Harmonic Planetary®
HPF Hollow Shaft Gear Unit

Size
25, 32

Peak torque
Size 25: 100Nm, Size 32: 220Nm

Reduction ratio
11:1

Low backlash
Standard: <3 arc-min Low Backlash for Life
Innovative ring gear inherently compensates for interference between meshing parts, ensuring consistent, low backlash for the life of the gearhead.

Inside diameter of the hollow shaft
Size 25: Ø25mm Size 32: Ø30mm

High Load Capacity Output Bearing
A Cross Roller bearing is integrated with the output flange to provide high moment stiffness, high load capacity and precise positioning accuracy.

Based on Harmonic Planetary® gearhead design concept, the hollow shaft planetary features the same superior performance and specifications as the HPG line. The large hollow shaft allows cables, pipes, or shafts to pass directly through the axis of rotation, simplifying the design and improving reliability.

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HPF - 25 A - 11 - F0 U1 - SP1

Gearhead Construction

Model Name Size Stage Number Reduction Ratio Output Configuration Input Configuration Options
HarmonicPlanetary® HPF Hollow Shaft 25 A 11 F0: Flange output U1: Hollow shaft None: Standard item SP: Special specification
25 32
### Rating Table

The HPF hollow shaft planetary gear features a large hollow shaft that allows cables, shafts, ball screws or lasers to pass directly through the axis of rotation.

<table>
<thead>
<tr>
<th>Size</th>
<th>Ratio</th>
<th>Rated Torque at 2000 rpm **</th>
<th>Rated Torque at 3000 rpm **</th>
<th>Limit for Repeated Peak Torque **</th>
<th>Limit for Momentary Torque **</th>
<th>Max. Input Speed **</th>
<th>Max. Input Moment of Inertia</th>
<th>Input Mass **</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>11</td>
<td>48</td>
<td>21</td>
<td>100</td>
<td>170</td>
<td>3000</td>
<td>5600</td>
<td>1.63</td>
</tr>
<tr>
<td>32</td>
<td>11</td>
<td>100</td>
<td>44</td>
<td>220</td>
<td>450</td>
<td>3000</td>
<td>4800</td>
<td>3.84</td>
</tr>
</tbody>
</table>

*1: Rated torque is based on L10 life of 20,000 hours when input speed is 2000 rpm.
*2: Rated torque is based on L10 life of 20,000 hours when input speed is 3000 rpm.
*3: The limit for torque during start and stop cycles.
*4: The limit for torque during emergency stops or from external shock loads. Always operate below this value. Calculate the number of permissible events to ensure it meets required operating conditions.
*5: Max value of average input rotational speed during operation.
*6: Maximum instantaneous input speed.

### Performance Table

<table>
<thead>
<tr>
<th>Size</th>
<th>Ratio</th>
<th>Transmission accuracy **</th>
<th>Repeatability **</th>
<th>Starting torque **</th>
<th>Backdriving torque **</th>
<th>No-load running torque **</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>11</td>
<td>arc min</td>
<td>arc sec</td>
<td>Ncm</td>
<td>Nm</td>
<td>Ncm</td>
</tr>
<tr>
<td>32</td>
<td>11</td>
<td>4</td>
<td>±15</td>
<td>59</td>
<td>6.5</td>
<td>78</td>
</tr>
</tbody>
</table>

*1: Accuracy values represent the difference between the theoretical angle and the actual angle of output for any given input. The values in the table are maximum values.

*2: The repeatability is measured by moving to a given theoretical position seven times, each time approaching from the same direction. The actual position of the output shaft is measured each time and repeatability is calculated as the 1/2 of the maximum difference of the seven data points. Measured values are indicated in angles (arc-sec) prefixed with “±”. The values in the table are maximum values.

*3: Starting torque is the torque value applied to the input side at which the output first starts to rotate. The values in the table are maximum values.

*4: Backdriving torque is the torque value applied to the output side at which the input first starts to rotate. The values in the table are maximum values.

*5: No-load running torque is the torque required at the input to operate the gearhead at a given speed under a no-load condition. The values in the table are average values.

---

**Figure 105-2**

### Torsional Stiffness Curve Backlash (Hysteresis Loss)

- **Calculation formula**

\[
\theta_{\text{er}} = \theta_1 - \frac{A}{R}
\]

- Where:
  - \( \theta_{\text{er}} \): Transmission accuracy
  - \( \theta_1 \): Input angle
  - \( \theta_2 \): Actual output angle
  - \( R \): Gear reduction ratio

**Figure 105-3**

- **Calculation of total torsion angle**

1. Clockwise torque to \( TR \),
2. Return to Zero,
3. Counter-Clockwise torque to \(-TR\),
4. Return to Zero and
5. again Counter-Clockwise torque to \(-TR\).

**Table 106-1**

<table>
<thead>
<tr>
<th>Load</th>
<th>No load</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPF speed reducer surface temperature</td>
<td>25°C</td>
</tr>
</tbody>
</table>

**Table 106-4**

<table>
<thead>
<tr>
<th>Load</th>
<th>No load</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPF speed reducer surface temperature</td>
<td>25°C</td>
</tr>
</tbody>
</table>

**Table 106-5**

| Input speed | 3000 rpm |
| Load | No load |
| HPF speed reducer surface temperature | 25°C |
Backlash and Torsional Stiffness

<table>
<thead>
<tr>
<th>HPF Hollow Shaft Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>25</td>
</tr>
<tr>
<td>32</td>
</tr>
</tbody>
</table>

**Torsional stiffness curve**

With the input of the gear locked in place, a torque applied to the output flange will torsionally deflect in proportion to the applied torque. We generate a torsional stiffness curve by slowly applying torque to the output in the following sequence:
1. Clockwise torque to TR,
2. Return to Zero,
3. Counter-Clockwise torque to -TR,
4. Return to Zero and
5. Again Clockwise torque to TR.

A loop of (1) > (2) > (3) > (4) > (5) will be drawn as in Fig. 106-1.
The torsional stiffness in the region from "0.15 x TR" to "TR" is calculated using the average value of this slope. The torsional stiffness in the region from "zero torque" to "0.15 x TR" is lower. This is caused by the small amount of backlash plus engagement of the mating parts and loading of the planet gears under the initial torque applied.

**Calculation of total torsion angle**

The method to calculate the total torsion angle (average value) in one direction when a load is applied from a no-load state.

\[ \theta = D + \frac{T \times T_l}{A/B} \]

- \( \theta \): Total torsion angle
- \( D \): Torsion angle in one direction at output torque x 0.15 torque
- \( T \): Load torque
- \( T_l \): Output torque x 0.15 torque (=TR x 0.15)
- \( A/B \): Torsional stiffness

**Backlash (Hysteresis Loss)**

The vertical distance between points (2) & (4) in Fig. 106-1 is called a hysteresis loss. The hysteresis loss between "Clockwise load torque Tr" and "Counter Clockwise load torque -Tr" is defined as the backlash of the HPF series. The backlash of the HPF series is less than 3 arc-min.

![Torque-torsion angle diagram](image-url)
Outline Dimensions

Only primary dimensions are shown in the drawings below. Refer to the confirmation drawing for detailed dimensions. For the specifications of the input side bearing of the hollow shaft gear unit, refer to page 145.

HPF-25 Outline Dimensions

(Note) The dimension tolerances that are not specified vary depending on the manufacturing method. Please check the confirmation drawing or contact us for dimension tolerances not shown on the drawing above.

*1: The inside diameter of the hollow shaft rotates with the input shaft (high speed). Use these holes for installing a sleeve which rotates with the output side. (These holes are not for mounting the load).

HPF-32 Outline Dimensions

(Note) The dimension tolerances that are not specified vary depending on the manufacturing method. Please check the confirmation drawing or contact us for dimension tolerances not shown on the drawing above.

*1: The inside diameter of the hollow shaft rotates with the input shaft (high speed). Use these holes for installing a sleeve which rotates with the output side. (These holes are not for mounting the load).
**Sizing & Selection**

To fully utilize the excellent performance of the HPF HarmonicPlanetary® gearheads, check your operating conditions and, using the flowchart, select the appropriate size gear for your application.

Check your operating conditions against the following application motion profile and select a suitable size based on the flowchart shown on the right. Also check the life and static safety coefficient of the cross roller bearing.

**Flowchart for selecting a size**

Please use the flowchart shown below for selecting a size. Operating conditions must not exceed the performance ratings.

1. Calculate the average load torque applied on the output side from the application motion profile: 
   \[
   T_{av} = \frac{T_1 \cdot t_1 + T_2 \cdot t_2 + T_3 \cdot t_3 + T_4 \cdot t_4}{t_1 + t_2 + t_3 + t_4}
   \]

2. Calculate the average output speed based on the application motion profile:
   \[
   n_{av} = \frac{n_{1} \cdot t_{1} + n_{2} \cdot t_{2} + n_{3} \cdot t_{3} + n_{4} \cdot t_{4}}{t_{1} + t_{2} + t_{3} + t_{4}}
   \]

3. Make a preliminary model selection with the following conditions:
   \[
   T_{s} = 120 \text{Nm} \quad n_{s} = 60 \text{rpm}
   \]

4. Determine the reduction ratio (R) based on the maximum output rotational speed (no max) and maximum input rotational speed (ni max).
   \[
   ni_{max} = no_{max} \cdot R
   \]

(A limit is placed on ni max by motors.)

5. Calculate the maximum input speed (ni max) from the maximum output speed (no max) and the reduction ratio (R).
   \[
   ni_{max} = no_{max} \cdot R
   \]

6. Calculate the average input speed (ni av) from the average output speed (no av) and the reduction ratio (R):
   \[
   ni_{av} = \frac{no_{av} \cdot R}{ni_{max}}
   \]

7. Check whether the maximum input speed is equal to or less than the values in the rating table.
   \[
   ni_{max} \leq \text{Max. average input speed (ni)}
   \]

8. Check whether T1 and T3 are within peak torques (Nm) on start and stop in the rating table.

9. Check whether T3 is less than the momentary max. torque (Nm) value from the ratings.

10. Calculate the lifetime and check whether it meets the specification requirement.
    \[
    L_{10} = 20,000 \cdot \left(\frac{T_{av}}{T_{r}}\right) \cdot \left(\frac{ni_{max}}{ni_{av}}\right) \text{ (Hour)}
    \]

   \[\text{OK}\]

11. The model number is confirmed.

**CAUTION**

If any of the following conditions exist, please consider selecting the next larger speed reducer, reduce the operating loads or reduce the operating speed. If this cannot be done, please contact Harmonic Drive LLC. Exercise caution especially when the duty cycle is close to continuous operation.

1. Actual average load torque (Tav) > Permissible maximum value of average load torque or
2. Actual average input rotational speed (ni av) > Permissible average input rotational speed (ni).
3. Gearhead housing temperature > 70°C.
Example of size selection

<table>
<thead>
<tr>
<th>Load torque T&lt;sub&gt;n&lt;/sub&gt; (Nm)</th>
<th>Maximum rotational speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time t&lt;sub&gt;n&lt;/sub&gt; (sec)</td>
<td>Max. output rotational speed no max = 120 rpm</td>
</tr>
<tr>
<td>Output rotational speed n&lt;sub&gt;n&lt;/sub&gt; (rpm)</td>
<td>Max. input rotational speed ni max = 5,000 rpm</td>
</tr>
</tbody>
</table>

Normal operation pattern

- Starting (acceleration) T<sub>1</sub> = 70 Nm, t<sub>1</sub> = 0.3 sec, n<sub>1</sub> = 60 rpm
- Steady operation (constant velocity) T<sub>2</sub> = 18 Nm, t<sub>2</sub> = 3 sec, n<sub>2</sub> = 120 rpm
- Stopping (deceleration) T<sub>3</sub> = 35 Nm, t<sub>3</sub> = 0.4 sec, n<sub>3</sub> = 60 rpm
- Dwell T<sub>4</sub> = 0 Nm, t<sub>4</sub> = 5 sec, n<sub>4</sub> = 0 rpm

Calculate the average load torque applied to the output side based on the application motion profile.

\[ T_{av} = \frac{1}{60} \left[ \frac{60rpm}{0.3sec} \cdot 70Nm + \frac{60rpm}{0.3sec} \cdot 18Nm + \frac{60rpm}{0.4sec} \cdot 35Nm \right] \]

Calculate the average load torque based on the application motion profile.

\[ T_{av} = \frac{1}{60} \left[ \frac{60rpm}{0.3sec} \cdot 70Nm + \frac{60rpm}{0.3sec} \cdot 18Nm + \frac{60rpm}{0.4sec} \cdot 35Nm \right] \]

Calculate the average output speed based on the application motion profile.

\[ n_{av} = \frac{1}{60} \left[ \frac{60rpm}{0.3sec} \cdot 70Nm + \frac{60rpm}{0.3sec} \cdot 18Nm + \frac{60rpm}{0.4sec} \cdot 35Nm \right] \]

Make a preliminary model selection with the following conditions. T<sub>av</sub> = 30.2 Nm \( \leq \) 48 Nm. (HPF-25A-11 is tentatively selected based on the average load torque (see the rating table on page 105) of size 25 and reduction ratio of 11.)

Determine the reduction ratio (R) from the maximum output speed (no max) and maximum input speed (ni max).

\[ R = \frac{ni_{max}}{no_{max}} = \frac{5,000 rpm}{120 rpm} = 41.7 \approx 11 \]

Calculate the maximum input speed (ni max) from the maximum output speed (no max) and reduction ratio (R): ni max = 120 rpm \( \cdot \) 11 = 1,320 rpm

Check whether the maximum input speed is less than the values specified in the rating table. ni max = 1,320 rpm \( \leq \) 5,600 rpm (maximum input speed of size 25)

Check whether T<sub>1</sub> and T<sub>4</sub> are within peak torques (Nm) on start and stop in the rating table. T<sub>1</sub> = 70 Nm \( \leq \) 100 Nm (Limit for repeated peak torque, size 25) T<sub>4</sub> = 0 Nm \( \leq \) 100 Nm (Limit for repeated peak peak torque, size 25)

Check whether Ts is equal to or less than limit for momentary torque (Nm) in the rating table.

Ts = 120 Nm \( \leq \) 170 Nm (momentary max. torque of size 25)

Calculate life and check whether the calculated life meets the requirement.

\[ L_{10} = 20,000 \cdot \frac{31 Nm}{30.2 Nm} \cdot \frac{3,000 rpm}{508 rpm} = 35,182 \text{ (hours)} \geq 30,000 \text{ (hours)} \]

The selection of model number HPF-25A-11 is confirmed from the above calculations.
Harmonic Planetary®
Planetary Gear Units

HPF Series - Hollow Shaft

High Load Capacity Output Bearing
A Cross Roller bearing is integrated with the output flange to provide high moment stiffness, high load capacity and precise positioning accuracy.

Based on Harmonic Planetary® gearhead design concept, the hollow shaft planetary features the same superior performance and specifications as the HPG line. The large hollow shaft allows cables, pipes, or shafts to pass directly through the axis of rotation, simplifying the design and improving reliability.

Planetary Gear Units

HPF Series - Hollow Shaft

Size

25, 32

Peak torque

Size 25: 100Nm, Size 32: 220Nm

Low backlash

Standard: <3 arc-min   Low Backlash for Life

Innovative ring gear automatically adjusts for backlash, ensuring consistent, low backlash for the life of the gearhead. The ring gear design automatically provides the optimum backlash in the planetary gear train and maintains the same low backlash for the life of the gearhead.

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Size 65

Reduction ratio = 120

Efficiency %

Graph 139-3
Graph 139-4

Technical Data

*1 The allowable axial load is the value of an axial load applied along the axis of rotation.

*2 The allowable radial load of HPG series is the value of a radial load applied at the mid-point of the input shaft.

*3 The allowable radial load of HPG series is the value of a radial load applied to the point of 20 mm from the shaft edge (input flange edge).

Checking procedure

Check the maximum load and life of the bearing on the input side if the reducer is an HPG input shaft unit or an HPF hollow shaft unit.

Specification of input shaft bearing

Specification of input bearing

NOTES

Maximum axial load (Fai max)

Allowable moment load Mc

Allowable axial load (Fac)

Allowable radial load Frc

Maximum moment load (Mi max)

Calculate:

Average input speed (Ni av)

Average axial load (Fai av)

Average moment load (Mi av)

Calculate the life and check it.

If moment load and axial load fluctuate, they should be converted into the average load to check the life of the bearing.

Calculating life of input bearing

How to calculate average load

How to calculate the average input speed (Ni av)

How to calculate the average moment load (Mi av)

(1) Checking maximum load

Check the maximum load and life of the bearing on the input side if the reducer is an HPG input shaft unit or an HPF hollow shaft unit.

Table 145-3

Table 145-4

Table 145-5 and check the life.

See Fig. 146-1.

See Fig. 146-1.

See Fig. 146-1.

Formula 146-1

Formula 146-2

Formula 146-3

Formula 146-4

Formula 146-5

Graph 146-1

Graph 146-2

Graph 146-3

Graph 146-4

Graph 146-5

Technical Information / Handling Explanation

Note

*3 The allowable radial load of HPG series is the value of a radial load applied to the point of 20 mm from the shaft edge (input flange edge).

*2 The allowable radial load of HPG series is the value of a radial load applied at the mid-point of the input shaft.

*1 The allowable axial load is the value of an axial load applied along the axis of rotation.

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Calculating life of input bearing

How to calculate average load

How to calculate the average input speed (Ni av)

How to calculate the average moment load (Mi av)

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Check the maximum load and life of the bearing on the input side if the reducer is an HPG input shaft unit or an HPF hollow shaft unit.

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See Fig. 146-1.

See Fig. 146-1.

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Formula 146-1

Formula 146-2

Formula 146-3

Formula 146-4

Formula 146-5

Graph 146-1

Graph 146-2

Graph 146-3

Graph 146-4

Graph 146-5

Technical Information / Handling Explanation

Note

*3 The allowable radial load of HPG series is the value of a radial load applied to the point of 20 mm from the shaft edge (input flange edge).

*2 The allowable radial load of HPG series is the value of a radial load applied at the mid-point of the input shaft.

*1 The allowable axial load is the value of an axial load applied along the axis of rotation.

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Check the maximum load and life of the bearing on the input side if the reducer is an HPG input shaft unit or an HPF hollow shaft unit.

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Specification of input bearing

NOTES

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Calculate:

Average input speed (Ni av)

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Calculate the life and check it.

If moment load and axial load fluctuate, they should be converted into the average load to check the life of the bearing.

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See Fig. 146-1.

Formula 146-1

Formula 146-2

Formula 146-3

Formula 146-4

Formula 146-5

Graph 146-1

Graph 146-2

Graph 146-3

Graph 146-4

Graph 146-5

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Note

*3 The allowable radial load of HPG series is the value of a radial load applied to the point of 20 mm from the shaft edge (input flange edge).

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Check the maximum load and life of the bearing on the input side if the reducer is an HPG input shaft unit or an HPF hollow shaft unit.

Specification of input shaft bearing

Specification of input bearing

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Maximum axial load (Fai max)

Allowable moment load Mc

Allowable axial load (Fac)

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Average axial load (Fai av)

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How to calculate average load

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How to calculate the average moment load (Mi av)

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Check the maximum load and life of the bearing on the input side if the reducer is an HPG input shaft unit or an HPF hollow shaft unit.

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Table 145-4

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See Fig. 146-1.

See Fig. 146-1.

See Fig. 146-1.

Formula 146-1

Formula 146-2

Formula 146-3

Formula 146-4

Formula 146-5

Graph 146-1

Graph 146-2

Graph 146-3

Graph 146-4

Graph 146-5

Technical Information / Handling Explanation

Note

*3 The allowable radial load of HPG series is the value of a radial load applied to the point of 20 mm from the shaft edge (input flange edge).

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*1 The allowable axial load is the value of an axial load applied along the axis of rotation.

Checking procedure

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Specification of input bearing

NOTES

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Allowable moment load Mc

Allowable axial load (Fac)

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Calculate:

Average input speed (Ni av)

Average axial load (Fai av)

Average moment load (Mi av)

Calculate the life and check it.

If moment load and axial load fluctuate, they should be converted into the average load to check the life of the bearing.

Calculating life of input bearing

How to calculate average load

How to calculate the average input speed (Ni av)

How to calculate the average moment load (Mi av)

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Check the maximum load and life of the bearing on the input side if the reducer is an HPG input shaft unit or an HPF hollow shaft unit.

Table 145-3

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Table 145-5 and check the life.

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See Fig. 146-1.

Formula 146-1

Formula 146-2

Formula 146-3

Formula 146-4

Formula 146-5

Graph 146-1

Graph 146-2

Graph 146-3

Graph 146-4

Graph 146-5
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The rated value and performance vary depending on the product series. Be sure to check the usage conditions and refer to the items conforming to the related product.
**Efficiency**

In general, the efficiency of a speed reducer depends on the reduction ratio, input rotational speed, load torque, temperature and lubrication condition. The efficiency of each series under the following measurement conditions is plotted in the graphs on the next page. The values in the graph are average values.

### Measurement condition

<table>
<thead>
<tr>
<th>Input rotational speed</th>
<th>HPGP / HPG / HPF / HPN: 3000rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CSG-GH / CSF-GH: Indicated on each efficiency graph.</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>25°C</td>
</tr>
<tr>
<td>Lubricant</td>
<td>Use standard lubricant for each model. (See pages 151-152 for details.)</td>
</tr>
</tbody>
</table>

### Efficiency compensated for low temperature

Calculate the efficiency at an ambient temperature of 25°C or less by multiplying the efficiency at 25°C by the low-temperature efficiency correction value. Obtain values corresponding to an ambient temperature and to an input torque (TRi) from the following graphs when calculating the low-temperature efficiency correction value.

* TRi is an input torque corresponding to output torque at 25°C.

---

**Graph 122-1**

* TRi is an input torque corresponding to output torque at 25°C.

---

**Graph 122-2**

* TRi is an input torque corresponding to output torque at 25°C.
Technical Data

Size 11: Gearhead
HPGP

Reduction Ratio = 5

Graph 123-1

<table>
<thead>
<tr>
<th>Efficiency %</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input torque Nm</td>
<td>0</td>
</tr>
</tbody>
</table>

- Gearhead (standard item)
- Gearhead with D bearing (double sealed)

*\( T_n \)*: Input torque corresponding to output torque

Reduction Ratio = 21

Graph 123-2

<table>
<thead>
<tr>
<th>Efficiency %</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input torque Nm</td>
<td>0</td>
</tr>
</tbody>
</table>

- Gearhead (standard item)
- Gearhead with D bearing (double sealed)

*\( T_n \)*: Input torque corresponding to output torque

Size 14: Gearhead
HPGP

Reduction Ratio = 5

Graph 123-4

<table>
<thead>
<tr>
<th>Efficiency %</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input torque Nm</td>
<td>0</td>
</tr>
</tbody>
</table>

- Gearhead (standard item)
- Gearhead with D bearing (double sealed)

*\( T_n \)*: Input torque corresponding to output torque

Reduction Ratio = 11

Graph 123-5

<table>
<thead>
<tr>
<th>Efficiency %</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input torque Nm</td>
<td>0</td>
</tr>
</tbody>
</table>

- Gearhead (standard item)
- Gearhead with D bearing (double sealed)

*\( T_n \)*: Input torque corresponding to output torque

Reduction Ratio = 15, 21

Graph 123-6

<table>
<thead>
<tr>
<th>Efficiency %</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input torque Nm</td>
<td>0</td>
</tr>
</tbody>
</table>

- Gearhead (standard item)
- Gearhead with D bearing (double sealed)

*\( T_n \)*: Input torque corresponding to output torque

Reduction Ratio = 33, 45

Graph 123-7

<table>
<thead>
<tr>
<th>Efficiency %</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input torque Nm</td>
<td>0</td>
</tr>
</tbody>
</table>

- Gearhead (standard item)
- Gearhead with D bearing (double sealed)

*\( T_n \)*: Input torque corresponding to output torque
**Technical Data**

### Specification of input shaft bearing

<table>
<thead>
<tr>
<th>Size</th>
<th>Gearhead</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPG</td>
<td></td>
</tr>
</tbody>
</table>

#### Reduction ratio = 5

- **Reduction ratio = 5**
- **Reduction ratio = 5**

#### Reduction ratio = 11

- **Reduction ratio = 11**
- **Reduction ratio = 11**

#### Reduction ratio = 15, 21

- **Reduction ratio = 15**
- **Reduction ratio = 21**

#### Reduction ratio = 33, 45

- **Reduction ratio = 33**
- **Reduction ratio = 45**

### Calculation of average load

- **Efficiency %**
- **Input speed Moment load**

### How to calculate average load

1. **Average input speed**
2. **Moment load**
3. **Efficiency %**

### Technical Information / Handling Explanation

- **Size 20**
- **Size 32**

*Only one line is shown because the difference between the gearhead and a bearing assembled on the input side is small.*
### Technical Data

#### Size 50

**Gearhead HPGP**

<table>
<thead>
<tr>
<th>Reduction ratio = 5 *2</th>
<th>Graph 125-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency %</td>
<td></td>
</tr>
<tr>
<td>Input torque Nm</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>20</td>
<td>90</td>
</tr>
<tr>
<td>40</td>
<td>80</td>
</tr>
<tr>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>80</td>
<td>60</td>
</tr>
<tr>
<td>100</td>
<td>50</td>
</tr>
</tbody>
</table>

* *2 Only one line is shown because the difference between the gearhead and a bearing assembled on the input side is small.*

<table>
<thead>
<tr>
<th>Reduction ratio = 11 *2</th>
<th>Graph 125-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency %</td>
<td></td>
</tr>
<tr>
<td>Input torque Nm</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td>20</td>
<td>80</td>
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<tr>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

#### Size 65

**Gearhead HPGP**

<table>
<thead>
<tr>
<th>Reduction ratio = 4, 5 *3</th>
<th>Graph 125-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency %</td>
<td></td>
</tr>
<tr>
<td>Input torque Nm</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>50</td>
<td>90</td>
</tr>
<tr>
<td>100</td>
<td>80</td>
</tr>
<tr>
<td>150</td>
<td>70</td>
</tr>
<tr>
<td>200</td>
<td>60</td>
</tr>
<tr>
<td>250</td>
<td>50</td>
</tr>
</tbody>
</table>

* *3 Only one line is shown because the difference between the gearhead and a bearing assembled on the input side is small.*
Technical Data

### Technical Information / Handling Explanation

- **Graph 126-1**
  - **Reduction ratio = 5**
  - **Gearhead & Input Shaft Unit**
  - **HPG**

### Gearhead & Input Shaft Unit

**HPG**

- **Size 11**
- **Size 14**

#### Gearhead Specifications

- **Input Bearing Specifications and Checking Procedure**
- **Maximum radial load (F_{radial})**
- **Maximum moment load (M_{moment})**
- **Efficiency (%)**
- **Reduction ratio**
- **Time (t)**
- **Graphs 126-1 to 126-8**

#### Gearhead Assembly

- **Gearhead with D bearing (double sealed)**
- **Input flange edge**
- **Shaft edge**

---

**Note:**

- *1 Only one line is shown because the difference between the gearhead and a bearing assembled on the input side is small.
- If moment load and axial load fluctuate, they should be converted into the average load to check the life of the bearing.
- Check that the following formulas are established in all circumstances:

\[
V = \frac{1}{2} F_{radial} \omega^2 \frac{r}{L} + \frac{1}{2} F_{axial} \omega^2 \frac{r}{L} + F_{axial} \frac{r}{L} \omega
\]

\[
T_{input} = \frac{1}{R} \left( F_{radial} \omega^2 r + F_{axial} \omega r \right)
\]

- **See Table 145-1 and -3**
- **See Fig. 146-1.**
- **Formula 146-1**
- **Formula 146-2**
- **Formula 146-3**
- **Formula 146-4**

---

**Technical Data**

- **Efficiency (%)**
- **Reduction ratio**
- **Input torque**
- **Nm**
- **N (kgf)**

---

**Input torque (Nm) and Efficiency (%)**

- **Graphs 126-9 to 126-12**

---

**Note:**

- **Input torque corresponding to output torque**
- **Gearhead (standard item)**
- **Gearhead with D bearing (double sealed)**

---

**Technical Data**

- **Efficiency (%)**
- **Reduction ratio**
- **Input torque**
- **Nm**
- **N (kgf)**

---

**Input torque (Nm) and Efficiency (%)**

- **Graphs 126-13 to 126-16**

---

**Note:**

- **Input torque corresponding to output torque**
- **Gearhead (standard item)**
- **Gearhead with D bearing (double sealed)**
**Technical Data**

### Gearhead Specifications and Checking Procedure

**Size 20**: Gearhead & Input Shaft Unit  
**HPG**

**Reduction ratio = 3, 5**  

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Efficiency %</th>
<th>Input torque (Nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>90</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>80</td>
<td>2</td>
</tr>
</tbody>
</table>

---

**Reduction ratio = 11**  

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Efficiency %</th>
<th>Input torque (Nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>80</td>
<td>2</td>
</tr>
</tbody>
</table>

---

**Reduction ratio = 15, 21**  

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Efficiency %</th>
<th>Input torque (Nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>70</td>
<td>2</td>
</tr>
<tr>
<td>21</td>
<td>60</td>
<td>3</td>
</tr>
</tbody>
</table>

---

**Reduction ratio = 33, 45**  

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Efficiency %</th>
<th>Input torque (Nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
<td>60</td>
<td>2</td>
</tr>
<tr>
<td>45</td>
<td>50</td>
<td>3</td>
</tr>
</tbody>
</table>

---

**Gearhead (standard item)**  
**Gearhead with D bearing (double sealed)**  
**Input Shaft**  
**Tn**: Input torque corresponding to output torque

---

*1 Only one line is shown because the difference between the gearhead and a bearing assembled on the input side is small.
Technical Data

Size 50: Gearhead & Input Shaft Unit  

HPG

Reduction ratio = 3, 5*2

Reduction ratio = 11*2

Reduction ratio = 15, 21*2

Reduction ratio = 33, 45

*2 Only one line is shown because the difference between the gearhead and a bearing assembled on the input side is small.

Size 65: Gearhead & Input Shaft Unit  

HPG

Reduction ratio = 4, 5*3

Reduction ratio = 12

Reduction ratio = 15, 20

Reduction ratio = 25

Reduction ratio = 40*3

Reduction ratio = 50

*3 Only one line is shown because the difference between the gearhead and a bearing assembled on the input side is small.
**Technical Data**

### Gearheads: HPG-Helical

#### Technical Data

**Technical Information / Handling Explanation**

Note: The allowable radial load of HPG series is the value of a radial load applied to the point of 20 mm from the shaft edge (input flange edge).

- The allowable axial load is the value of an axial load applied along the axis of rotation.

(1) **Checking maximum load**

- Calculate the maximum load and life of the bearing on the input side if the reducer is an HPG input shaft unit or an HPF hollow shaft unit.

#### Gearhead Specifications

<table>
<thead>
<tr>
<th>Size</th>
<th>Reduction Ratio</th>
<th>Gearhead Type</th>
<th>Efficiency %</th>
<th>Input Torque Nm</th>
<th>Output Torque Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>3, 4</td>
<td>Gearhead with D bearing (double sealed)</td>
<td>100</td>
<td>0</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gearhead with Z bearing (Double shielded)</td>
<td>90</td>
<td>0</td>
<td>1.5</td>
</tr>
<tr>
<td>14</td>
<td>5, 6</td>
<td>Gearhead with D bearing (double sealed)</td>
<td>100</td>
<td>0</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gearhead with Z bearing (Double shielded)</td>
<td>90</td>
<td>0</td>
<td>1.5</td>
</tr>
</tbody>
</table>

#### Life Calculation

- The life of the bearing is calculated using the following formulas:

- **Efficiency %**

  - See Table 145-1 and -3

- **Input Bearing Specifications and Checking Procedure**

  - See Formula 146-1

- **External load influence diagram**

  - See Fig. 146-1.
### Technical Data

#### Gearhead with D bearing (double sealed)

#### Technical Information / Handling Explanation

1. **The allowable radial load of HPG series** is the value of a radial load applied to the point of 20 mm from the shaft edge (input flange edge).

2. **The allowable axial load** is the value of an axial load applied along the axis of rotation.

#### Specification of input bearing

<table>
<thead>
<tr>
<th>Size 20</th>
<th>Gearhead</th>
<th>HPG-Helical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction ratio = 3, 4</td>
<td>$T_i$, $T_o$</td>
<td>Graph 130-1</td>
</tr>
<tr>
<td>Efficiency %</td>
<td>0 2 4 6 8 10</td>
<td></td>
</tr>
<tr>
<td>Reduction ratio = 5, 6</td>
<td>$T_i$, $T_o$</td>
<td>Graph 130-2</td>
</tr>
<tr>
<td>Efficiency %</td>
<td>0 2 4 6 8 10</td>
<td></td>
</tr>
<tr>
<td>Reduction ratio = 7, 8</td>
<td>$T_i$, $T_o$</td>
<td>Graph 130-3</td>
</tr>
<tr>
<td>Efficiency %</td>
<td>0 2 4 6 8 10</td>
<td></td>
</tr>
<tr>
<td>Reduction ratio = 9, 10</td>
<td>$T_i$, $T_o$</td>
<td>Graph 130-4</td>
</tr>
<tr>
<td>Efficiency %</td>
<td>0 2 4 6 8 10</td>
<td></td>
</tr>
</tbody>
</table>

- **Graph 130-3**
- **Graph 130-4**

#### Graph 130-7

- **Graph 130-8**

#### Table 145-1 and 145-2

<table>
<thead>
<tr>
<th>Size 32</th>
<th>Gearhead</th>
<th>HPG-Helical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction ratio = 3, 4</td>
<td>$T_i$, $T_o$</td>
<td>Graph 130-5</td>
</tr>
<tr>
<td>Efficiency %</td>
<td>0 2 4 6 8 10</td>
<td></td>
</tr>
<tr>
<td>Reduction ratio = 5, 6</td>
<td>$T_i$, $T_o$</td>
<td>Graph 130-6</td>
</tr>
<tr>
<td>Efficiency %</td>
<td>0 2 4 6 8 10</td>
<td></td>
</tr>
<tr>
<td>Reduction ratio = 7, 8</td>
<td>$T_i$, $T_o$</td>
<td>Graph 130-7</td>
</tr>
<tr>
<td>Efficiency %</td>
<td>0 2 4 6 8 10</td>
<td></td>
</tr>
<tr>
<td>Reduction ratio = 9, 10</td>
<td>$T_i$, $T_o$</td>
<td>Graph 130-8</td>
</tr>
<tr>
<td>Efficiency %</td>
<td>0 2 4 6 8 10</td>
<td></td>
</tr>
</tbody>
</table>

- **Graph 130-5**
- **Graph 130-6**

#### Table 145-3

- **Table 145-4**

---

**Note:** See Formula 146-1 and Formula 146-2 for calculations.
### Technical Information / Handling Explanation

#### Specification of input shaft bearing

**Size**

- 65
- 32

**Reduction ratio**

- 5
- 11
- 15, 21
- 21
- 33, 45

**Efficiency %**

- 90
- 60
- 40
- 50
- 20
- 10

**Input torque**

- 8600 Nm
- 335 kgf

**Max. axial load**

- 2300 Nm
- 98.5 kgf

**Allowable moment load (Mc)**

- 100 kgf

**Checking procedure**

1. Calculate the average input speed $N_i$.
2. Calculate the average moment load $F_{ai}$.
3. Calculate the life and check it.

### Technical Data

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Input torque (Nm)</th>
<th>Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>11</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>15, 21</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>21</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>33, 45</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

*$T_n$: Input torque corresponding to output torque

$N_i$: Average input speed

$F_{ai}$: Average moment load

$L_{10}$: Life
Technical Data

**Size 50 RA5**: Right Angle Gearhead  
HPG

**Reduction ratio = 5**

![Graph 132-1](image)

Efficiency %

<table>
<thead>
<tr>
<th>Input torque (Nm)</th>
<th>0</th>
<th>20</th>
<th>40</th>
<th>60</th>
<th>80</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reduction ratio = 11**

![Graph 132-2](image)

Efficiency %

<table>
<thead>
<tr>
<th>Input torque (Nm)</th>
<th>0</th>
<th>20</th>
<th>40</th>
<th>60</th>
<th>80</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reduction ratio = 15, 21**

![Graph 132-3](image)

Efficiency %

<table>
<thead>
<tr>
<th>Input torque (Nm)</th>
<th>0</th>
<th>20</th>
<th>40</th>
<th>60</th>
<th>80</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reduction ratio = 33, 45**

![Graph 132-4](image)

Efficiency %

<table>
<thead>
<tr>
<th>Input torque (Nm)</th>
<th>0</th>
<th>20</th>
<th>40</th>
<th>60</th>
<th>80</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Size 65 RA5**: Right Angle Gearhead  
HPG

**Reduction ratio = 5**

![Graph 132-5](image)

Efficiency %

<table>
<thead>
<tr>
<th>Input torque (Nm)</th>
<th>0</th>
<th>20</th>
<th>40</th>
<th>60</th>
<th>80</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reduction ratio = 12, 15**

![Graph 132-6](image)

Efficiency %

<table>
<thead>
<tr>
<th>Input torque (Nm)</th>
<th>0</th>
<th>20</th>
<th>40</th>
<th>60</th>
<th>80</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reduction ratio = 20, 25**

![Graph 132-7](image)

Efficiency %

<table>
<thead>
<tr>
<th>Input torque (Nm)</th>
<th>0</th>
<th>20</th>
<th>40</th>
<th>60</th>
<th>80</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reduction ratio = 40, 50**

![Graph 132-8](image)

Efficiency %

<table>
<thead>
<tr>
<th>Input torque (Nm)</th>
<th>0</th>
<th>20</th>
<th>40</th>
<th>60</th>
<th>80</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Tn**: Input torque corresponding to output torque.
## Technical Data

### Size 11A: Gearhead

#### HPN

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Graph</th>
<th>Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>133-1</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>133-2</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>133-3</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Graph</th>
<th>Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>133-4</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Graph</th>
<th>Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>133-5</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Graph</th>
<th>Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>133-6</td>
<td></td>
</tr>
</tbody>
</table>

### Size 14A: Gearhead

#### HPN

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Graph</th>
<th>Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>133-9</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Graph</th>
<th>Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>133-10</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Graph</th>
<th>Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>133-11</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Graph</th>
<th>Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>133-12</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Graph</th>
<th>Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>133-13</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Graph</th>
<th>Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>133-14</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Graph</th>
<th>Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>133-15</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Graph</th>
<th>Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>133-16</td>
<td></td>
</tr>
</tbody>
</table>
Technical Data

**Size 20A**: Gearhead

**Reduction ratio = 3**

**Graph 134-1**

![Graph 134-1](image1.png)

**Reduction ratio = 4**

**Graph 134-2**

![Graph 134-2](image2.png)

**Reduction ratio = 5**

**Graph 134-3**

![Graph 134-3](image3.png)

**Reduction ratio = 7**

**Graph 134-4**

![Graph 134-4](image4.png)

**Reduction ratio = 10**

**Graph 134-5**

![Graph 134-5](image5.png)

**Reduction ratio = 13**

**Graph 134-6**

![Graph 134-6](image6.png)

**Reduction ratio = 21**

**Graph 134-7**

![Graph 134-7](image7.png)

**Reduction ratio = 31**

**Graph 134-8**

![Graph 134-8](image8.png)

**Size 32A**: Gearhead

**Reduction ratio = 3**

**Graph 134-9**

![Graph 134-9](image9.png)

**Reduction ratio = 4**

**Graph 134-10**

![Graph 134-10](image10.png)

**Reduction ratio = 5**

**Graph 134-11**

![Graph 134-11](image11.png)

**Reduction ratio = 7**

**Graph 134-12**

![Graph 134-12](image12.png)

**Reduction ratio = 10**

**Graph 134-13**

![Graph 134-13](image13.png)

**Reduction ratio = 13**

**Graph 134-14**

![Graph 134-14](image14.png)

**Reduction ratio = 21**

**Graph 134-15**

![Graph 134-15](image15.png)

**Reduction ratio = 31**

**Graph 134-16**

![Graph 134-16](image16.png)
Checking maximum load

Checking the life

Check the maximum load and life of the bearing on the input side if the reducer is an HPG input shaft unit or an HPF hollow.

Specification of input shaft bearing

Average input speed (N):

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>210</th>
<th>2700</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nm</td>
<td>600</td>
<td>800</td>
</tr>
<tr>
<td>5200</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Maximum radial load (Fri):

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>210</th>
<th>2700</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nm</td>
<td>67</td>
<td>89</td>
</tr>
<tr>
<td>2050</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Basic load rating (max):

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>210</th>
<th>2700</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nm</td>
<td>67</td>
<td>89</td>
</tr>
<tr>
<td>2050</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If moment load and axial load fluctuate, they should be converted into the average load to check the life of the bearing.

Calculating life of input bearing

\[ \text{Average moment load, average axial load, average input speed} \]

\[ \text{Efficiency} = \frac{\text{Input torque}}{\text{Output torque}} \]

Reduction ratio = 3

Graph 135-1

Input torque Nm

Efficiency %

Reduction ratio = 4

Graph 135-2

Input torque Nm

Efficiency %

Reduction ratio = 5

Graph 135-3

Input torque Nm

Efficiency %

Reduction ratio = 7

Graph 135-4

Input torque Nm

Efficiency %

Reduction ratio = 10

Graph 135-5

Input torque Nm

Efficiency %

Reduction ratio = 13

Graph 135-6

Input torque Nm

Efficiency %

Reduction ratio = 21

Graph 135-7

Input torque Nm

Efficiency %

Reduction ratio = 31

Graph 135-8

Input torque Nm

Efficiency %
Technical Information / Handling Explanation

Reduction ratio = 11

Size 25: Hollow Shaft Unit

Reduction ratio = 11

Size 32: Hollow Shaft Unit

Graph 136-1

Graph 136-2

Note

*2 The allowable radial load of HPG series is the value of a radial load applied at the mid-point of the input shaft.

*1 The allowable axial load is the value of an axial load applied along the axis of rotation.

(1) Checking maximum load
(2) Checking the life

Check the maximum load and life of the bearing on the input side if the reducer is an HPG input shaft unit or an HPF hollow shaft unit.

Input Bearing Specifications and Checking Procedure

<table>
<thead>
<tr>
<th>Size</th>
<th>Hollow Shaft Unit</th>
<th>HPF</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Technical Data

Table 145-2

Table 145-1

Table 145-3

Table 145-4

Reduction ratio = 11

Reduction ratio = 11

Size 25: Hollow Shaft Unit

HPF

Efficiency %

50

30

90

100

40

60

80

0 1 2 3 4 5 6

Input torque Nm

Graph 146-1

Graph 146-2

Efficiency %

50

30

90

100

40

60

80

0 1 2 3 4 5 6

Input torque Nm

Technical Data

Input Bearing Specifications and Checking Procedure

<table>
<thead>
<tr>
<th>Specification of input shaft bearing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size 65 RA5</td>
</tr>
</tbody>
</table>

Maximum radial load (Frimax) ≤ 2000 kgf

Average input speed (Niav) = 1000 rpm

Average axial load (Faiav) ≤ 100 kgf

Maximum moment load (Miimax) ≤ 2000 Nm

Allowable moment load (Mc) ≤ 1000 Nm

Allowable axial load (Fac) ≤ 100 kgf

Allowable radial load (Frc) ≤ 2000 kgf

Allowable dynamic load rating (Cr) ≤ 1000 kgf

Allowable static load rating (Cor) ≤ 1000 kgf

Basic dynamic load rating (Cr) = 2000 kgf

Basic static load rating (Cor) = 1000 kgf

How to calculate the maximum moment load (Miimax):

Miimax = 0.053 × Mi + 0.109 × Mi + 0.444 × Mi + 1.232 × Fai + 1.426 × Fai

How to calculate the average axial load (Faiav):

Faiav = 0.053 × Mi + 0.109 × Mi + 0.444 × Mi + 1.232 × Fai

See Table 145-1 and -3

Calculating life of input bearing

Calculating formula:

Life (L) = Pci × Cor / (2 × 10^6)

Pci = 9.88 × 10^6 N

Calculating formula:

L = (9.88 × 10^6 N) × 1000 rpm / (2 × 10^6)

L = 4940 hours

Calculating life of input bearing:

L = 4940 hours

See Formula 146-3

10 20 30 40 50 60 70 80 90 100

Efficiency %

0 20 40 60 80 100

Graph 146-1

Graph 146-2

100

90

80

70

60

50

40

30

20

10

0

0 1 2 3 4 5 6

Input torque Nm

Reduction ratio = 11

Reduction ratio = 11
The allowable radial load of HPG series is the value of a radial load applied at the mid-point of the input shaft.

The allowable axial load is the value of an axial load applied along the axis of rotation.

**Specification of input shaft bearing**

**Specification of input bearing**

<table>
<thead>
<tr>
<th>Size</th>
<th>Size</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>32</td>
<td>11</td>
<td>11</td>
</tr>
</tbody>
</table>

**Checking procedure**

<table>
<thead>
<tr>
<th>Size</th>
<th>Size</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>25</td>
<td>11</td>
</tr>
<tr>
<td>32</td>
<td>11</td>
<td>11</td>
</tr>
</tbody>
</table>

Maximum axial load (\(F_{ai}\))

Maximum moment load (\(M_{i}\))

Average input speed (\(N_{i}\))

Average axial load (\(F_{ai}\))

Calculate:

Average input speed (\(N_{i}\))

500 rpm

600 rpm

1000 rpm

2000 rpm

3500 rpm

**Technical Data**

Input rotational speed

- 500 rpm
- 1000 rpm
- 2000 rpm
- 3500 rpm

**Graphs**

- Graph 137-1
- Graph 137-2
- Graph 137-3
- Graph 137-4
- Graph 137-5
- Graph 137-6
- Graph 137-7
- Graph 137-8
Technical Data

Size 32: Gearhead  CSG-GH  CSF-GH

Reduction ratio = 50  Reduction ratio = 80  Reduction ratio = 100

Graph 138-1  Graph 138-2  Graph 138-3

Input rotational speed  500 rpm  1000 rpm  2000 rpm  3500 rpm

Graph 138-4  Graph 138-5

Graph 138-6  Graph 138-7  Graph 138-8

Input rotational speed  500 rpm  1000 rpm  2000 rpm  3500 rpm

Reduction ratio = 120  Reduction ratio = 160

Graph 138-9  Graph 138-10

Size 45: Gearhead  CSG-GH  CSF-GH

Reduction ratio = 50  Reduction ratio = 80  Reduction ratio = 100

Graph 138-6  Graph 138-7  Graph 138-8

Input rotational speed  500 rpm  1000 rpm  2000 rpm  3500 rpm

Graph 138-9  Graph 138-10

Reduction ratio = 120  Reduction ratio = 160

Graph 138-9  Graph 138-10

Input rotational speed  500 rpm  1000 rpm  2000 rpm  3500 rpm
**Technical Data**

**Size 65**

**Gearhead**  
CSG-GH  
CSF-GH

---

### Technical Information / Handling Explanation

#### Note

1. **The allowable radial load of HPG series is the value of a radial load applied to the point of 20 mm from the shaft edge (input flange edge).**

#### Checking the Life of Input Bearing

**Input Bearing Specifications and Checking Procedure**

<table>
<thead>
<tr>
<th>Size 65</th>
<th>20</th>
<th>25</th>
<th>32</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>20</td>
<td>25</td>
<td>32</td>
</tr>
<tr>
<td>32</td>
<td>11</td>
<td>14</td>
<td>11</td>
</tr>
</tbody>
</table>

**Maximum radial load** $(F_{ri})$

$$F_{ri} = \text{Maximum radial load}$$

**Maximum axial load** $(F_{ai})$

$$F_{ai} = \text{Maximum axial load}$$

**Maximum moment load** $(M_{mi})$

$$M_{mi} = \text{Maximum moment load}$$

#### Checking Procedure

1. **Calculate:**

   - Average axial load $(F_{ai})$
   - Average moment load $(M_{mi})$

2. **Calculate the life and check it.**

3. **See Table 145-1 and 145-3**

#### Technical Data

**HPG HPF**

<table>
<thead>
<tr>
<th>Gearhead</th>
<th>Reduction ratio</th>
<th>Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSF-GH</td>
<td>80</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>110</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>120</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>130</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>140</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>100</td>
</tr>
</tbody>
</table>

**Input rotational speed**

- 500 rpm
- 1000 rpm
- 2000 rpm
- 3500 rpm

---

**Graphs**

- **Graph 139-1**
- **Graph 139-2**
- **Graph 139-3**
- **Graph 139-4**

Input torque Ncm

**Input torque** $(N_{cm})$

$$N_{cm} = \text{Input torque}$$

**Graphs**

- **Graph 139-1**
- **Graph 139-2**
- **Graph 139-3**
- **Graph 139-4**

Input rotational speed

- 500 rpm
- 1000 rpm
- 2000 rpm
- 3500 rpm

---

**Technical Information / Handling Explanation**

---

---
Output Shaft Bearing Load Limits

HPN uses radial ball bearings to support the output shaft. Please use the curve on the graph for the appropriate load coefficient (fw) that represents the expected operating condition.

Output shaft speed - 100 rpm, bearing life is based on 20,000 hours. The load-point is based on shaft center of radial load and axial load.
### Output Bearing Specifications and Checking Procedure

HPGP, HPG, HPG Helical, CSF-GH, CSG-GH, HPF, and HPG-U1 are equipped with cross roller bearings. A precision cross roller bearing supports the external load (output flange).

Check the maximum load, moment load, life of the bearing and static safety coefficient to maximize performance.

#### Checking procedure

1. **Checking the maximum moment load**

   Calculate the maximum moment load \( M_{\text{max}} \) \[ M_{\text{max}} \leq M_{\text{c}} \] Permissible moment \( M_{\text{c}} \)

2. **Checking the life**

   Calculate the average radial load \( F_{\text{av}} \) and the average axial load \( F_{\text{av}} \).

3. **Checking the static safety coefficient**

   Calculate the static equivalent radial load coefficient \( F_{\text{av}} \).

#### Specification of output bearing

| HPG/HPG Series | Tables 141-1, -2 and -3 indicate the cross roller bearing specifications for in-line, right angle and input shaft gears. |

<table>
<thead>
<tr>
<th>Size</th>
<th>Pitch circle ( dp )</th>
<th>Offset amount ( R )</th>
<th>Basic dynamic load rating ( C )</th>
<th>Basic static load rating ( C_0 )</th>
<th>Allowable moment load ( M_{\text{c}} )</th>
<th>Moment stiffness ( K_{\text{m}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \text{Nm} )</td>
<td>( \text{kgf} )</td>
<td>( \times 10^5 ) ( \text{Nm/rad} )</td>
<td>( \text{kgf/arc min} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>0.0275</td>
<td>0.006</td>
<td>3116</td>
<td>318</td>
<td>4087</td>
<td>417</td>
</tr>
<tr>
<td>14</td>
<td>0.0405</td>
<td>0.011</td>
<td>5110</td>
<td>521</td>
<td>7060</td>
<td>720</td>
</tr>
<tr>
<td>20</td>
<td>0.064</td>
<td>0.0115</td>
<td>10600</td>
<td>1082</td>
<td>17300</td>
<td>1765</td>
</tr>
<tr>
<td>32</td>
<td>0.085</td>
<td>0.014</td>
<td>20500</td>
<td>2092</td>
<td>32800</td>
<td>3347</td>
</tr>
<tr>
<td>50</td>
<td>0.123</td>
<td>0.019</td>
<td>41600</td>
<td>4245</td>
<td>76000</td>
<td>7755</td>
</tr>
<tr>
<td>65</td>
<td>0.170</td>
<td>0.023</td>
<td>90600</td>
<td>9245</td>
<td>148000</td>
<td>15102</td>
</tr>
</tbody>
</table>

#### Technical Information / Handling Explanation

*1 The allowable axial load is the value of an axial load applied along the axis of rotation.

*2 Check the maximum load and life of the bearing on the input side if the reducer is an HPG input shaft unit or an HPF hollow input bearing.

*4 The value of the moment stiffness is the average value.

*5 The allowable radial load and allowable axial load are the values that satisfy the life of a speed reducer when a pure radial load or an axial load applies to the main bearing. \( (L_r + R = 0 \text{ mm for radial load and } L_a = 0 \text{ mm for axial load}) \) If a compound load applies, refer to the calculations shown on the next page.

---

**Note:**

1. The basic dynamic load rating means a certain static radial load so that the basic dynamic rated life of the roller bearing is a million rotations.
2. The basic static load rating means a static load that gives a certain level of contact stress (4kN/mm²) in the center of the contact area between rolling element receiving the maximum load and orbit.
3. The allowable moment load is a maximum moment load applied to the bearing. Within the allowable range, basic performance is maintained and the bearing is operable. Check the bearing life based on the calculations shown on the next page.
4. The value of the moment stiffness is the average value.
5. The allowable radial load and allowable axial load are the values that satisfy the life of a speed reducer when a pure radial load or an axial load applies to the main bearing. \( (L_r + R = 0 \text{ mm for radial load and } L_a = 0 \text{ mm for axial load}) \) If a compound load applies, refer to the calculations shown on the next page.
### Technical Data

#### CSG-GH/CSF-GH Series

Table 142-1 indicates the specifications for cross roller bearing.

<table>
<thead>
<tr>
<th>Size</th>
<th>Pitch circle</th>
<th>Offset amount</th>
<th>Basic load rating</th>
<th>Allowable moment load Mc*3</th>
<th>Moment stiffness Km*4</th>
<th>Allowable axial load*5</th>
<th>Allowable radial load*5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>dp R</td>
<td>N kgf</td>
<td>N kgf</td>
<td>x10⁴ Nm/rad</td>
<td>kgf/arc min</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>14</td>
<td>0.0405 0.011</td>
<td>5110 521</td>
<td>7060 720</td>
<td>27 2.76</td>
<td>3.0 0.89</td>
<td>732</td>
<td>1093</td>
</tr>
<tr>
<td>20</td>
<td>0.064 0.0115</td>
<td>10600 1082</td>
<td>17300 1765</td>
<td>145 14.8</td>
<td>17 5.0</td>
<td>1519</td>
<td>2267</td>
</tr>
<tr>
<td>32</td>
<td>0.065 0.014</td>
<td>20500 2092</td>
<td>32800 3347</td>
<td>258 26.3</td>
<td>42 12.0</td>
<td>2938</td>
<td>4385</td>
</tr>
<tr>
<td>45</td>
<td>0.123 0.019</td>
<td>41600 4245</td>
<td>76000 7755</td>
<td>797 81.3</td>
<td>100 30.0</td>
<td>5962</td>
<td>8899</td>
</tr>
<tr>
<td>65</td>
<td>0.170 0.0225</td>
<td>81600 8327</td>
<td>149000 15204</td>
<td>2156 220</td>
<td>323 96.0</td>
<td>11693</td>
<td>17454</td>
</tr>
</tbody>
</table>

#### HPF Series

Table 142-2 indicates the specifications for cross roller bearing.

<table>
<thead>
<tr>
<th>Size</th>
<th>Pitch circle</th>
<th>Offset amount</th>
<th>Basic load rating</th>
<th>Allowable moment load Mc*3</th>
<th>Moment stiffness Km*4</th>
<th>Allowable axial load*5</th>
<th>Allowable radial load*5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>dp R</td>
<td>N kgf</td>
<td>N kgf</td>
<td>x10⁴ Nm/rad</td>
<td>kgf/arc min</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>25</td>
<td>0.085 0.0153</td>
<td>11400 1163</td>
<td>20300 2071</td>
<td>410 41.8</td>
<td>37.9 11.3</td>
<td>1330</td>
<td>1990</td>
</tr>
<tr>
<td>32</td>
<td>0.1115 0.015</td>
<td>22500 2296</td>
<td>39900 4071</td>
<td>932 95</td>
<td>86.1 25.7</td>
<td>2640</td>
<td>3940</td>
</tr>
</tbody>
</table>

(Note: Table 142-1 and 2

*1 The basic dynamic load rating means a certain static radial load so that the basic dynamic rated life of the roller bearing is a million rotations.

*2 The basic static load rating means a static load that gives a certain level of contact stress (4kN/mm²) in the center of the contact area between rolling element receiving the maximum load and orbit.

*3 The allowable moment load is a maximum moment load applied to the bearing. Within the allowable range, basic performance is maintained and the bearing is operable. Check the bearing life based on the calculations shown on the next page.

*4 The value of the moment stiffness is the average value.

*5 The allowable radial load and allowable axial load are the values that satisfy the life of a speed reducer when a pure radial load or an axial load applies to the main bearing. (Lr + R = 0 mm for radial load and La = 0 mm for axial load) If a compound load applies, refer to the calculations shown on the next page.
How to calculate the maximum moment load

Maximum moment load \( (M_{\text{max}}) \) is obtained as follows. Make sure that \( M_{\text{max}} \leq M_c \).

\[
M_{\text{max}} = F_{r_{\text{max}}} \left( L_r+R \right) + F_{a_{\text{max}}} \max \ La
\]

Where:
- \( F_{r_{\text{max}}} \): Max. radial load \( N \) (kgf)
- \( F_{a_{\text{max}}} \): Max. axial load \( N \) (kgf)
- \( L_r, La \): \( m \) See Fig. 143-1.
- \( R \): Offset amount \( m \) See Fig. 143-1.
- \( \text{dp} \): Circular pitch of roller \( m \) See Fig. 143-1.

\[
F_{r_{\text{av}}} = \frac{\text{Fr}_{\text{av}} + 2 \left( F_{r_{\text{av}}}(L_r+R) + F_{a_{\text{av}}}(La) \right)}{\text{dp}} \leq 1.5
\]

\[
F_{a_{\text{av}}} = \frac{\text{Fr}_{\text{av}} + 2 \left( F_{r_{\text{av}}}(L_r+R) + F_{a_{\text{av}}}(La) \right)}{\text{dp}} > 1.5
\]

How to calculate the radial and the axial load coefficient

The radial load coefficient \( (X) \) and the axial load coefficient \( (Y) \)

\[
X = \frac{1}{1.5} \quad Y = 0.45
\]

\[
X = \frac{0.67}{1.5} \quad Y = 0.67
\]

How to calculate the average load (Average radial load, average axial load, average output speed)

If the radial load and the axial load fluctuate, they should be converted into the average load to check the life of the cross roller bearing.

**How to obtain the average radial load \( \left( F_{r_{\text{av}}} \right) \)**

\[
F_{r_{\text{av}}} = \left( \frac{n_1 (F_{r_1})^{10/3} + n_2 (F_{r_2})^{10/3} + \ldots + n_t (F_{r_t})^{10/3}}{n_1 + n_2 + \ldots + n_t} \right)^{3/10}
\]

Note that the maximum radial load within the \( t_1 \) section is \( F_{r_1} \) and the maximum radial load within the \( t_t \) section is \( F_{r_t} \).

**How to obtain the average axial load \( \left( F_{a_{\text{av}}} \right) \)**

\[
F_{a_{\text{av}}} = \left( \frac{n_1 (F_{a_1})^{10/3} + n_2 (F_{a_2})^{10/3} + \ldots + n_t (F_{a_t})^{10/3}}{n_1 + n_2 + \ldots + n_t} \right)^{3/10}
\]

Note that the maximum axial load within the \( t_1 \) section is \( F_{a_1} \) and the maximum axial load within the \( t_t \) section is \( F_{a_t} \).

**How to obtain the average output speed \( \left( N_{\text{av}} \right) \)**

\[
N_{\text{av}} = \frac{n_1 + n_2 + \ldots + n_t}{t_1 + t_2 + \ldots + t_t}
\]
How to calculate the life

Calculate the life of the cross roller bearing using Formula 144-1. You can obtain the dynamic equivalent load \( P_c \) using Formula 144-2.

\[
L_{oc} = \frac{10^6}{60 \times n_{av}} \times \left( \frac{C}{f_w \times P_c} \right)^{1/3}
\]

*Note: When the oscillating angle is small (5° or less), it is difficult to generate an oil film on the contact surface of the orbit ring and the rolling element and fretting corrosion may develop.*

In general, the basic static load rating \( C_0 \) is considered to be the permissible limit of the static equivalent load. However, obtain the limit based on the operating and required conditions. Calculate the static safety coefficient \( f_s \) of the cross roller bearing using Formula 144-4.

\[
f_s = \frac{C_0}{P_0}
\]

<table>
<thead>
<tr>
<th>Load status</th>
<th>( f_s )</th>
</tr>
</thead>
<tbody>
<tr>
<td>When high precision is required</td>
<td>( \geq 3 )</td>
</tr>
<tr>
<td>When impact or vibration is expected</td>
<td>( \geq 2 )</td>
</tr>
<tr>
<td>Under normal operating condition</td>
<td>( \geq 1.5 )</td>
</tr>
</tbody>
</table>

How to calculate the static safety coefficient

General values under the operating condition are shown in Table 144-2. You can calculate the static equivalent load \( P_0 \) using Formula 144-5.

\[
P_0 = \frac{F_r \times \max + 2M_{\max} + 0.44F_{a\max}}{dp} + 0.44M_{\max}
\]

<table>
<thead>
<tr>
<th>Load status</th>
<th>( f_s )</th>
</tr>
</thead>
<tbody>
<tr>
<td>When high precision is required</td>
<td>( \geq 3 )</td>
</tr>
<tr>
<td>When impact or vibration is expected</td>
<td>( \geq 2 )</td>
</tr>
<tr>
<td>Under normal operating condition</td>
<td>( \geq 1.5 )</td>
</tr>
</tbody>
</table>

Note:

- Time  
- Allowable moment load \( M_{\max} \)  
- Allowable axial load \( F_{a\max} \)  
- Allowable radial load \( F_{r\max} \)

When it is used for a long time while the rotation speed of the output shaft is in the ultra-low operation range (0.02rpm or less), the lubrication of the bearing becomes insufficient, resulting in deterioration of the bearing or increased load in the output side. When using it in the ultra-low operation range, contact us.
Input Bearing Specifications and Checking Procedure

Check the maximum load and life of the bearing on the input side if the reducer is an HPG input shaft unit or an HPF hollow shaft unit.

**Checking procedure**

(1) Checking maximum load

Calculate:
- Maximum moment load (\(M_{max}\))
- Maximum axial load (\(F_{ax} \))
- Maximum radial load (\(F_{ri} \))

Maximum moment load (\(M_{max}\)) \(\leq\) Allowable moment load (\(M_{c}\))
Maximum axial load (\(F_{ax} \)) \(\leq\) Allowable axial load (\(F_{ac} \))
Maximum radial load (\(F_{ri} \)) \(\leq\) Allowable radial load (\(F_{rc} \))

(2) Checking the life

Calculate:
- Average moment load (\(M_{av} \))
- Average axial load (\(F_{av} \))
- Average input speed (\(N_{iav} \))

Calculate the life and check it.

**Specification of input bearing**

### Specification of input bearing

#### HPG

<table>
<thead>
<tr>
<th>Size</th>
<th>Basic dynamic load rating</th>
<th>Basic static load rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cr</td>
<td>Cor</td>
</tr>
<tr>
<td></td>
<td>N (kgf)</td>
<td>N (kgf)</td>
</tr>
<tr>
<td>11</td>
<td>2700</td>
<td>275</td>
</tr>
<tr>
<td>14</td>
<td>5800</td>
<td>590</td>
</tr>
<tr>
<td>20</td>
<td>9700</td>
<td>990</td>
</tr>
<tr>
<td>32</td>
<td>22500</td>
<td>2300</td>
</tr>
<tr>
<td>50</td>
<td>35500</td>
<td>3600</td>
</tr>
<tr>
<td>65</td>
<td>51000</td>
<td>5200</td>
</tr>
</tbody>
</table>

#### HPF

<table>
<thead>
<tr>
<th>Size</th>
<th>Allowable moment load</th>
<th>Allowable axial load</th>
<th>Allowable radial load</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(M_{c}) (Nm)</td>
<td>(F_{ac}) (N)</td>
<td>(F_{rc}) (N)</td>
</tr>
<tr>
<td>11</td>
<td>0.16</td>
<td>245</td>
<td>25</td>
</tr>
<tr>
<td>14</td>
<td>6.3</td>
<td>1206</td>
<td>123</td>
</tr>
<tr>
<td>20</td>
<td>13.5</td>
<td>3285</td>
<td>335</td>
</tr>
<tr>
<td>32</td>
<td>44.4</td>
<td>5540</td>
<td>565</td>
</tr>
<tr>
<td>50</td>
<td>96.9</td>
<td>8600</td>
<td>878</td>
</tr>
<tr>
<td>65</td>
<td>210</td>
<td>21.4</td>
<td>180</td>
</tr>
</tbody>
</table>

**Technical Data**

See Table 145-1 and -3

See Table 146-1 and -2

### Technical Information / Handling Explanation

*3 The allowable radial load of HPG series is the value of a radial load applied to the point of 20 mm from the shaft edge (input flange edge).
Technical Information / Handling Explanation

### Calculating maximum moment load ON input shaft

The maximum moment load \( (M_{\text{max}}) \) is calculated as follows. Check that the following formulas are established in all circumstances:

\[
M_{\text{max}} = F_{\text{max radial}} \cdot L_{\text{ri}} + F_{\text{max axial}} \cdot L_{\text{ai}}
\]

- \( F_{\text{max radial}} \): Max. radial load (N (kgf))
- \( F_{\text{max axial}} \): Max. axial load (N (kgf))
- \( L_{\text{ri}}, L_{\text{ai}} \): Time (m) See Fig. 146-1.

\[
M_{\text{max}} \leq M_{\text{c}} \text{ (Allowable moment load)}
\]

\[
F_{\text{max axial}} \leq F_{\text{c}} \text{ (Allowable axial load)}
\]

### How to calculate average load
(Average moment load, average axial load, average input speed)

If moment load and axial load fluctuate, they should be converted into the average load to check the life of the bearing.

#### How to calculate the average moment load \( (M_{\text{av}}) \)

\[
M_{\text{av}} = \frac{n_{\text{t1}} (M_{1})^{3} + n_{\text{t2}} (M_{2})^{3} + \ldots + n_{\text{tn}} (M_{n})^{3}}{n_{\text{t1}} + n_{\text{t2}} + \ldots + n_{\text{tn}}}
\]

#### How to calculate the average axial load \( (F_{\text{av}}) \)

\[
F_{\text{av}} = \frac{n_{\text{t1}} (F_{1})^{3} + n_{\text{t2}} (F_{2})^{3} + \ldots + n_{\text{tn}} (F_{n})^{3}}{n_{\text{t1}} + n_{\text{t2}} + \ldots + n_{\text{tn}}}
\]

#### How to calculate the average input speed \( (N_{\text{av}}) \)

\[
N_{\text{av}} = \frac{n_{\text{t1}} + n_{\text{t2}} + \ldots + n_{\text{tn}}}{t_{1} + t_{2} + \ldots + t_{n}}
\]

### Calculating life of input bearing

Calculate the bearing life according to Calculation Formula 132-5 and check the life.

\[
L_{\text{VI}} = \frac{10^{6}}{60 \times N_{\text{av}}} \times \left( \frac{C_{\text{r}}}{{P}_{\text{ci}}} \right)^{3}
\]

- \( L_{\text{VI}} \): Life (Hour)
- \( N_{\text{av}} \): Average input speed (rpm) See Formula 146-4
- \( C_{\text{r}} \): Basic dynamic load rating (N (kgf)) See Table 145-1 and -3
- \( {P}_{\text{ci}} \): Dynamic equivalent load (N) See Table 146-1 and -2

### Dynamic equivalent load

#### HPG

<table>
<thead>
<tr>
<th>Size</th>
<th>Pci</th>
<th>HPG</th>
<th>Table 146-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>0.444 x M_{\text{av}} + 1,426 x F_{\text{av}}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>0.137 x M_{\text{av}} + 1,232 x F_{\text{av}}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>0.109 x M_{\text{av}} + 1,232 x F_{\text{av}}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>0.071 x M_{\text{av}} + 1,232 x F_{\text{av}}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>0.053 x M_{\text{av}} + 1,232 x F_{\text{av}}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>0.041 x M_{\text{av}} + 1,232 x F_{\text{av}}</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### HPF

<table>
<thead>
<tr>
<th>Size</th>
<th>Pci</th>
<th>HPF</th>
<th>Table 146-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>121 x M_{\text{av}} + 2.7 x F_{\text{av}}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>106 x M_{\text{av}} + 2.7 x F_{\text{av}}</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( M_{\text{av}} \): Average moment load Nm (kgfm) See Formula 146-2
\( F_{\text{av}} \): Average axial load N (kgf) See Formula 146-3
Assembly

Assemble and mount your gearhead in accordance with these instructions to achieve the best performance. Be sure to use the recommended bolts and use a torque wrench to achieve the proper tightening torques as recommended in tables below.

Motor assembly procedure

To properly mount the motor to the gearhead, follow the procedure outlined below, refer figure 147-1.

1. Turn the input shaft coupling and align the bolt head with the rubber cap hole.

2. With the speed reducer in an upright position as illustrated in the figure below, slowly insert the motor shaft into the coupling of speed reducer. Slide the motor shaft without letting it drop down. If the speed reducer cannot be positioned upright, slowly insert the motor shaft into the coupling of speed reducer, then tighten the motor bolts evenly until the motor flange and gearhead flange are in full contact. Exercise care to avoid tilting the motor when inserting it into the gear head.

3. Tighten the input shaft coupling bolt to the recommended torque specified in the table below. The bolt(s) or screw(s) is (are) already inserted into the input coupling when delivered. Check the bolt size on the confirmation drawing provided.

4. Fasten the motor to the gearhead flange with bolts.

5. Insert the rubber cap provided. This completes the assembly. (Size 11: Fasten screws with a gasket in two places)

<table>
<thead>
<tr>
<th>Bolt tightening torque</th>
<th>Table 147-1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bolt size</strong></td>
<td>M3</td>
</tr>
<tr>
<td><strong>Tightening torque</strong></td>
<td>Nm</td>
</tr>
<tr>
<td></td>
<td>kgfm</td>
</tr>
</tbody>
</table>

Caution: Always tighten the bolts to the tightening torque specified in the table above. If the bolt is not tightened to the torque value recommended slippage of the motor shaft in the shaft coupling may occur. The bolt size will vary depending on the size of the gear and the shaft diameter of the mounted motor. Check the bolt size on the confirmation drawing provided.

Two setscrews need to be tightened on size 11. See the outline dimensions on page 22 (HPGP) and page 34 (HPG standard) and page 46 (HP helical). Tighten the screws to the tightening torque specified below.

<table>
<thead>
<tr>
<th>Bolt tightening torque</th>
<th>Table 147-2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bolt size</strong></td>
<td>M3</td>
</tr>
<tr>
<td><strong>Tightening torque</strong></td>
<td>Nm</td>
</tr>
<tr>
<td></td>
<td>kgfm</td>
</tr>
</tbody>
</table>

(4) Fasten the motor to the gearhead flange with bolts.

<table>
<thead>
<tr>
<th>Bolt tightening torque</th>
<th>Table 147-3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bolt size</strong></td>
<td>M2.5</td>
</tr>
<tr>
<td><strong>Tightening torque</strong></td>
<td>Nm</td>
</tr>
<tr>
<td></td>
<td>kgfm</td>
</tr>
</tbody>
</table>

*Recommended bolt: JIS B 1176 Hexagon socket head bolt, Strength: JIS B 1051 12.9 or higher

Caution: Be sure to tighten the bolts to the tightening torques specified in the table.

Assembly Instructions

See Table 145-1 and -3

Bolt size

Transmission torque

Mounting PCD

Bolt size

Tightening torque

Number of bolts

Transmission torque

Bolt size

Bolt tightening torque
Some right angle gearhead models weigh as much as 60 kg. No thread for an eyebolt is provided because the mounting orientation varies depending on the customer’s needs. When mounting the reducer, hoist it using a sling paying extreme attention to safety.

When assembling gearheads into your equipment, check the flatness of your mounting surface and look for any burrs on tapped holes. Then fasten the flange (Part A in the diagram below) using appropriate bolts.

**Bolt** tightening torque for flange (Part A in the diagram below)

<table>
<thead>
<tr>
<th>Size</th>
<th>HPN</th>
<th>HPG</th>
<th>CSG-GH</th>
<th>CSF-GH</th>
<th>HPF</th>
<th>HPGP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>11</td>
<td>14</td>
<td>20</td>
<td>32</td>
<td>40</td>
<td>11</td>
</tr>
<tr>
<td>Number of bolts</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Bolt size</td>
<td>M3</td>
<td>M5</td>
<td>M6</td>
<td>M8</td>
<td>M10</td>
<td>M3</td>
</tr>
<tr>
<td>Mounting PCD</td>
<td>mm</td>
<td>50</td>
<td>70</td>
<td>100</td>
<td>130</td>
<td>165</td>
</tr>
<tr>
<td>Tightening torque</td>
<td>Nm</td>
<td>1.4</td>
<td>6.3</td>
<td>10.7</td>
<td>26.1</td>
<td>51.5</td>
</tr>
<tr>
<td>Transmission torque</td>
<td>Nm</td>
<td>27.9</td>
<td>110</td>
<td>223</td>
<td>528</td>
<td>1063</td>
</tr>
<tr>
<td></td>
<td>kgf</td>
<td>0.14</td>
<td>0.64</td>
<td>1.09</td>
<td>2.66</td>
<td>5.26</td>
</tr>
</tbody>
</table>

* Recommended bolts: JIS B 1176 "Hexagon socket head bolts." Strength classification 12.9 or higher in JIS B 1051.

### Mounting the load to the output flange

Follow the specifications in the table below when mounting the load onto the output flange.

![Diagram of output flange mounting](image)

**Output flange mounting specifications**

**Bolt** tightening torque for output flange (Part B in the Figure 148-1)

<table>
<thead>
<tr>
<th>Size</th>
<th>HPGP</th>
<th>HPG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of bolts</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Bolt size</td>
<td>M4</td>
<td>M4</td>
</tr>
<tr>
<td>Mounting PCD</td>
<td>mm</td>
<td>8</td>
</tr>
<tr>
<td>Tightening torque</td>
<td>Nm</td>
<td>4.5</td>
</tr>
<tr>
<td>Transmission torque</td>
<td>Nm</td>
<td>25.3</td>
</tr>
</tbody>
</table>

* Recommended bolts: JIS B 1176 "Hexagon socket head bolts." Strength classification 12.9 or higher in JIS B 1051.

**Bolt** tightening torque for output flange (Part B in the Figure 148-1)

<table>
<thead>
<tr>
<th>Size</th>
<th>HPG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of bolts</td>
<td>3</td>
</tr>
<tr>
<td>Bolt size</td>
<td>M4</td>
</tr>
<tr>
<td>Mounting PCD</td>
<td>mm</td>
</tr>
<tr>
<td>Tightening torque</td>
<td>Nm</td>
</tr>
<tr>
<td>Transmission torque</td>
<td>Nm</td>
</tr>
</tbody>
</table>

* Recommended bolts: JIS B 1176 "Hexagon socket head bolts." Strength classification 12.9 or higher in JIS B 1051.
### Technical Information / Handling Explanation

**Technical Data**

- **Bolt tightening torque for output flange (Part B in Figure 148-1)**

<table>
<thead>
<tr>
<th>Size</th>
<th>14</th>
<th>20</th>
<th>32</th>
<th>45</th>
<th>65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of bolts</td>
<td>8</td>
<td>8</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Bolt size</td>
<td>M4</td>
<td>M6</td>
<td>M8</td>
<td>M12</td>
<td>M16</td>
</tr>
<tr>
<td>Mounting PCD</td>
<td>mm</td>
<td>30</td>
<td>45</td>
<td>60</td>
<td>94</td>
</tr>
<tr>
<td>Tightening torque</td>
<td>Nm</td>
<td>4.5</td>
<td>15.3</td>
<td>37</td>
<td>128</td>
</tr>
<tr>
<td>Transmission torque</td>
<td>Nm</td>
<td>84</td>
<td>287</td>
<td>867</td>
<td>3067</td>
</tr>
<tr>
<td>kgf</td>
<td>8.6</td>
<td>29.3</td>
<td>88.5</td>
<td>313</td>
<td>763</td>
</tr>
</tbody>
</table>

- **Bolt tightening torque for output flange (Part B in Figure 148-1)**

<table>
<thead>
<tr>
<th>Size</th>
<th>14</th>
<th>20</th>
<th>32</th>
<th>45</th>
<th>65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of bolts</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>Bolt size</td>
<td>M4</td>
<td>M6</td>
<td>M8</td>
<td>M8</td>
<td>M16</td>
</tr>
<tr>
<td>Mounting PCD</td>
<td>mm</td>
<td>30</td>
<td>45</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>Tightening torque</td>
<td>Nm</td>
<td>4.5</td>
<td>15.3</td>
<td>37.2</td>
<td>319</td>
</tr>
<tr>
<td>kgf</td>
<td>0.46</td>
<td>1.56</td>
<td>3.80</td>
<td>3.80</td>
<td>32.5</td>
</tr>
<tr>
<td>Transmission torque</td>
<td>Nm</td>
<td>63</td>
<td>215</td>
<td>524</td>
<td>2326</td>
</tr>
<tr>
<td>kgf</td>
<td>6.5</td>
<td>21.9</td>
<td>53.4</td>
<td>237</td>
<td>610</td>
</tr>
</tbody>
</table>

- **Bolt tightening torque for output flange (Part B in Figure 148-1)**

<table>
<thead>
<tr>
<th>Size</th>
<th>25</th>
<th>32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of bolts</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Bolt size</td>
<td>M4</td>
<td>M5</td>
</tr>
<tr>
<td>Mounting PCD</td>
<td>mm</td>
<td>77</td>
</tr>
<tr>
<td>Tightening torque</td>
<td>Nm</td>
<td>4.5</td>
</tr>
<tr>
<td>kgf</td>
<td>0.46</td>
<td>0.92</td>
</tr>
<tr>
<td>Transmission torque</td>
<td>Nm</td>
<td>322</td>
</tr>
<tr>
<td>kgf</td>
<td>32.9</td>
<td>68.9</td>
</tr>
</tbody>
</table>

* Recommended bolts: JIS B 1176 "Hexagon socket head bolts." Strength classification 12.9 or higher in JIS B 1051.

**Gearheads with an output shaft**

- **Do not subject the output shaft to any impact when mounting a pulley, pinion or other parts.**
- **An impact to the output bearing may affect the speed reducer precision and may cause reduced life or failure.**
Mechanical Tolerances

Superior mechanical precision is achieved by integrating the output flange with a high-precision cross roller bearing as a single component. The mechanical tolerances of the output shaft and mounting flange are specified below.

### Output Flange: F0 (flange)

<table>
<thead>
<tr>
<th>Size</th>
<th>Axial runout of output flange a</th>
<th>Radial runout of output flange pilot or output shaft b</th>
<th>Perpendicularity of mounting flange c</th>
<th>Concentricity of mounting flange d</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>0.020</td>
<td>0.030</td>
<td>0.050</td>
<td>0.040</td>
</tr>
<tr>
<td>14</td>
<td>0.020</td>
<td>0.040</td>
<td>0.060</td>
<td>0.050</td>
</tr>
<tr>
<td>20</td>
<td>0.020</td>
<td>0.040</td>
<td>0.060</td>
<td>0.050</td>
</tr>
<tr>
<td>32</td>
<td>0.020</td>
<td>0.040</td>
<td>0.060</td>
<td>0.050</td>
</tr>
</tbody>
</table>

### Output shaft: J2 [J20], J6 [J60] (shaft output)

### Transmission Torque

<table>
<thead>
<tr>
<th>Size</th>
<th>Tightening torque Nm</th>
<th>Mounting PCD mm</th>
<th>Transmission torque kgfN</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.46</td>
<td>M4</td>
<td>8</td>
<td>68.9</td>
</tr>
<tr>
<td>4.5</td>
<td>M4</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>8.6</td>
<td>M6</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>12</td>
<td>M8</td>
<td>25</td>
<td>60</td>
</tr>
<tr>
<td>14</td>
<td>M16</td>
<td>32</td>
<td>120</td>
</tr>
</tbody>
</table>

### Technical Data

<table>
<thead>
<tr>
<th>Series</th>
<th>Technical Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPGP</td>
<td>HPG</td>
</tr>
<tr>
<td>CSG-GH</td>
<td>CSF-GH</td>
</tr>
</tbody>
</table>

### Table 150-1

<table>
<thead>
<tr>
<th>Size</th>
<th>Axial runout of output flange a</th>
<th>Radial runout of output flange pilot or output shaft b</th>
<th>Perpendicularity of mounting flange c</th>
<th>Concentricity of mounting flange d</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>0.020</td>
<td>0.040</td>
<td>0.060</td>
<td>0.050</td>
</tr>
<tr>
<td>65</td>
<td>0.040</td>
<td>0.060</td>
<td>0.090</td>
<td>0.080</td>
</tr>
</tbody>
</table>

### Table 150-2

<table>
<thead>
<tr>
<th>Size</th>
<th>Axial runout of output flange a</th>
<th>Radial runout of output flange pilot or output shaft b</th>
<th>Perpendicularity of mounting flange c</th>
<th>Concentricity of mounting flange d</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>0.020</td>
<td>0.040</td>
<td>0.060</td>
<td>0.050</td>
</tr>
<tr>
<td>65</td>
<td>0.020</td>
<td>0.040</td>
<td>0.060</td>
<td>0.050</td>
</tr>
</tbody>
</table>

### Table 150-3

<table>
<thead>
<tr>
<th>Size</th>
<th>Axial runout of output flange a</th>
<th>Radial runout of output flange pilot or output shaft b</th>
<th>Perpendicularity of mounting flange c</th>
<th>Concentricity of mounting flange d</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>0.020</td>
<td>0.040</td>
<td>0.060</td>
<td>0.050</td>
</tr>
<tr>
<td>32</td>
<td>0.020</td>
<td>0.040</td>
<td>0.060</td>
<td>0.050</td>
</tr>
</tbody>
</table>

* T.I.R.: Total indicator reading (T.I.R.* Unit: mm)
Lubrication

Prevention of grease and oil leakage

(Common to all models)
- Only use the recommended greases.
- Provisions for proper sealing to prevent grease leakage are incorporated into the gearheads. However, please note that some leakage may occur depending on the application or operating condition. Discuss other sealing options with our applications engineers.
- When mounting the gearhead horizontally, position the gearhead so that the rubber plug in the adapter flange is facing upwards.

(CSG/CSF-GH Series)
- Contact us when using HarmonicDrive® CSG/CSF-GH series with the output shaft facing downward (motor on top) at a constant load or rotating continuously in one direction.

Sealing

(Common to all models)
- Provisions for proper sealing to prevent grease leakage from the input shaft are incorporated into the gearhead.
- A double lip Teflon oil seal is used for the output shaft (HPG/HPG uses a single lip seal), gaskets or o-rings are used on all mating surfaces, and non contact shielded bearings are used for the motor shaft coupling (Double sealed bearings (D type) are available as an option*). On the CSG/CSF-GH series, non contact shielded bearing and a Teflon oil seal with a spring is used.
- Material and surface: Gearbox: Aluminum, corrosion protected roller bearing steel, carbon steel (output shaft).
- Adapter flange: (if provided by Harmonic Drive) high-strength aluminum or carbon steel. Screws: black phosphate. The ambient environment should not subject any corrosive agents to the above mentioned material. The product provides protection class IP 65 under the provision that corrosion from the ambient atmosphere (condensation, liquids or gases) at the running surface of the output shaft seal is prevented. If necessary, the adapter flange can be sealed by means of a surface seal (e.g. Loctite 515).

* D type: Bearing with a rubber contact seal on both sides

(HPG/HPGP/HPF/HPN Series)
- Using the double sealed bearing (D type) for the HPG/HPGP series gearhead will result in a slightly lower efficiency compared to the standard product.
- An oil seal without a spring is used ON the input side of HPG series with an input shaft (HPG-1U) and HPF series hollow shaft reducer. An option for an oil seal with a spring is available for improved seal reliability, however, the efficiency will be slightly lower (available for HPF and HPG series for sizes 14 and larger).
- Do not remove the screw plug and seal cap of the HPG series right angle gearhead. Removing them may cause leakage of grease or affect the precision of the gear.

Standard Lubricants

HPG/HPGP/HPF/HPN Series

The standard lubrication for the HPG/HPGP/HPF/HPN series gearheads is grease. All gearheads are lubricated at the factory prior to shipment and additional application of grease during assembly is not required. The gearheads are lubricated for the life of the gear and do not require re-lubrication. High efficiency is achieved through the unique planetary gear design and grease selection.

Lubricants

Harmonic Grease SK-2  (HPG/HPG-14, 20, 32)
Manufacturer: Harmonic Drive Systems Inc.
- Base oil: Refined mineral oil
- Thickening agent: Lithium soap
- Additive: Extreme pressure agent and other
- Standard: NLGI No. 2
- Consistency: 265 to 295 at 25°C
- Color: Green

EPNOC Grease AP (N) 2  (HPG/HPG-11, 50, 65,/HPF-25, 32)
Manufacturer: Nippon Oil Co.
- Base oil: Refined mineral oil
- Thickening agent: Lithium soap
- Additive: Extreme pressure agent and other
- Standard: NLGI No. 2
- Consistency: 282 at 25°C
- Color: Light brown

PYRONOC UNIVERSAL 00  (HPG right angle gearhead/HPN)
Manufacturer: Nippon Oil Co.
- Base oil: Refined mineral oil
- Thickening agent: Urea
- Standard: NLGI No. 00
- Consistency: 420 at 25°C
- Dropping point: 250°C or higher
- Color: Light yellow

MULTEMP AC-P  (HPG-X-R)
Manufacturer: KYODO YUSHI CO., LTD
- Base oil: Composite hydrocarbon oil and diester
- Thickening agent: Lithium soap
- Additive: Extreme pressure and others
- Standard: NLGI No. 2
- Consistency: 280 at 25°C
- Dropping point: 200°C
- Color: Black viscous

Ambient operating temperature range: -10°C to +40°C

The lubricant may deteriorate if the ambient operating temperature is outside of recommended operating range. Please contact our sales office or distributor for operation outside of the ambient operating temperature range.

The temperature rise of the gear depends upon the operating cycle, ambient temperature and heat conduction and radiation based on the customers installation of the gear. A housing surface temperature of 70°C is the maximum allowable limit.
The standard lubrication for the CGS-GH / CSF-GH series gearheads is grease. All gearheads are lubricated at the factory prior to shipment and additional application of grease during assembly is not necessary.

### Lubricants

**Harmonic Grease SK-1A**  
(Size 20, 32, 45, 65)  
Manufacturer: Harmonic Drive Systems Inc.  
This grease has been developed exclusively for HarmonicDrive® gears and is excellent in durability and efficiency compared to commercial general-purpose grease.

- **Base oil:** Refined mineral oil
- **Additive:** Extreme pressure agent and other
- **Consistency:** 265 to 295 at 25°C
- **Dropping point:** 197°C
- **Color:** Yellow

**Harmonic Grease SK-2**  
(Size 14)  
Manufacturer: Harmonic Drive Systems Inc.  
This grease has been developed exclusively for smaller sized HarmonicDrive® gears and allows smooth wave generator rotation.

- **Base oil:** Refined mineral oil
- **Additive:** Extreme pressure agent and other
- **Consistency:** 265 to 295 at 25°C
- **Dropping point:** 198°C
- **Color:** Green

### Ambient operating temperature range: -10°C to +40°C

The lubricant may deteriorate if the ambient operating temperature is outside the recommended temperature range. Please contact our sales office or distributor for operation outside of the ambient operating temperature range.

The temperature rise of the gear depends upon the operating cycle, ambient temperature and heat conduction and radiation based on the customers installation of the gear. A housing surface temperature of 70°C is the maximum allowable limit.

### When to change the grease

The life of the Harmonic Drive® gear is affected by the grease performance. The grease performance varies with temperature and deteriorates at elevated temperatures. Therefore, the grease will need to be changed sooner than usual when operating at higher temperatures. The graph on the right indicates when to change the grease based upon the temperature (when the average load torque is less than or equal to the rated output torque at 2000 rpm). Also, using the formula below, you can calculate when to change the grease when the average load torque exceeds the rated output torque (at 2000 rpm).

**Formula to calculate the grease change interval when the average load torque exceeds the rated torque**

\[
L_{\text{avg}} = L_{\text{GTn}} \times \left( \frac{T_{\text{av}}}{T_{\text{av}} \text{ max}} \right)^{3}
\]

**Formula symbols**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(L_{\text{avg}})</td>
<td>Grease change interval when (T_{\text{av}} \geq T_{\text{av max}})</td>
</tr>
<tr>
<td>(L_{\text{GTn}})</td>
<td>Grease change interval when (T_{\text{av}} \leq T_{\text{av max}})</td>
</tr>
<tr>
<td>(T_{\text{av}})</td>
<td>Output torque at 2000 rpm</td>
</tr>
<tr>
<td>(T_{\text{av max}})</td>
<td>Average load torque</td>
</tr>
</tbody>
</table>

### Precautions when changing the grease

Strictly observe the following instructions when changing the grease to avoid problems such as grease leakage or increase in running torque.

- **Note that the amount of grease listed in Table 152-2 is the amount used to lubricate the gear at assembly. This should be used as a reference. Do not exceed this amount when re-greasing the gearhead.**
- **Remove grease from the gearhead and refill it with the same quantity. The adverse effects listed above normally do not occur until the gear has been re-greased 2 times. When re-greasing 3 times or more, it is essential to remove grease (using air pressure or other means) before re-lubricating with the same amount of grease that was removed.**
**Warranty**

Please contact us or visit our website at www.harmonicdrive.net for warranty details for your specific product.

All efforts have been made to ensure that the information in this catalog is complete and accurate. However, Harmonic Drive LLC is not liable for any errors, omissions or inaccuracies in the reported data. Harmonic Drive LLC reserves the right to change the product specifications, for any reason, without prior notice. For complete details please refer to our current Terms and Conditions posted on our website.

**Disposal**

When disposing of the product, disassemble it and sort the component parts by material type and dispose of the parts as industrial waste in accordance with the applicable laws and regulations. The component part materials can be classified into three categories.

- **(1) Rubber parts:** Oil seals, seal packings, rubber caps, seals of shielded bearings on input side (D type only)
- **(2) Aluminum parts:** Housings, motor flanges
- **(3) Steel parts:** Other parts

**Trademark**

HarmonicDrive® is a registered trademark of Harmonic Drive LLC.
HarmonicPlanetary® is a registered trademark of Harmonic Drive LLC.
## Safety

**Warning**: Means that improper use or handling could result in a risk of death or serious injury.

**Caution**: Means that improper use or handling could result in personal injury or damage to property.

### Application Restrictions

This product cannot be used for the following applications:

- Space flight hardware
- Aircraft equipment
- Nuclear power equipment
- Equipment and apparatus used in residential dwellings
- Medical equipment

- Vacuum environments
- Automotive equipment
- Personal recreation equipment
- Equipment that directly works on human bodies

Please consult Harmonic Drive LLC beforehand if intending to use one of our product for the aforementioned applications.

Fail-safe devices that prevent an accident must be designed into the equipment when the products are used in any equipment that could result in personal injury or damage to property in the event of product failure.

### Design Precaution: Be certain to read the catalog when designing the equipment.

<table>
<thead>
<tr>
<th>Caution</th>
<th>Use only in the proper environment.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Please ensure to comply with the following environmental conditions:</td>
</tr>
<tr>
<td></td>
<td>- Ambient temperature 0 to 40°C</td>
</tr>
<tr>
<td></td>
<td>- Prevent splashing of water or oil</td>
</tr>
<tr>
<td></td>
<td>- Do not expose to corrosive or explosive gas</td>
</tr>
<tr>
<td></td>
<td>- Do not use dirt such as metal powder</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Caution</th>
<th>Install the equipment properly.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Carry out the assembly and installation precisely as specified in the catalog.</td>
</tr>
<tr>
<td></td>
<td>Observe our recommended fastening methods (including bolts used and tightening torques).</td>
</tr>
<tr>
<td></td>
<td>Operating the equipment without precise assembly can cause problems such as vibration, reduction in life, deterioration of precision and product failure.</td>
</tr>
</tbody>
</table>

### Install the equipment with the required precision. |

- Design and assemble parts to keep all catalog recommended tolerances for installation.
- Failure to hold the recommended tolerances can cause problems such as vibration, reduction in life, deterioration of precision and product failure.

### Operational Precaution: Be certain to read the catalog before operating the equipment.

<table>
<thead>
<tr>
<th>Caution</th>
<th>Use caution when handling the product and parts.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Do not hit the gear or any part with a hammer.</td>
</tr>
<tr>
<td></td>
<td>If you use the equipment in a damaged condition, the gearhead may not perform to catalog specifications. It can also cause problems including product failure.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Caution</th>
<th>Install the equipment properly.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Carry out the assembly and installation precisely as specified in the catalog.</td>
</tr>
<tr>
<td></td>
<td>Observe our recommended fastening methods (including bolts used and tightening torques).</td>
</tr>
<tr>
<td></td>
<td>Operating the equipment without precise assembly can cause problems such as vibration, reduction in life, deterioration of precision and product failure.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Caution</th>
<th>Do not alter or disassemble the product or parts.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Harmonic Planetary® and Harmonic Drive® products are manufactured as matched sets. Catalog ratings may not be achieved if the component parts are interchanged.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Caution</th>
<th>Do not disassemble the products.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Do not disassemble and reassemble the products. Original performance may not be achieved.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Warning</th>
<th>Stop operating the system if any abnormality occurs.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Shut down the system promptly if any abnormal sound or vibration is detected, the rotation has stopped, an abnormally high temperature is generated, an abnormal motor current value is observed or any other anomalies are detected. Continuing to operate the system may adversely affect the product or equipment.</td>
</tr>
<tr>
<td></td>
<td>Please contact our sales office or distributor if any anomaly is detected.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Warning</th>
<th>Rust-proofing was applied before shipping. However, please note that rusting may occur depending on the customers' storage environment.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Although black oxide finish is applied to some of our products, it does not guarantee that rust will not form.</td>
</tr>
</tbody>
</table>

### Handling Lubricant

<table>
<thead>
<tr>
<th>Caution</th>
<th>Precautions on handling lubricants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lubricant in the eye can cause inflammation. Wear protective glasses to prevent it from getting into your eye.</td>
</tr>
<tr>
<td></td>
<td>Lubricant coming in contact with the skin can cause inflammation. Wear protective gloves when you handle the lubricant to prevent it from contacting your skin.</td>
</tr>
<tr>
<td></td>
<td>Do not ingest (to avoid diarrhea and vomiting).</td>
</tr>
<tr>
<td></td>
<td>Use caution when opening the container. There may be sharp edges that can cut your hand. Wear protective gloves.</td>
</tr>
<tr>
<td></td>
<td>Keep lubricant out of reach of children.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Caution</th>
<th>Disposal of waste oil and containers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Follow all applicable laws regarding waste disposal. Contact your distributor if you are unsure how to properly dispose of the material.</td>
</tr>
<tr>
<td></td>
<td>Do not apply pressure to an empty container. The container may explode.</td>
</tr>
<tr>
<td></td>
<td>Do not weld, heat, drill or cut the container. This may cause residual oil to ignite or cause an explosion.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Caution</th>
<th>Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tightly seal the container after use. Store in a cool, dry, dark place. Keep away from open flames and high temperatures.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Caution</th>
<th>First-aid</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inhalation: Remove exposed person to fresh air if adverse effects are observed.</td>
</tr>
<tr>
<td></td>
<td>Ingestion: Seek immediate medical attention and do not induce vomiting unless directed by medical personnel.</td>
</tr>
<tr>
<td></td>
<td>Eyes: Flush immediately with water for at least 15 minutes. Get immediate medical attention.</td>
</tr>
<tr>
<td></td>
<td>Skin: Wash with soap and water. Get medical attention if irritation develops.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Caution</th>
<th>Disposal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Please dispose of as industrial waste.</td>
</tr>
<tr>
<td></td>
<td>Please dispose of the products as industrial waste when their useful life is over.</td>
</tr>
</tbody>
</table>
Technical Data

Size 65:

- Gearhead CSG-GH
- Gearhead CSF-GH

Input rotational speed:

- 500 rpm
- 1000 rpm
- 2000 rpm
- 3500 rpm

Efficiency vs. input torque for different reduction ratios:

- Reduction ratio = 100
- Reduction ratio = 160
- Reduction ratio = 120
- Reduction ratio = 80
Major Applications of Our Products

- Metal Working Machines
- Processing Machine Tools
- Measurement, Analytical and Test Systems
- Medical Equipment
- Telescopes
- Energy
- Crating and Packaging Machines
- Communication Equipment
- Glass and Ceramic Manufacturing Systems
- Robots
- Humanoid Robots
- Printing, Bookbinding and Paper Machines
- Semiconductor Manufacturing Equip.
- Optical Equipment
- Machine Tools
- Paper-making Machines
- Flat Panel Display Manufacturing Equip.
- Printed Circuit Board Manufacturing Machines
- Aerospace

HarmonicDrive® speed reducer delivers precise motion control by utilizing the strain wave gearing principle.

HarmonicDrive® Gearing

Linear Actuators
Compact linear actuators combine a precision lead screw and HarmonicDrive® gear. Our versatile actuators deliver both ultra precise positioning and high torque.

CSF Mini Gearheads
CSF mini gearheads provide high positioning accuracy in a super-compact package.

High-torque actuators combine performance matched servomotors with HarmonicDrive® gears to deliver excellent dynamic control characteristics.
Experts in Precision Motion Control

HarmonicDrive® Gearing
HarmonicDrive® speed reducer delivers precise motion control by utilizing the strain wave gearing principle.

Rotary Actuators
High-torque actuators combine performance matched servomotors with HarmonicDrive® gears to deliver excellent dynamic control characteristics.

Linear Actuators
Compact linear actuators combine a precision lead screw and HarmonicDrive® gear. Our versatile actuators deliver both ultra precise positioning and high torque.

CSF Mini Gearheads
CSF mini gearheads provide high positioning accuracy in a super-compact package.