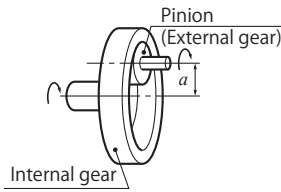


9.9 Calculation for Planetary gear mechanism

1. Engagement between Internal gear and pinion (External gear)



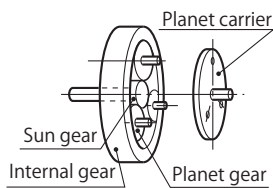
Centre distance 'a' for the Internal gear trains are shorter than the External gear trains. Internal gear train operates in the same gear direction. Calculation formulas for transfer ratio 'u' are as follows.

- a) When pinion is driver

$$u = \frac{\text{No. of teeth of Pinion}}{\text{No. of teeth of Internal gear}} \text{ (speed reduction)}$$
- b) When Internal gear is driver

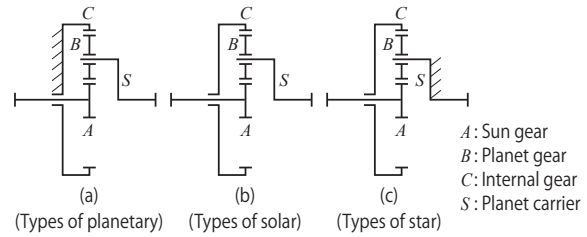
$$u = \frac{\text{No. of teeth of Internal gear}}{\text{No. of teeth of Pinion}} \text{ (increase speed)}$$

2. Planetary gear mechanism



Most mechanism of Planetary gear comes with compact design and high reductive gear ratio consisting of Sun, Planet, Internal gears and Planet carrier.

Basic gear axis for Planetary gear train mechanism (2K-H)



Types of mechanism	Fixed member	Input	Output	Formula of gear ratio	Ratio range
(a) Types of planetary	Internal gear	Sun gear	Planet carrier	$\frac{1}{\frac{z_C}{z_A} + 1}$	1/3 - 1/12
(b) Types of solar	Sun gear	Internal gear	Planet carrier	$\frac{1}{\frac{z_A}{z_C} + 1}$	1/1.2 - 1/1.7
(c) Types of star	Planet carrier	Sun gear	Internal gear	$-\frac{1}{\frac{z_C}{z_A}}$	1/2 - 1/11

- z: No. of teeth. A & C: Sun and Internal gear
- '-' symbol indicates output revolving direction

Interference of Internal gear

Interference will occur when design provides insufficient Number of teeth between Internal and Planet gears (External gear) during assembly. Please refer to the causes and types of interference as follows.

Interference	Phenomenon	Cause	Interference	Phenomenon	Cause
Involute interference	Unworkable conditions when a Tooth tip of Internal gear cuts into Dedendum of pinion during operations.	Insufficient No. of teeth for pinion	Trimming interference	During assembling, pinion can be assembled to axial direction but not to radius direction.	Same as trochoid interference
Trochoid interference	Tip of pinion after engaging with Sun gear interferes to Tooth tip of Internal gear causing unworkable conditions.	Difference in No. of teeth between Internal and Planet is insufficient.	Fillet interference	Tooth tip of pinion touched Dedendum fillet of Internal gear causing unworkable condition.	Insufficient No. of teeth for pinion. (insufficient Tooth depth of pinion).

Relationship among the gears in a Planetary gear mechanism

When designing Planet gear, please achieve following conditions.

- ① No. of teeth of Internal gears = (No. of teeth of Sun gear + 2) × No. of teeth of Planet gear.
- ② $\frac{\text{No. of teeth of Internal gear} + \text{No. of teeth of Sun gear}}{\text{The number of planet gears}} = \text{Should be integer number}$
- ③ Prevent the Tip interference among Planetary gears.

$$m(Z_B + 2) < m(Z_A + Z_B) \sin \frac{\pi}{n} \quad (n: \text{The number of Planet gears})$$

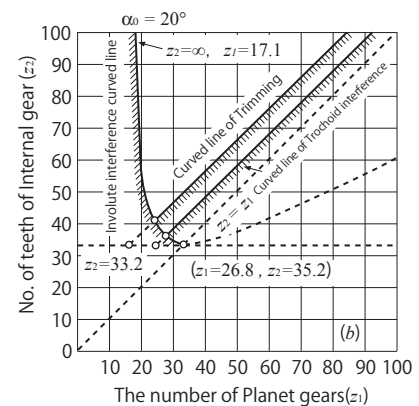


Fig. 6 Interference of Internal gear

Range of Number of teeth for pinion and KG-Internal gears

No. of teeth of Internal gear	Range of No. of teeth for pinion	No. of teeth of Internal gear	Range of No. of teeth for pinion
60	21 - 44	96	19 - 80
72	20 - 56	100	19 - 84
80	20 - 64	108	19 - 92
84	20 - 68	120	19 - 104
90	19 - 74		