the proper normal direction backlash when assembled using the center distance given by the formula below. The amount of backlash is given in the product table for each gear.

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

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



$$\text{Gear Ratio } i = \frac{z_2}{z_1} = \frac{n_1}{n_2}$$

$z$  : No. of teeth  
 $n$  : Rotational speed

- 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