Harmonic Planetary®
HPG Standard Series

Size
11, 14, 20, 32, 50, 65

Peak torque
5Nm – 3200Nm

Reduction ratio
Single Stage: 3:1 to 9:1, Two Stage: 11:1 to 50:1

Low Backlash
Standard: <3 arc-min Optional: <1 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.

High efficiency
Up to 95%

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.

Easy mounting to a wide variety of servomotors
Quick Connect® motor adaptation system includes a clamshell style servo coupling and piloted adapter flange.

Gearhead Construction

Contents
Rating Table ........................................... 31
Performance Table ................................. 32
Backlash and Torsional Stiffness ................. 33
Outline Dimensions ............................... 34-39
Product Sizing & Selection .................. 40-41

HPG - 20 A - 05 - BL3 - Z - F0 - Motor Code

Model Name     Size     Design Revision Reduction Ratio  Backlash              Input Side Bearing  Output Configuration  Input Configuration & Options
Harmonic Planetary® HPG Standard
11             B         5, 9, 21, 37, 46  BL1: Backlash less than 1 arc-min (Sizes 14 to 65)
14             A         5, 5, 11, 15, 21, 33, 45  BL2: Backlash less than 3 arc-min
20             A         4, 5, 12, 15, 20, 25, 40, 50
32             A
50             A
65

This code represents the motor mounting configuration. Please contact us for a unique part number based on the motor you are using.

Figure 030-1
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1: Rated torque is based on life of 20,000 hours at max average input speed.
2: Average load torque calculated based on the application motion profile must not exceed values shown in the table. See p. 40.
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.
5: Max value of average input rotational speed during operation.
6: Maximum instantaneous input speed.

*2: Average load torque calculated based on the application motion profile must not exceed values shown in the table. See p. 40.
*6: Maximum instantaneous input speed.
### Performance Table

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*1: Transmission 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 "x". 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, and are based on Z option shielded input bearing unloaded.

*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, and are based on Z option shielded input bearing unloaded.

Note: Never rely on these values as a margin in a system that must hold an external load. A brake must be used where back driving is not permissible.

*5: No-load running torque is the torque required at the input to operate the gearbox at a given speed under a no-load condition. The values in the table are average values, and are based on Z option shielded input bearing unloaded at 25°C at 3,000 rpm.
Backlash and Torsional Stiffness

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 T<sub>R</sub>
2. Return to Zero
3. Counter-Clockwise torque to -T<sub>R</sub>
4. Return to Zero
5. Again Clockwise torque to T<sub>R</sub>

A loop of (1) > (2) > (3) > (4) > (5) will be drawn as in Fig. 033-1. The torsional stiffness in the region from “0.15 x T<sub>R</sub>” to “T<sub>R</sub>” is calculated using the average value of this slope. The torsional stiffness in the region from “zero torque” to “0.15 x T<sub>R</sub>” 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.

\[ \theta = D + \frac{T - T_n}{A/B} \]

Calculation formula

- \( \theta \): Total torsion angle
- \( D \): Torsion angle in one direction at output torque \( \times 0.15 \)
- \( T \): Load torque
- \( T_n \): Output torque \( \times 0.15 \) (See Fig. 033-1)
- \( A/B \): Torsional stiffness (See Fig. 033-1, Table 033-1 to 2)

Backlash (Hysteresis loss)

The vertical distance between points (2) & (4) in Fig. 033-1 is called a hysteresis loss. The hysteresis loss between “Clockwise load torque T<sub>n</sub>” and “Counter Clockwise load torque -T<sub>n</sub>” is defined as the backlash of the HPG series. Backlash of the HPG series is less than 3 arc-min (1 arc-min or less for a reduced backlash option, size 14-65).

Torque-torsion angle diagram

The figure shows the relationship between the input torque and the torsion angle at the output. The angle is measured in both directions from the initial zero position. The hysteresis loss is the difference between the two curves.
HPG-11 Outline Dimensions

Only primary dimensions are shown in the drawings below. Refer to the confirmation drawing for detailed 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.

Dimension Table

<table>
<thead>
<tr>
<th>Flange Coupling</th>
<th>A (H7)</th>
<th>B (H7)</th>
<th>C (H7)</th>
<th>F (H7)</th>
<th>G (H7)</th>
<th>H (H)</th>
<th>Mass (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min.</td>
<td>Max.</td>
<td>Min.</td>
<td>Max.</td>
<td>Min.</td>
<td>Max.</td>
<td>Typical</td>
</tr>
<tr>
<td>Single Stage 1</td>
<td>1</td>
<td>20</td>
<td>55</td>
<td>4</td>
<td>25</td>
<td>75</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td>54.5</td>
</tr>
<tr>
<td>Two Stage 1</td>
<td>1</td>
<td>20</td>
<td>55</td>
<td>4</td>
<td>25</td>
<td>75</td>
<td>5</td>
</tr>
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</tr>
</tbody>
</table>

Refer to the confirmation drawing for detailed dimensions. Dimensions of typical products are shown. Please contact us for other mounting options if the configurations shown above are not suitable for your particular motor.

1. May vary depending on motor interface dimensions.
2. The mass will vary slightly depending on the ratio and on the inside diameter of the input shaft coupling.
3. Tapped hole for motor mounting screw.

Moment of Inertia

<table>
<thead>
<tr>
<th>HPG</th>
<th>Coupling</th>
<th>5</th>
<th>9</th>
<th>21</th>
<th>37</th>
<th>45</th>
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<tbody>
<tr>
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<td>0.003</td>
<td>0.004</td>
<td>0.0027</td>
<td>0.0025</td>
<td></td>
</tr>
</tbody>
</table>

10^4 kgm^2
| HPG-14 Outline Dimensions |

Only primary dimensions are shown in the drawings below. Refer to the confirmation drawing for detailed dimensions.

![Diagram](image)

(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.

| Dimension Table |

<table>
<thead>
<tr>
<th>Flange</th>
<th>Coupling</th>
<th>A (H7) ¹</th>
<th>B ²</th>
<th>C ³</th>
<th>F (H7) ⁴</th>
<th>G ⁵</th>
<th>H ⁶</th>
<th>Mass (kg) ²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Min.</td>
<td>Max.</td>
<td>Min.</td>
<td>Max.</td>
<td>Min.</td>
<td>Max.</td>
<td>Typical</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>30</td>
<td>55</td>
<td>7</td>
<td>35</td>
<td>75</td>
<td>6.0</td>
<td>7.8</td>
</tr>
<tr>
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</tbody>
</table>

Refer to the confirmation drawing for detailed dimensions. Dimensions of typical products are shown. Please contact us for other mounting options if the configurations shown above are not suitable for your particular motor.

¹ May vary depending on motor interface dimensions.
² The mass will vary slightly depending on the ratio and on the inside diameter of the input shaft coupling.
³ Tapped hole for motor mounting screw.

| Moment of Inertia (10⁻⁴ kgm²) |

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Coupling</th>
<th>3</th>
<th>5</th>
<th>11</th>
<th>15</th>
<th>21</th>
<th>33</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPG 14</td>
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<td>0.044</td>
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<td>0.180</td>
<td>0.171</td>
<td>0.167</td>
<td>0.165</td>
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</tbody>
</table>
### HPG-20 Outline Dimensions

Only primary dimensions are shown in the drawings below. Refer to the confirmation drawing for detailed dimensions.

![HPG-20 Outline Dimensions Diagram]

### Dimension Table

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<tr>
<th>Flange</th>
<th>Coupling</th>
<th>A (H7)</th>
<th>B</th>
<th>C</th>
<th>F (H7)</th>
<th>G</th>
<th>H</th>
<th>Mass (kg)</th>
</tr>
</thead>
<tbody>
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<td>95</td>
<td>10</td>
<td>85</td>
<td>125</td>
<td>7.0</td>
<td>19.6</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>30</td>
<td>45</td>
<td>10</td>
<td>35</td>
<td>50</td>
<td>6.0</td>
<td>7.8</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>40</td>
<td>75</td>
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<td>45</td>
<td>100</td>
<td>7.0</td>
<td>19.6</td>
</tr>
</tbody>
</table>

Refer to the confirmation drawing for detailed dimensions. Dimensions of typical products are shown. Please contact us for other mounting options if the configurations shown above are not suitable for your particular motor.

1. May vary depending on motor interface dimensions.
2. The mass will vary slightly depending on the ratio and on the inside diameter of the input shaft coupling.
3. Tapped hole for motor mounting screw.

### Moment of Inertia

<table>
<thead>
<tr>
<th>HPG 20</th>
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</tbody>
</table>

(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.
HPG Standard Gearhead Series

HPG-32 Outline Dimensions

Only primary dimensions are shown in the drawings below. Refer to the confirmation drawing for detailed dimensions.

![Diagram of HPG-32 Outline Dimensions]

Dimension Table

<table>
<thead>
<tr>
<th>Flange</th>
<th>Coupling</th>
<th>A (H7) ¹</th>
<th>B ²</th>
<th>C ³</th>
<th>F (H7) ⁴</th>
<th>G ⁵</th>
<th>H ⁶</th>
<th>Mass (kg) ⁷</th>
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<tbody>
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<td></td>
<td></td>
<td></td>
<td>7.8</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
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<td></td>
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<td>6.4</td>
</tr>
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</tr>
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<td></td>
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<td>6.5</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>55</td>
<td>175</td>
<td>10</td>
<td>65</td>
<td>225</td>
<td>10</td>
<td>28.6</td>
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<tr>
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</tr>
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</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td>9.5</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8.1</td>
</tr>
</tbody>
</table>

Refer to the confirmation drawing for detailed dimensions. Dimensions of typical products are shown. Please contact us for other mounting options if the configurations shown above are not suitable for your particular motor.

¹ May vary depending on motor interface dimensions.
² The mass will vary slightly depending on the ratio and on the inside diameter of the input shaft coupling.
³ Tapped hole for motor mounting screw.

Moment of Inertia

<table>
<thead>
<tr>
<th>HPG 32</th>
<th>Coupling</th>
<th>3</th>
<th>5</th>
<th>11</th>
<th>15</th>
<th>21</th>
<th>33</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.6</td>
<td>3.9</td>
<td>3.4</td>
<td>3.2</td>
<td>3</td>
<td>2.8</td>
<td>2.8</td>
<td></td>
</tr>
</tbody>
</table>
HPG-50 Outline Dimensions

Only primary dimensions are shown in the drawings below. Refer to the confirmation drawing for detailed dimensions.

![Diagram of HPG-50 Outline Dimensions]

Dimension Table

<table>
<thead>
<tr>
<th>Flange</th>
<th>Coupling</th>
<th>A (H7)</th>
<th>B</th>
<th>C</th>
<th>F (H7)</th>
<th>G</th>
<th>H</th>
<th>Mass (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>65</td>
<td>175</td>
<td>15</td>
<td>75</td>
<td>235</td>
<td>19.0</td>
<td>41.0</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>80</td>
<td>130</td>
<td>10</td>
<td>90</td>
<td>160</td>
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<tr>
<td>3</td>
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<td>75</td>
<td>235</td>
<td>19.0</td>
<td>41.0</td>
</tr>
</tbody>
</table>

Refer to the confirmation drawing for detailed dimensions. Dimensions of typical products are shown. Please contact us for other mounting options if the configurations shown above are not suitable for your particular motor.

1 May vary depending on motor interface dimensions.
2 The mass will vary slightly depending on the ratio and on the inside diameter of the input shaft coupling. Use flange type 3 for motors weighing over 65 kg.
3 Tapped hole for motor mounting screw.

Moment of Inertia

<table>
<thead>
<tr>
<th>HPG 50 Coupling</th>
<th>Ratio</th>
<th>4</th>
<th>5</th>
<th>11</th>
<th>15</th>
<th>21</th>
<th>33</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
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<td>5.8</td>
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</table>
### HPG-65 Outline Dimensions

Only primary dimensions are shown in the drawings below. Refer to the confirmation drawing for detailed dimensions.

![Dimension Table](image)

### Dimension Table

<table>
<thead>
<tr>
<th>Flange</th>
<th>Coupling</th>
<th>A (HT)</th>
<th>B (HT)</th>
<th>C (HT)</th>
<th>F (HT)</th>
<th>G (HT)</th>
<th>H</th>
<th>Mass (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Min.</td>
<td>Max.</td>
<td>Min.</td>
<td>Max.</td>
<td>Min.</td>
<td>Max.</td>
<td>Typical</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Shaft</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Flange</td>
</tr>
<tr>
<td>Single Stage</td>
<td>2</td>
<td>2</td>
<td>130</td>
<td>245</td>
<td>15</td>
<td>140</td>
<td>290</td>
<td>35.0</td>
</tr>
<tr>
<td>Two Stage 1</td>
<td>1</td>
<td>1</td>
<td>65</td>
<td>175</td>
<td>15</td>
<td>75</td>
<td>225</td>
<td>24.0</td>
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<tr>
<td></td>
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<td>290</td>
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<td>15</td>
<td>75</td>
<td>225</td>
<td>24.0</td>
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</tbody>
</table>

Refer to the confirmation drawing for detailed dimensions. Dimensions of typical products are shown. Please contact us for other mounting options if the configurations shown above are not suitable for your particular motor.

1. May vary depending on motor interface dimensions.
2. The mass will vary slightly depending on the ratio and on the inside diameter of the input shaft coupling.
3. Tapped hole for motor mounting screw.

### Moment of Inertia

<table>
<thead>
<tr>
<th>Coupling</th>
<th>Ratio</th>
<th>4</th>
<th>5</th>
<th>12</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>40</th>
<th>50</th>
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<td>65</td>
<td>53</td>
<td>53</td>
<td>-</td>
<td>-</td>
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</tbody>
</table>
Sizing & Selection

To fully utilize the excellent performance of the HPG 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 and input side main bearing (input shaft type only).

**Flowchart for selecting a size**

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

![Flowchart](image-url)

**Application motion profile**

Review the application motion profile. Check the specifications shown in the figure below.

**Obtain the value of each application motion profile**

- **Load torque**: $T_1$ to $T_n$ (Nm)
- **Time**: $t_1$ to $t_n$ (sec)
- **Output rotational speed**: $n_1$ to $n_n$ (rpm)

**Normal operation pattern**

- **Starting (acceleration)**: $T_1$, $t_1$, $n_1$
- **Steady operation (constant velocity)**: $T_2$, $t_2$, $n_2$
- **Stopping (deceleration)**: $T_3$, $t_3$, $n_3$
- **Dwell**: $T_4$, $t_4$, $n_4$

**Maximum rotational speed**

- **Max. output rotational speed**: $n_{0\max}$ to $n_n$
- **Max. input rotational speed**: $n_{i\max}$ to $n_{i}\times R$
  (Restricted by motors)
- **R**: Reduction ratio

**Emergency stop torque**

- **When impact torque is applied**: $T_s$

**Required life**

- **$L_{50} = L$ (hours)**

**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 $(T_{av}) >$ 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</th>
<th>Tn (Nm)</th>
<th>Maximum rotational speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>tn (sec)</td>
<td>Max. output rotational speed</td>
</tr>
<tr>
<td>Output rotational speed</td>
<td>n (rpm)</td>
<td>Max. input rotational speed</td>
</tr>
</tbody>
</table>

Normal operation pattern
- Starting (acceleration): T1 = 70 Nm, t1 = 0.3 sec, n1 = 60 rpm
- Steady operation (constant velocity): T2 = 18 Nm, t2 = 3 sec, n2 = 120 rpm
- Stopping (deceleration): T3 = 35 Nm, t3 = 0.4 sec, n3 = 60 rpm
- Dwell: T4 = 0 Nm, t4 = 5 sec, n4 = 0 rpm

Required life
Lso = 30,000 (hours)

Load torque Tn (Nm)
Time tn (sec)
Output rotational speed n (rpm)

Maximum rotational speed
- Max. output rotational speed: no max = 120 rpm
- Max. input rotational speed: ni max = 5,000 rpm

Emergency stop torque
When impact torque is applied: T5 = 180 Nm

Example of size selection

<table>
<thead>
<tr>
<th>Load torque</th>
<th>Tn (Nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 Nm</td>
<td>120 Nm</td>
</tr>
<tr>
<td>70 Nm</td>
<td>180 Nm</td>
</tr>
<tr>
<td>180 Nm</td>
<td>180 Nm</td>
</tr>
<tr>
<td>30 Nm</td>
<td>120 Nm</td>
</tr>
<tr>
<td>60 Nm</td>
<td>180 Nm</td>
</tr>
<tr>
<td>180 Nm</td>
<td>180 Nm</td>
</tr>
</tbody>
</table>

Maximum rotational speed
- Max. output rotational speed: no max = 120 rpm
- Max. input rotational speed: ni max = 5,000 rpm

Emergency stop torque
When impact torque is applied: T5 = 180 Nm

The selection of model number HPG-20A-33 is confirmed from the above calculations.
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>HPG / HPF / HPN / HPF : 3000rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambiente temperature</td>
<td>25°C</td>
</tr>
<tr>
<td>Lubricant</td>
<td>Use standard lubricant for each model. (See pages 163-164 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.
(1) Checking maximum load

Shaft unit.

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.

Checking procedure

| Size | Gearhead | HPGP |

Table 157-4

| Reduction Ratio | Graph 135-1 | Graph 135-2 |

Reduction Ratio = 5

Reduction Ratio = 21

Reduction Ratio = 5

Reduction Ratio = 11

Reduction Ratio = 5

Reduction Ratio = 15, 21

Reduction Ratio = 33, 45

Graph 135-3

Graph 135-4

Graph 135-5

Graph 135-6

Graph 135-7

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

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

**Size 20**: Gearhead  **HPGP**

### Reduction ratio = 5

Graph 136-1

<table>
<thead>
<tr>
<th>Efficiency %</th>
<th>Input torque Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>40</td>
<td>15</td>
</tr>
<tr>
<td>50</td>
<td>20</td>
</tr>
</tbody>
</table>

--- Gearhead (standard item)  --- Gearhead with D bearing (double sealed)  T<sub>n</sub> Input torque corresponding to output torque

### Reduction ratio = 11

Graph 136-2

<table>
<thead>
<tr>
<th>Efficiency %</th>
<th>Input torque Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>40</td>
<td>15</td>
</tr>
<tr>
<td>50</td>
<td>20</td>
</tr>
</tbody>
</table>

--- Gearhead (standard item)  --- Gearhead with D bearing (double sealed)  T<sub>n</sub> Input torque corresponding to output torque

### Reduction ratio = 15, 21

Graph 136-3

<table>
<thead>
<tr>
<th>Efficiency %</th>
<th>Input torque Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>40</td>
<td>15</td>
</tr>
<tr>
<td>50</td>
<td>20</td>
</tr>
</tbody>
</table>

--- Gearhead (standard item)  --- Gearhead with D bearing (double sealed)  T<sub>n</sub> Input torque corresponding to output torque

### Reduction ratio = 33, 45

Graph 136-4

<table>
<thead>
<tr>
<th>Efficiency %</th>
<th>Input torque Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>40</td>
<td>15</td>
</tr>
<tr>
<td>50</td>
<td>20</td>
</tr>
</tbody>
</table>

--- Gearhead (standard item)  --- Gearhead with D bearing (double sealed)  T<sub>n</sub> Input torque corresponding to output torque

**Size 32**: Gearhead  **HPGP**

### Reduction ratio = 5 *1

Graph 136-5

<table>
<thead>
<tr>
<th>Efficiency %</th>
<th>Input torque Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>40</td>
<td>15</td>
</tr>
<tr>
<td>50</td>
<td>20</td>
</tr>
</tbody>
</table>

--- Gearhead (standard item)  --- Gearhead with D bearing (double sealed)  T<sub>n</sub> Input torque corresponding to output torque

### Reduction ratio = 11

Graph 136-6

<table>
<thead>
<tr>
<th>Efficiency %</th>
<th>Input torque Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>40</td>
<td>15</td>
</tr>
<tr>
<td>50</td>
<td>20</td>
</tr>
</tbody>
</table>

--- Gearhead (standard item)  --- Gearhead with D bearing (double sealed)  T<sub>n</sub> Input torque corresponding to output torque

### Reduction ratio = 15, 21

Graph 136-7

<table>
<thead>
<tr>
<th>Efficiency %</th>
<th>Input torque Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>40</td>
<td>15</td>
</tr>
<tr>
<td>50</td>
<td>20</td>
</tr>
</tbody>
</table>

--- Gearhead (standard item)  --- Gearhead with D bearing (double sealed)  T<sub>n</sub> Input torque corresponding to output torque

### Reduction ratio = 33, 45

Graph 136-8

<table>
<thead>
<tr>
<th>Efficiency %</th>
<th>Input torque Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>40</td>
<td>15</td>
</tr>
<tr>
<td>50</td>
<td>20</td>
</tr>
</tbody>
</table>

--- Gearhead (standard item)  --- Gearhead with D bearing (double sealed)  T<sub>n</sub> 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.
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 radial load of HPG series is the value of a radial load applied at the mid-point of the input shaft.

**Input Bearing Specifications and Checking Procedure**

<table>
<thead>
<tr>
<th>Size</th>
<th>Specification</th>
<th>Checking</th>
<th>Efficiency %</th>
<th>Technical Information / Handling Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Gearhead</td>
<td></td>
<td>80</td>
<td>See Table 157-1 and -3</td>
</tr>
<tr>
<td>25</td>
<td>Gearhead</td>
<td></td>
<td>90</td>
<td>See Table 158-1 and -2</td>
</tr>
<tr>
<td>32</td>
<td>Gearhead</td>
<td></td>
<td>30</td>
<td>See Fig. 158-1.</td>
</tr>
<tr>
<td>32</td>
<td>Gearhead with D bearing (double sealed)</td>
<td></td>
<td>20</td>
<td>Formula 158-4</td>
</tr>
</tbody>
</table>

- **Reduction ratio = 5**
  - Gearhead (standard item)
  - Gearhead with D bearing (double sealed)
  - Tn: Input torque corresponding to output torque

- **Reduction ratio = 11**
  - Gearhead (standard item)
  - Gearhead with D bearing (double sealed)
  - Tn: Input torque corresponding to output torque

- **Reduction ratio = 15, 21**
  - Gearhead (standard item)
  - Gearhead with D bearing (double sealed)
  - Tn: Input torque corresponding to output torque

- **Reduction ratio = 33, 45**
  - Gearhead (standard item)
  - Gearhead with D bearing (double sealed)
  - Tn: Input torque corresponding to output torque

* 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>Size</th>
<th>Specification</th>
<th>Checking</th>
<th>Efficiency %</th>
<th>Technical Information / Handling Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>Gearhead</td>
<td></td>
<td>80</td>
<td>See Table 157-1 and -3</td>
</tr>
<tr>
<td>65</td>
<td>Gearhead</td>
<td></td>
<td>90</td>
<td>See Table 158-1 and -2</td>
</tr>
<tr>
<td>65</td>
<td>Gearhead</td>
<td></td>
<td>30</td>
<td>See Fig. 158-1.</td>
</tr>
<tr>
<td>65</td>
<td>Gearhead with D bearing (double sealed)</td>
<td></td>
<td>20</td>
<td>Formula 158-4</td>
</tr>
</tbody>
</table>

- **Reduction ratio = 4, 5**
  - Gearhead (standard item)
  - Gearhead with D bearing (double sealed)
  - Tn: Input torque corresponding to output torque

- **Reduction ratio = 12**
  - Gearhead (standard item)
  - Gearhead with D bearing (double sealed)
  - Tn: Input torque corresponding to output torque

- **Reduction ratio = 15, 20**
  - Gearhead (standard item)
  - Gearhead with D bearing (double sealed)
  - Tn: Input torque corresponding to output torque

- **Reduction ratio = 25**
  - Gearhead (standard item)
  - Gearhead with D bearing (double sealed)
  - Tn: Input torque corresponding to output torque

* 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**

- **Gearhead & Input Shaft Unit**
  - **HPG**

#### Reduction ratio = 5

- **Graph 138-1**

#### Reduction ratio = 21

- **Graph 138-3**

#### Reduction ratio = 37, 45

- **Graph 138-4**

#### Reduction ratio = 3, 5

- **Graph 138-5**

#### Reduction ratio = 11

- **Graph 138-6**

#### Reduction ratio = 15, 21

- **Graph 138-7**

#### Reduction ratio = 33, 45

- **Graph 138-8**

---

**Note**

- *1* The allowable moment load of the input bearing is the value of the moment load applied to the shaft of the input flange.

- *2* The allowable radial load of the input bearing is the value of the radial load applied to the mid-point of the input shaft.

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

---

**Specifications of Input Bearing**

- **Allowable moment load**
  - **Mc**
  - **Allowable axial load**
  - **Fac**
  - **Allowable radial load**
  - **Frc**

---

**Checking Procedure**

1. **Checking maximum load**
2. **Checking the life**

---

**Graphs**

- Graph 138-1
- Graph 138-2
- Graph 138-3
- Graph 138-4
- Graph 138-5
- Graph 138-6
- Graph 138-7
- Graph 138-8

---

**Formulae**

- Formula 158-4
- Formula 158-5
- Formula 158-6

---

**Input Torque Corresponding to Output Torque**

- **Input torque**
- **Output torque**

---

**Efficiency**

- **Efficiency %**

---

**Technical Information / Handling Explanation**

- **Gearhead & Input Shaft Unit**
- **HPG**
Technical Data

Size 20: Gearhead & Input Shaft Unit

HPG

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

**Checking procedure**

1. Checking maximum load
2. Checking the life

#### Specification of input shaft bearing

<table>
<thead>
<tr>
<th>Size</th>
<th>Reduction ratio</th>
<th>Basic load rating</th>
<th>Input torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>3, 5</td>
<td>Cr: 39500 Nm</td>
<td>TRi: 14800 kgf</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cor: 25100 Nm</td>
<td>TRi: 10100 kgf</td>
</tr>
<tr>
<td>32</td>
<td>11</td>
<td>Cr: 60000 Nm</td>
<td>TRi: 13800 kgf</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cor: 31500 Nm</td>
<td>TRi: 6200 kgf</td>
</tr>
</tbody>
</table>

#### Gearheads

- **Technical Data**
  - **HPG HPF**
    - Input torque corresponding to output torque

#### Input Bearing Specifications and Checking Procedure

- **Calculating maximum moment load**
  
  \[ M_i = \frac{1}{2} \left( \frac{N_i}{n_i} \right) \]

  where:
  - \( N_i \) is the average input speed
  - \( n_i \) is the average input speed

- **Calculating life of input bearing**

  \[ L_i = \frac{C_i}{D_i} \]

  where:
  - \( C_i \) is the basic dynamic load rating
  - \( D_i \) is the basic static load rating

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

### Graphs

- **Graph 139-1**
  - **Reduction ratio = 3, 5**
  - **Reduction ratio = 15**
  - **Reduction ratio = 21**

- **Graph 139-2**
  - **Reduction ratio = 11**

- **Graph 139-3**
  - **Reduction ratio = 15**
  - **Reduction ratio = 21**

- **Graph 139-4**
  - **Reduction ratio = 33**
  - **Reduction ratio = 45**

- **Graph 139-5**
  - **Reduction ratio = 3, 5**

- **Graph 139-6**
  - **Reduction ratio = 11**

- **Graph 139-7**
  - **Reduction ratio = 15**
  - **Reduction ratio = 21**

- **Graph 139-8**
  - **Reduction ratio = 33**
  - **Reduction ratio = 45**

**Notes:**

- **Size 20**
  - Gearhead & Input Shaft Unit

- **Note:**
  - *3 Only one line is shown because the difference between the gearhead and a bearing assembled on the input side is small.
**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).

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

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.

---

**Size 50** Gearhead & Input Shaft Unit

**HPG**

**Reduction ratio = 3, 5**

![Graph 140-1](image)

**Reduction ratio = 15, 21**

![Graph 140-2](image)

**Reduction ratio = 11**

![Graph 140-3](image)

**Reduction ratio = 33, 45**

![Graph 140-4](image)

---

**Size 65** Gearhead & Input Shaft Unit

**HPG**

**Reduction ratio = 4, 5**

![Graph 140-5](image)

**Reduction ratio = 12**

![Graph 140-6](image)

**Reduction ratio = 15, 20**

![Graph 140-7](image)

**Reduction ratio = 25**

![Graph 140-8](image)

**Reduction ratio = 40**

![Graph 140-9](image)

**Reduction ratio = 50**

![Graph 140-10](image)

---

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

*3 Only one line is shown because the difference between the gearhead and a bearing assembled on the input side is small.
Note 1. The allowable axial load is the value of an axial load applied along the axis of rotation.

Checking the life of the shaft unit.
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

Size

<table>
<thead>
<tr>
<th>Size 11</th>
<th>Gearhead</th>
<th>HPG-Helical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction ratio = 4</td>
<td>Graph 141-1</td>
<td></td>
</tr>
<tr>
<td>Reduction ratio = 7, 8</td>
<td>Graph 141-3</td>
<td></td>
</tr>
<tr>
<td>Reduction ratio = 9, 10</td>
<td>Graph 141-4</td>
<td></td>
</tr>
<tr>
<td><strong>Reduction ratio = 5, 6</strong></td>
<td>Graph 141-2</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size 14</th>
<th>Gearhead</th>
<th>HPG-Helical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction ratio = 3, 4</td>
<td>Graph 141-6</td>
<td></td>
</tr>
<tr>
<td>Reduction ratio = 7, 8</td>
<td>Graph 141-7</td>
<td></td>
</tr>
<tr>
<td>Reduction ratio = 9, 10</td>
<td>Graph 141-8</td>
<td></td>
</tr>
<tr>
<td><strong>Reduction ratio = 5, 6</strong></td>
<td>Graph 141-6</td>
<td></td>
</tr>
</tbody>
</table>
Technical Data

Size 20: Gearhead  
HPG-Helical

Reduction ratio = 3, 4

Graph 142-1

Reduction ratio = 5, 6

Graph 142-2

Reduction ratio = 7, 8

Graph 142-3

Reduction ratio = 9, 10

Graph 142-4

Efficiency %

Input torque (Nm)

Gearhead with Z bearing (Double shielded)
Gearhead with D bearing (Double sealed)

\[ T_{in} \]

Input torque corresponding to output torque

Note

*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 specification of input shaft bearing.

Specification of input bearing

<table>
<thead>
<tr>
<th>Size</th>
<th>( T_{in} )</th>
<th>( T_{out} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>32</td>
<td>25</td>
</tr>
<tr>
<td>32</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>25</td>
<td>14</td>
<td>11</td>
</tr>
</tbody>
</table>

Allowable moment load \( M_{ci} \), Allowable axial load \( F_{ai} \), Allowable radial load \( F_{ri} \)

\[
M_{ci} = \frac{P_{ci} \times L_{10}}{N_{t}}
\]

\[
F_{ai} = \frac{P_{ai} \times L_{10}}{N_{t}}
\]

\[
F_{ri} = \frac{P_{ri} \times L_{10}}{N_{t}}
\]

Average input speed \( N_{av} \)

Efficiency %

Reduction ratio = 7, 8
Reduction ratio = 9, 10

Graph 142-5

Graph 142-6

Graph 142-7

Graph 142-8

Reduction ratio = 7
Reduction ratio = 9

\[ T_{in} \]

Input torque corresponding to output torque

Technical Information / Handling Explanation

See Table 157-1 and -3
See Table 158-1 and -2
See Formula 158-4
See Fig. 158-1.

How to calculate the average axial load \( F_{ai} \)

\[
F_{ai} = \frac{1}{T} \int_{t_1}^{t_2} F_{ai}(t) \, dt
\]

How to calculate the average moment load \( M_{ai} \)

\[
M_{ai} = \frac{1}{T} \int_{t_1}^{t_2} M_{ai}(t) \, dt
\]

Average input speed \( N_{av} \)
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.

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

<table>
<thead>
<tr>
<th>Size 32 RA3</th>
<th>Right Angle Gearhead</th>
<th>HPG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction ratio = 5</td>
<td>Tn</td>
<td>Graph 143-1</td>
</tr>
<tr>
<td>Reduction ratio = 11</td>
<td>Tn</td>
<td>Graph 143-2</td>
</tr>
<tr>
<td>Reduction ratio = 15, 21</td>
<td>Tn</td>
<td>Graph 143-3</td>
</tr>
<tr>
<td>Reduction ratio = 33, 45</td>
<td>Tn</td>
<td>Graph 143-4</td>
</tr>
</tbody>
</table>

### Reduction ratio = 5

- **Tn** Input torque corresponding to output torque

### Reduction ratio = 11

- **Tn** Input torque corresponding to output torque

### Reduction ratio = 15, 21

- **Tn** Input torque corresponding to output torque

### Reduction ratio = 33, 45

- **Tn** Input torque corresponding to output torque

---

**Technical Data**

- **Input Bearing Specifications and Checking Procedure**
  - See Table 157-1 and -3
  - See Formula 158-4

---

**Gearheads Technical Information / Handling Explanation**

- **Reduction ratio = 5**
  - Tn Input torque corresponding to output torque

- **Reduction ratio = 11**
  - Tn Input torque corresponding to output torque

- **Reduction ratio = 15, 21**
  - Tn Input torque corresponding to output torque

- **Reduction ratio = 33, 45**
  - Tn Input torque corresponding to output torque
**Technical Data**

**Technical Information / Handling Explanation**

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

**Graph 144-2**

Reduction ratio = 11

**Graph 144-3**

Reduction ratio = 15, 21

**Graph 144-4**

Reduction ratio = 33, 45

---

**Graph 144-5**

Reduction ratio = 5

**Graph 144-6**

Reduction ratio = 12, 15

**Graph 144-7**

Reduction ratio = 20, 25

**Graph 144-8**

Reduction ratio = 40, 50

---

**Note**

- **Size 50 RA5**  Right Angle Gearhead  HPG
- **Size 65 RA5**  Right Angle Gearhead  HPG

---

*T* = Input torque corresponding to output torque
**Technical Data**

### Size 11  **HPN**

- **Reduction ratio = 4**
  - [Graph 145-1]
- **Reduction ratio = 5**
  - [Graph 145-2]
- **Reduction ratio = 7**
  - [Graph 145-3]
- **Reduction ratio = 10**
  - [Graph 145-4]
- **Reduction ratio = 15**
  - [Graph 145-5]
- **Reduction ratio = 20, 25**
  - [Graph 145-6]
- **Reduction ratio = 30, 35**
  - [Graph 145-7]
- **Reduction ratio = 40, 45, 50**
  - [Graph 145-8]

### Size 14  **HPN**

- **Reduction ratio = 3**
  - [Graph 145-1]
- **Reduction ratio = 4**
  - [Graph 145-2]
- **Reduction ratio = 5**
  - [Graph 145-3]
- **Reduction ratio = 7**
  - [Graph 145-4]
- **Reduction ratio = 10**
  - [Graph 145-5]
- **Reduction ratio = 15**
  - [Graph 145-6]
- **Reduction ratio = 20, 25**
  - [Graph 145-7]
- **Reduction ratio = 30, 35**
  - [Graph 145-8]
- **Reduction ratio = 40, 45, 50**
  - [Graph 145-9]
Technical Data

Size 20

**HPN**

- **Reduction ratio = 3**
  - Graph 146-10

- **Reduction ratio = 4**
  - Graph 146-11

- **Reduction ratio = 5**
  - Graph 146-12

- **Reduction ratio = 7**
  - Graph 146-13

- **Reduction ratio = 10**
  - Graph 146-14

- **Reduction ratio = 15**
  - Graph 146-15

- **Reduction ratio = 20, 25**
  - Graph 146-16

- **Reduction ratio = 30, 35**
  - Graph 146-17

- **Reduction ratio = 40, 45, 50**
  - Graph 146-18

Size 32

**HPN**

- **Reduction ratio = 3**
  - Graph 146-1

- **Reduction ratio = 4**
  - Graph 146-2

- **Reduction ratio = 5**
  - Graph 146-3

- **Reduction ratio = 7**
  - Graph 146-4

- **Reduction ratio = 10**
  - Graph 146-5

- **Reduction ratio = 15**
  - Graph 146-6

- **Reduction ratio = 20, 25**
  - Graph 146-7

- **Reduction ratio = 30, 35**
  - Graph 146-8

- **Reduction ratio = 40, 45, 50**
  - Graph 146-9

Note

*1 The allowable axial load is the value of an axial load applied along the axis of rotation. Calculate the life and check it.

Efficiency %

<table>
<thead>
<tr>
<th>Gearheads</th>
<th>Input speed</th>
<th>Moment load</th>
<th>Allowable moment load</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPG</td>
<td>N</td>
<td>N</td>
<td>kgf</td>
</tr>
<tr>
<td>HPF</td>
<td>N</td>
<td>N</td>
<td>kgf</td>
</tr>
</tbody>
</table>

See Table 157-1 and -3

How to calculate the average input speed (Nini)

\[
\text{Nini} = \frac{1}{2} \times (\text{Ni} + \text{Nf})
\]

Formula 158-3

\[
L_{ri} = 0.444 \times \text{Mi}
\]

\[
L_{ri} = 1.232 \times F_{ai}
\]

\[
L_{ri} = 2.7 \times F_{ai}
\]
**Input Bearing Specifications and Checking Procedure**

<table>
<thead>
<tr>
<th>Size</th>
<th>HPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Reduction ratio = 3]</td>
<td>[Reduction ratio = 4]</td>
</tr>
<tr>
<td>[Reduction ratio = 7]</td>
<td>[Reduction ratio = 10]</td>
</tr>
<tr>
<td>[Reduction ratio = 20, 25]</td>
<td>[Reduction ratio = 30, 36]</td>
</tr>
</tbody>
</table>

**Technical Data**

- **Maximum radial load** (Fri):
  - Size 40
  - HPN

- **Average input speed** (Nia):
  - Size 40
  - HPN

- **Average moment load** (Mia):
  - Size 40
  - HPN

- **Allowable moment load** (Mai):
  - Size 40
  - HPN

- **Allowable axial load** (Fai):
  - Size 40
  - HPN

- **Allowable radial load** (Fria):
  - Size 40
  - HPN

**Graphs**

- Graph 147-1
- Graph 147-2
- Graph 147-3
- Graph 147-4
- Graph 147-5
- Graph 147-6
- Graph 147-7
- Graph 147-8
- Graph 147-9
Technical Data

**Graph 148-1**

Reduction ratio = 11

<table>
<thead>
<tr>
<th>Efficiency (%)</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input torque</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nm</td>
<td>0</td>
<td>100</td>
<td>90</td>
<td>80</td>
<td>70</td>
<td>60</td>
<td>50</td>
<td>40</td>
<td>30</td>
<td>20</td>
<td>10</td>
</tr>
</tbody>
</table>

**Graph 148-2**

Reduction ratio = 11

<table>
<thead>
<tr>
<th>Efficiency (%)</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input torque</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nm</td>
<td>0</td>
<td>100</td>
<td>90</td>
<td>80</td>
<td>70</td>
<td>60</td>
<td>50</td>
<td>40</td>
<td>30</td>
<td>20</td>
<td>10</td>
</tr>
</tbody>
</table>

---

**Technical Data**

- **Input Bearing Specifications and Checking Procedure**
  - **Allowable Moment Load**
    - **Mc** (Allowable Moment Load)
    - **Fac** (Allowable Axial Load)
  - **Basic Load Rating**
    - **Cr** (Basic Dynamic Load Rating)
    - **Cor** (Basic Static Load Rating)
  - **Check the Maximum Load and Life of the Bearing**
  - **Check that the Following Formulas are Established in All Circumstances**
  - **Calculation of Maximum Load**
    - **Fmax** = 1.232 × **Fai**
  - **Calculation of Average Load**
    - **Nia** = 0.041 × **M1** + 0.016 × **M2**
  - **Calculation of Average Input Speed**
    - **Niav** = 35500 × **n1** + 9700 × **n2**
  - **Calculation of Dynamic Equivalent Load**
    - **Lai** = 2.7 × **Fai**
  - **Check the Life of the Bearing**
    - **Lri** = 1.232 × **Fai**

---

**Input Torque Corresponding to Output Torque (TRi)**

<table>
<thead>
<tr>
<th>Efficiency (%)</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Torque</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nm</td>
<td>0</td>
<td>100</td>
<td>90</td>
<td>80</td>
<td>70</td>
<td>60</td>
<td>50</td>
<td>40</td>
<td>30</td>
<td>20</td>
<td>10</td>
</tr>
</tbody>
</table>

---

**Technical Information / Handling Explanation**

- **Size 25**: Hollow Shaft Unit
- **Size 32**: Hollow Shaft Unit
- **Size 50**: RA5

---

*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 to the point of 20 mm from the shaft edge (input flange edge).
**Technical Data**

### Technical Information / Handling Explanation

- **Graph 149-1**
  - **Efficiency %**
  - **Input torque Ncm**

- **Graph 149-2**
  - **Efficiency %**
  - **Input torque Ncm**

- **Graph 149-3**
  - **Efficiency %**
  - **Input torque Ncm**

- **Graph 149-4**
  - **Efficiency %**
  - **Input torque Ncm**

- **Graph 149-5**
  - **Efficiency %**
  - **Input torque Ncm**

- **Graph 149-6**
  - **Efficiency %**
  - **Input torque Ncm**

- **Graph 149-7**
  - **Efficiency %**
  - **Input torque Ncm**

- **Graph 149-8**
  - **Efficiency %**
  - **Input torque Ncm**

**Technical Data**

### Reduction ratio = 50

#### Gearhead CSG-GH CSF-GH

**Input rotational speed**
- 500 rpm
- 1000 rpm
- 2000 rpm
- 3500 rpm

### Reduction ratio = 80

#### Gearhead CSG-GH CSF-GH

**Input rotational speed**
- 500 rpm
- 1000 rpm
- 2000 rpm
- 3500 rpm

### Reduction ratio = 100

#### Gearhead CSG-GH CSF-GH

**Input rotational speed**
- 500 rpm
- 1000 rpm
- 2000 rpm
- 3500 rpm

### Reduction ratio = 120

#### Gearhead CSG-GH CSF-GH

**Input rotational speed**
- 500 rpm
- 1000 rpm
- 2000 rpm
- 3500 rpm

### Reduction ratio = 160

#### Gearhead CSG-GH CSF-GH

**Input rotational speed**
- 500 rpm
- 1000 rpm
- 2000 rpm
- 3500 rpm

---

*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.

### Specification of input bearing

<table>
<thead>
<tr>
<th>Size</th>
<th>65</th>
<th>50</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>25</td>
<td>32</td>
<td>14</td>
</tr>
<tr>
<td>50</td>
<td>32</td>
<td>25</td>
<td>11</td>
</tr>
</tbody>
</table>

### Calculate:

- Table 157-2 and 157-4

<table>
<thead>
<tr>
<th>Allowable moment load Mc</th>
<th>Allowable axial load Fac</th>
<th>Allowable radial load Frc</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.16</td>
<td>210</td>
<td>9700</td>
</tr>
<tr>
<td>0.016</td>
<td>4.53</td>
<td>14500</td>
</tr>
<tr>
<td>0.64</td>
<td>1.38</td>
<td>21.4</td>
</tr>
<tr>
<td>1.02</td>
<td>3600</td>
<td>360</td>
</tr>
</tbody>
</table>

### Technical Information / Handling Explanation

- **Gearhead**
  - **CSG-GH**
  - **CSF-GH**

- **Input rotational speed**
  - 500 rpm
  - 1000 rpm
  - 2000 rpm
  - 3500 rpm

- **Efficiency %**
  - 30%
  - 60%
  - 90%

- **Input torque Ncm**
  - 500 rpm
  - 1000 rpm
  - 2000 rpm
  - 3500 rpm

---

**Formula 158-1**

- **Dynamic equivalent load**
  - **N (kgf)**
  - **N (kgf)**
  - **N (kgf)**

- **Graph 150-4**
  - **Graph 150-5**
  - **Graph 150-6**
  - **Graph 150-7**
  - **Graph 150-8**

- **Graph 150-9**
  - **Graph 150-10**

---

**Reduction ratio**

- 50
- 80
- 100
- 120
- 160
### Technical Data

#### Gearhead: CSG-GH / CSF-GH

**Reduction ratio = 50**

[Graph 150-1]

- **Input rotational speed:**
  - 500 rpm
  - 1000 rpm
  - 2000 rpm
  - 3500 rpm

**Reduction ratio = 80**

[Graph 150-2]

**Reduction ratio = 100**

[Graph 150-3]

**Reduction ratio = 120**

[Graph 150-4]

**Reduction ratio = 160**

[Graph 150-5]

---

**Size 45**

- **Gearhead:** CSG-GH / CSF-GH

**Reduction ratio = 50**

[Graph 150-6]

**Reduction ratio = 80**

[Graph 150-7]

**Reduction ratio = 100**

[Graph 150-8]

**Reduction ratio = 120**

[Graph 150-9]

**Reduction ratio = 160**

[Graph 150-10]

**Input rotational speed:**
- 500 rpm
- 1000 rpm
- 2000 rpm
- 3500 rpm

---

**Input Bearing Specifications and Checking Procedure**

- See Table 157-1 and -3
- See Table 158-1 and -2

**Calculating life of input bearing**

\[
\text{Life} = \frac{10^6}{C_r N}
\]

where:
- \(C_r\): Basic load rating
- \(N\): Average input speed

**Calculating maximum moment load ON input shaft**

\[
M_c = \frac{N}{t_1} N (kgf)
\]

where:
- \(M_c\): Allowable moment load
- \(t_1\): Average input speed

**Calculating formula**

\[
F_{ai} = \frac{1}{2} F_{ai} \text{max}
\]

where:
- \(F_{ai}\): Allowable axial load

**How to calculate the average axial load**

\[
F_{ai} \text{av} = \frac{1}{2} F_{ai} \text{max}
\]

**How to calculate the average moment load**

\[
M_{1} \text{av} = \frac{1}{2} M_{1} \text{max}
\]

**Calculating formulas**

\[
L_{ri} = \frac{1}{2} L_{ri} \text{max}
\]

\[
L_{ai} = \frac{1}{2} L_{ai} \text{max}
\]

**Technical Data**

- Input speed
- Moment load
- Life

---

**Graphs**

- Graph 149-1
- Graph 149-4
- Graph 149-5
- Graph 149-6
- Graph 150-1
- Graph 150-2
- Graph 150-3
- Graph 150-4
- Graph 150-5
- Graph 150-6
- Graph 150-7
- Graph 150-8
- Graph 150-9
- Graph 150-10

---

**Technical Information / Handling Explanation**

- Reducer size
- Reduction ratio
- Efficiency
- Gearhead
- Input torque
- Nm
- rpm

---

**Formulas**

- Formula 158-1
- Formula 158-2
- Formula 158-3
- Formula 158-4

---

**Specifications**

- Size 20
- Reduction ratio = 50
- Efficiency %
- Gearhead
- Graph 149-1

---

**Specifications**

- Size 32
- Gearhead
- Reduction ratio = 50
- Efficiency %
- Graph 149-4

---

**Specifications**

- Size 45
- Gearhead
- Reduction ratio = 50
- Efficiency %
- Graph 150-1
Technical Data

Size 65: Gearhead

Reduction ratio = 80

Graph 151-1

Reduction ratio = 100

Graph 151-2

Reduction ratio = 120

Graph 151-3

Reduction ratio = 160

Graph 151-4

Input rotational speed

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

Technical Information / Handling Explanation

Note ʤ

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

(2) Checking the life

Shaft unit.

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 bearing

<table>
<thead>
<tr>
<th>Size</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>25</td>
<td>32</td>
<td></td>
</tr>
</tbody>
</table>

Checking procedure

- Maximum radial load (Fr max)
- Maximum axial load (Fai max)
- Average input speed (Ni av)
- Average axial load (Fai av)
- Average moment load (Mi av)

Calculate:

Table 157-2 and 157-4

Allowable moment load (Mc)

Allowable axial load (Fai)

Allowable radial load (Frc)

Basic load rating

- Basic dynamic load rating (Cr)
- Basic static load rating (Cor)

Graph 151-1

Graph 151-2

Graph 151-3

Graph 151-4

External load influence diagram

Input torque (Ncm)

Graph 158-1

Graph 158-2

Graph 158-3

Graph 158-4

Formula 158-1

Formula 158-2

Formula 158-3

Formula 158-4

See Table 158-1 and -2

See Fig. 158-1.

Calculating maximum moment load ON input shaft

Calculating life of input bearing

Calculating average load

How to calculate average load

Reduction ratio = 100

Reduction ratio = 160

Reduction ratio = 200

Reduction ratio = 300

Input torque

Efficiency %

Graph 151-1

Graph 151-2

Graph 151-3

Graph 151-4

Input rotational speed

- 500 rpm
- 1000 rpm
- 2000 rpm
- 3500 rpm
Output Shaft Bearing Load Limits

HPN Series Output Shaft Load Limits are plotted below.

HPN uses deep groove 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** ($M_{max}$)
   - Calculate the maximum moment load ($M_{max}$).
   - Maximum moment load ($M_{max}$) - Permissible moment ($M_c$)

2. **Checking the life**
   - Calculate the average radial load ($F_{av}$) and the axial load ($F_{ai}$).
   - Calculate the radial load coefficient ($X$) and the axial load coefficient ($Y$).
   - Calculate the life and check it.

3. **Checking the static safety coefficient**
   - Calculate the equivalent radial load ($P_{ci}$) and the average axial load.
   - Check the static safety coefficient ($f_s$).

**Specification of output bearing**

<table>
<thead>
<tr>
<th>Table 153-1</th>
<th>Table 153-2</th>
<th>Table 153-3</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Size</th>
<th>Gearheads</th>
<th>Technical Data</th>
</tr>
</thead>
</table>

**Note:** Table 153-1, -2 and -3 Table 154-1 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 ($4kN/mm^2$) 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. ($L_r + R = 0$ mm for radial load and $L_a = 0$ mm for axial load). If a compound load applies, refer to the calculations shown on the next page.
### CSG-GH/CSF-GH Series

Table 154-1 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</th>
<th>Moment stiffness Km</th>
<th>Allowable axial load Fac</th>
<th>Allowable radial load Frc</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>m</td>
<td>m</td>
<td>N</td>
<td>kgf</td>
<td>N</td>
<td>kgf</td>
<td>N</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>
<td>Fr</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>
<td>Fr</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>
<td>Fr</td>
</tr>
<tr>
<td>45</td>
<td>0.123</td>
<td>0.019</td>
<td>41600</td>
<td>4245</td>
<td>76000</td>
<td>7755</td>
<td>Fr</td>
</tr>
<tr>
<td>65</td>
<td>0.170</td>
<td>0.0225</td>
<td>81800</td>
<td>8327</td>
<td>149000</td>
<td>15204</td>
<td>Fr</td>
</tr>
</tbody>
</table>

### HPF Series

Table 154-2 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</th>
<th>Moment stiffness Km</th>
<th>Allowable axial load Fac</th>
<th>Allowable radial load Frc</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>m</td>
<td>m</td>
<td>N</td>
<td>kgf</td>
<td>N</td>
<td>kgf</td>
<td>N</td>
</tr>
<tr>
<td>25</td>
<td>0.085</td>
<td>0.0153</td>
<td>11400</td>
<td>1163</td>
<td>20300</td>
<td>2071</td>
<td>Fr</td>
</tr>
<tr>
<td>32</td>
<td>0.1115</td>
<td>0.015</td>
<td>22500</td>
<td>2296</td>
<td>39900</td>
<td>4071</td>
<td>Fr</td>
</tr>
</tbody>
</table>

[Note: Table 153-1, 2 and 3 Table 154-1 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.
Technical Data

How to calculate the maximum moment load

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

\[
M_{max} = Fr \ max \ (Lr+R) + Fa \ max \ La
\]

| Fr \ max | Max. radial load \( N \) (kgf) | See Fig. 155-1. |
| Fa \ max | Max. axial load \( N \) (kgf) | See Fig. 155-1. |
| Lr, La | \( m \) | See Fig. 155-1. |
| R | Offset amount \( m \) | See "Output Bearing Specifications" of each series, p. 153 & 154 |
| \( dp \) | Circular pitch of roller \( m \) | See Fig. 155-1. |

How to calculate the radial and the axial load coefficient

The radial load coefficient \( X \) and the axial load coefficient \( Y \) can be calculated as follows:

\[
X = \frac{Fa}{Fr \ av} \bigg| \begin{array}{c}
Fr \ av = \frac{Fr_{av} + 2(Fr_{av} + Fa_{av} - La)}{dp} \leq 1.5 \\
Fr \ av = \frac{Fr_{av} + 2(Fr_{av} + Fa_{av} - La)}{dp} > 1.5
\end{array}
\]

<table>
<thead>
<tr>
<th>Formula</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Fr_{av} = \frac{Fr_{av} + 2(Fr_{av} + Fa_{av} - La)}{dp} \leq 1.5 )</td>
<td>1</td>
<td>0.45</td>
</tr>
<tr>
<td>( Fr_{av} = \frac{Fr_{av} + 2(Fr_{av} + Fa_{av} - La)}{dp} &gt; 1.5 )</td>
<td>0.67</td>
<td>0.67</td>
</tr>
</tbody>
</table>

| Fr \ av | Average radial load \( N \) (kgf) | See "How to calculate the average load below."
| Fa \ av | Average axial load \( N \) (kgf) | See "How to calculate the average load below."
| Lr, La | \( m \) | See Fig. 155-1. |
| R | Offset amount \( m \) | See Fig. 155-1. |
| \( dp \) | Circular pitch of roller \( m \) | See Fig. 155-1. |

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 calculate the average load (Frav)

\[
Fr_{av} = \sqrt{\frac{n_{t1} \ (Fr_{1})^{10.0} + n_{t2} \ (Fr_{2})^{10.0} + \cdots + n_{t} \ (Fr_{n})^{10.0}}{n_{t1} + n_{t2} + \cdots + n_{t}}}
\]

Note that the maximum radial load within the \( t_1 \) section is \( Fr_1 \) and the maximum radial load within the \( t_n \) section is \( Fr_n \).

### How to calculate the average axial load (Faav)

\[
Fa_{av} = \sqrt{\frac{n_{t1} \ (Fa_{1})^{10.0} + n_{t2} \ (Fa_{2})^{10.0} + \cdots + n_{t} \ (Fa_{n})^{10.0}}{n_{t1} + n_{t2} + \cdots + n_{t}}}
\]

Note that the maximum axial load within the \( t_1 \) section is \( Fa_1 \) and the maximum axial load within the \( t_n \) section is \( Fa_n \).

### How to calculate the average output speed (Nav)

\[
Nav = \frac{n_{t1} + n_{t2} + \cdots + n_{t}}{t_1 + t_2 + \cdots + t_n}
\]
How to calculate the life of the cross roller bearing using Formula 156-1. You can obtain the dynamic equivalent load (Pc) using Formula 156-2.

\[
L_0 = \frac{10^6}{60 \times N_{av} \times \left( \frac{C}{\text{fw} \times \text{Pc}} \right)^{1/3}}
\]

See Table 156-1.

### Load coefficient

<table>
<thead>
<tr>
<th>Load status</th>
<th>fw</th>
</tr>
</thead>
<tbody>
<tr>
<td>During smooth operation without impact or vibration</td>
<td>1 to 1.2</td>
</tr>
<tr>
<td>During normal operation</td>
<td>1.2 to 1.5</td>
</tr>
<tr>
<td>During operation with impact or vibration</td>
<td>1.5 to 3</td>
</tr>
</tbody>
</table>

How to calculate the life during oscillating motion

Calculate the life of the cross roller bearing during oscillating motion by Formula 156-3.

\[
L_{oc} = \frac{10^6 \times 90 \times C}{60 \times n1 \times \text{fw} \times \text{Pc}}
\]

See Table 156-1.

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.

How to calculate the static safety coefficient

In general, the basic static load rating (Co) 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 (fs) of the cross roller bearing using Formula 156-4.

\[
fs = \frac{Co}{Po}
\]

See Table 156-2.

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

Static safety coefficient

Po = Fr max + \( \frac{2M_{max} \times 0.44Fa_{max}}{dp} \)

See Table 156-2 and -3.
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 \( (\text{Mi}_{\text{max}}) \)
  - Maximum axial load \( (F_{\text{ai}}_{\text{max}}) \)
  - Maximum radial load \( (F_{\text{rc}}_{\text{max}}) \)

\[
\text{Maximum moment load (Mi max)} \leq \text{Allowable moment load (Mc)}
\]

\[
\text{Maximum axial load (Fai max)} \leq \text{Allowable axial load (Fac)}
\]

\[
\text{Maximum radial load (Frc max)} \leq \text{Allowable radial load (Frc)}
\]

#### (2) Checking the life

- Calculate:
  - Average moment load \( (M_i) \)
  - Average axial load \( (F_{ai}) \)
  - Average input speed \( (N_{i}) \)

\[
\text{Calculate the life and check it.}
\]

### Specification of input bearing

#### Specification of input bearing

<table>
<thead>
<tr>
<th>Size</th>
<th>Basic load rating</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic dynamic load rating ( C_r )</td>
<td>Basic static load rating ( C_{or} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>( N )</td>
<td>kgf</td>
<td>( N )</td>
<td>kgf</td>
</tr>
<tr>
<td>11</td>
<td>2700</td>
<td>275</td>
<td>1270</td>
<td>129</td>
</tr>
<tr>
<td>14</td>
<td>5800</td>
<td>590</td>
<td>3150</td>
<td>320</td>
</tr>
<tr>
<td>20</td>
<td>9700</td>
<td>990</td>
<td>5600</td>
<td>570</td>
</tr>
<tr>
<td>32</td>
<td>22500</td>
<td>2300</td>
<td>14800</td>
<td>1510</td>
</tr>
<tr>
<td>50</td>
<td>35500</td>
<td>3600</td>
<td>25100</td>
<td>2560</td>
</tr>
<tr>
<td>65</td>
<td>51000</td>
<td>5200</td>
<td>39500</td>
<td>4050</td>
</tr>
</tbody>
</table>

#### Specification of input shaft bearing

<table>
<thead>
<tr>
<th>Size</th>
<th>Allowable moment load ( M_c )</th>
<th>Allowable axial load ( F_{ai} )</th>
<th>Allowable radial load ( F_{rc} )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( Nm )</td>
<td>kgf</td>
<td>( \text{N} )</td>
</tr>
<tr>
<td>11</td>
<td>0.16</td>
<td>0.016</td>
<td>245</td>
</tr>
<tr>
<td>14</td>
<td>6.3</td>
<td>0.64</td>
<td>657</td>
</tr>
<tr>
<td>20</td>
<td>13.5</td>
<td>1.38</td>
<td>1206</td>
</tr>
<tr>
<td>32</td>
<td>44.4</td>
<td>4.53</td>
<td>3285</td>
</tr>
<tr>
<td>50</td>
<td>96.9</td>
<td>9.88</td>
<td>5540</td>
</tr>
<tr>
<td>65</td>
<td>210</td>
<td>21.4</td>
<td>8600</td>
</tr>
</tbody>
</table>

(Note: Table 157-2 and 157-4)

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 HPF 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**

*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.

**Checking the life**

**Shaft unit.** 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**

**Size**

<table>
<thead>
<tr>
<th>Size</th>
<th>Size</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>65</td>
<td>25</td>
</tr>
</tbody>
</table>

**Checking procedure**

Calculate: $L_{av} = \frac{10^6}{60 \times N_{av}} \times \left( \frac{C_r}{Pci} \right)^{2/3}$

$L_{av}$ = Life (Hour)  

$N_{av}$ = Average input speed (rpm) See Formula 158-4  

$C_r$ = Basic dynamic load rating (N) See Table 157-1 and -3  

$Pci$ = Dynamic equivalent load (N) See Table 158-1 and -2

**Calculation of maximum moment load**

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

$M_{iav} = \frac{n_k \left( M_i \right)^3 + n_k \left( M_i \right)^2 \cdots + n_k \left( M_i \right)}{t_k + t_z + \cdots + t_k}$

$M_{iav} \leq M_{cav}$ (Allowable moment load)

$F_{aiav} \leq F_{aci}$ (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 ($M_{iav}$)**

$M_{iav} = \frac{n_k \left( M_i \right)^3 + n_k \left( M_i \right)^2 \cdots + n_k \left( M_i \right)}{t_k + t_z + \cdots + t_k}$

**How to calculate the average axial load ($F_{aiav}$)**

$F_{aiav} = \frac{n_k \left( F_{ai} \right)^3 + n_k \left( F_{ai} \right)^2 \cdots + n_k \left( F_{ai} \right)}{t_k + t_z + \cdots + t_k}$

**How to calculate the average input speed ($Niav$)**

$Niav = \frac{n_k + n_z + \cdots + n_k}{t_k + t_z + \cdots + t_k}$

**Calculating life of input bearing**

Calculate the bearing life according to Calculation Formula 158-5 and check the life.

$L_{av} = \frac{10^6}{60 \times N_{av}} \times \left( \frac{C_r}{Pci} \right)^{2/3}$

**Technical Data**

See Table 158-1 and -2

**Dynamic equivalent load**

**HPG**

<table>
<thead>
<tr>
<th>Size</th>
<th>11</th>
<th>14</th>
<th>20</th>
<th>32</th>
<th>50</th>
<th>65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pci</td>
<td>0.444 $\times$ Mi $av$ + 1.426 $\times$ Fai $av$</td>
<td>0.137 $\times$ Mi $av$ + 1.232 $\times$ Fai $av$</td>
<td>0.109 $\times$ Mi $av$ + 1.232 $\times$ Fai $av$</td>
<td>0.071 $\times$ Mi $av$ + 1.232 $\times$ Fai $av$</td>
<td>0.053 $\times$ Mi $av$ + 1.232 $\times$ Fai $av$</td>
<td>0.041 $\times$ Mi $av$ + 1.232 $\times$ Fai $av$</td>
</tr>
</tbody>
</table>

**HPF**

<table>
<thead>
<tr>
<th>Size</th>
<th>25</th>
<th>32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pci</td>
<td>121 $\times$ Mi $av$ + 2.7 $\times$ Fai $av$</td>
<td>106 $\times$ Mi $av$ + 2.7 $\times$ Fai $av$</td>
</tr>
</tbody>
</table>

$M_{iav}$ = Average moment load Nm (kgf)  

$F_{aiav}$ = Average axial load N (kgf)
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 to figure 159-1

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.

<table>
<thead>
<tr>
<th>Bolt tightening torque</th>
<th>Table 159-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolt size</td>
<td>M3</td>
</tr>
<tr>
<td>Tightening torque (Nm)</td>
<td>2.0</td>
</tr>
<tr>
<td>(kgf)</td>
<td>0.20</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 (HPG helical). Tighten the screws to the tightening torque specified below.

| Bolt size | M3 |
| Tightening torque (Nm) | 0.69 |
| (kgf) | 0.07 |

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

<table>
<thead>
<tr>
<th>Bolt tightening torque</th>
<th>Table 159-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolt size</td>
<td>M2.5</td>
</tr>
<tr>
<td>Tightening torque (Nm)</td>
<td>0.59</td>
</tr>
<tr>
<td>(kgf)</td>
<td>0.06</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.

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

### Speed reducer assembly

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 / HPG / CSG-GH / CSF-GH</th>
<th>HPF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>Number of bolts</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>
</tr>
<tr>
<td>Mounting PCD (mm)</td>
<td>50</td>
<td>70</td>
<td>100</td>
</tr>
<tr>
<td>Tightening torque (Nm)</td>
<td>1.4</td>
<td>6.3</td>
<td>10.7</td>
</tr>
<tr>
<td>Transmission torque (kgf-m)</td>
<td>2.85</td>
<td>11.3</td>
<td>22.8</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.

**Output flange mounting specifications**

**Bolt* tightening torque for output flange (Part B in the Figure 160-1)**

<table>
<thead>
<tr>
<th>Size</th>
<th>HPGP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>11</td>
</tr>
<tr>
<td>Number of bolts</td>
<td>4</td>
</tr>
<tr>
<td>Bolt size</td>
<td>M4</td>
</tr>
<tr>
<td>Mounting PCD (mm)</td>
<td>18</td>
</tr>
<tr>
<td>Tightening torque (Nm)</td>
<td>4.5</td>
</tr>
<tr>
<td>Transmission torque (kgf-m)</td>
<td>0.46</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 160-1)**

<table>
<thead>
<tr>
<th>Size</th>
<th>HPG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>11</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 (mm)</td>
<td>18</td>
</tr>
<tr>
<td>Tightening torque (Nm)</td>
<td>4.5</td>
</tr>
<tr>
<td>Transmission torque (kgf-m)</td>
<td>0.46</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

Bolt* tightening torque for output flange (Part B in Figure 160-1)  

<table>
<thead>
<tr>
<th>Size</th>
<th>14</th>
<th>20</th>
<th>22</th>
<th>25</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>
<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>
<td></td>
<td></td>
</tr>
<tr>
<td>Mounting PCD</td>
<td>mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tightening torque</td>
<td>Nm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmission torque</td>
<td>Nm</td>
<td>kgf</td>
<td>kgf</td>
<td>kgf</td>
<td>kgf</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bolt* tightening torque for output flange (Part B in Figure 160-1)  

<table>
<thead>
<tr>
<th>Size</th>
<th>14</th>
<th>20</th>
<th>22</th>
<th>25</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>
<td>8</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>
<td></td>
<td></td>
</tr>
<tr>
<td>Mounting PCD</td>
<td>mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tightening torque</td>
<td>Nm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmission torque</td>
<td>Nm</td>
<td>kgf</td>
<td>kgf</td>
<td>kgf</td>
<td>kgf</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bolt* tightening torque for output flange (Part B in Figure 160-1)  

<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></td>
</tr>
<tr>
<td>Tightening torque</td>
<td>Nm</td>
<td></td>
</tr>
<tr>
<td>Transmission torque</td>
<td>Nm</td>
<td>kgf</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.

<table>
<thead>
<tr>
<th>HPGP</th>
<th>HPG</th>
<th>CSG-GH</th>
<th>CSF-GH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>Axial runout of output flange</td>
<td>Radial runout of output flange pilot or output shaft</td>
<td>Perpendicularity of mounting flange</td>
</tr>
<tr>
<td>11</td>
<td>0.020</td>
<td>0.030</td>
<td>0.050</td>
</tr>
<tr>
<td>14</td>
<td>0.020</td>
<td>0.040</td>
<td>0.060</td>
</tr>
<tr>
<td>20</td>
<td>0.020</td>
<td>0.040</td>
<td>0.060</td>
</tr>
<tr>
<td>32</td>
<td>0.020</td>
<td>0.040</td>
<td>0.060</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HPGP</th>
<th>HPG</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>0.020</td>
</tr>
<tr>
<td>65</td>
<td>0.040</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CSG-GH</th>
<th>CSF-GH</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>0.020</td>
</tr>
<tr>
<td>65</td>
<td>0.020</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HPF</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
</tr>
<tr>
<td>32</td>
</tr>
</tbody>
</table>

* T.I.R.: Total indicator reading

**Note**

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

**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 bearing**
  - **Size**: 65, 50, 20, 32
  - **Axial runout**: 0.050, 0.060
  - **Radial runout**: 0.040, 0.060
  - **Perpendicularity**: 0.060, 0.080
  - **Concentricity of mounting flange**: 0.050

**Calculating maximum moment load**

ON input shaft

- **Average input speed (Ni)**
- **Average moment load (Mi)**
- **Allowable moment load (Mc)**
- **Allowable axial load (Fac)**
- **Allowable radial load (Frc)**

**Calculating bearing life**

According to Calculation Formula 158-4

- **T1**
- **T2**
- **T3**
- **T4**

See Table 157-1 and -2

See Formula 158-4
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 cap 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 (HPGP/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 54 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 HPGP/HPG 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

HGP/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 (HPGP/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 (HPGP/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 viscose

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.
**CSG-GH/CSF-GH Series**

The standard lubrication for the CSG-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**

<table>
<thead>
<tr>
<th>Harmonic Grease SK-1A</th>
<th>Harmonic Grease SK-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Size 20, 32, 45, 65)</td>
<td>(Size 14)</td>
</tr>
<tr>
<td>Manufacturer: Harmonic Drive Systems Inc.</td>
<td>Manufacturer: Harmonic Drive Systems Inc.</td>
</tr>
<tr>
<td>This grease has been developed exclusively for HarmonicDrive® gears and is excellent in durability and efficiency compared to commercial general-purpose grease.</td>
<td>This grease has been developed exclusively for smaller sized HarmonicDrive® gears and allows smooth wave generator rotation.</td>
</tr>
</tbody>
</table>

| Base oil: Refined mineral oil | Base oil: Refined mineral oil |
| Additive: Extreme pressure agent and other | Additive: Extreme pressure agent and other |
| Consistency: 265 to 295 at 25°C | Consistency: 265 to 295 at 25°C |
| Dropping point: 197°C | Dropping point: 198°C |
| Color: Yellow | Color: Green |
| Standard: NLGI No. 2 | Standard: NLGI No. 2 |

**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: 

$$ L_{ct} = \frac{L_{gt}}{T_{av}} x \left( \frac{T_{r}}{T_{av}} \right) ^ 3 $$

**Formula symbols**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_{ct}$</td>
<td>Grease change interval when $T_{av} &gt; T_{r}$</td>
</tr>
<tr>
<td>$L_{gt}$</td>
<td>Grease change interval when $T_{av} = T_{r}$</td>
</tr>
<tr>
<td>$T_{r}$</td>
<td>Output torque at 2000 rpm</td>
</tr>
<tr>
<td>$T_{av}$</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 164-2 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
- Vacuum environments
- Automotive equipment
- Personal recreation equipment
- Equipment that directly works on human bodies
- Equipment for transport of humans
- Equipment for use in a special environment
- Medical equipment

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>Install the equipment with the required precision.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please ensure to comply with the following environmental conditions:</td>
<td></td>
</tr>
<tr>
<td>• Ambient temperature 0 to 40°C</td>
<td></td>
</tr>
<tr>
<td>• Prevent splashing of water or oil</td>
<td></td>
</tr>
<tr>
<td>• Do not expose to corrosive or explosive gas</td>
<td></td>
</tr>
<tr>
<td>• Do not use dust such as metal powder</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Caution</th>
<th>Use only in the proper environment.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do not hit the gear or any part with a hammer.</td>
<td></td>
</tr>
<tr>
<td>Do not use the equipment in a damaged condition; the gearhead may not perform to catalog specifications.</td>
<td></td>
</tr>
</tbody>
</table>

### Handling Lubricant

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

### Disposal of waste oil and containers

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

### Storage

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

### Disposal

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

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* HarmonicPlanetary® is a registered trademark of Harmonic Drive LLC.

* HarmonicDrive® is a registered trademark of Harmonic Drive LLC.

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166 HarmonicPlanetary® & HarmonicDrive® Gearheads
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

Harmonic Drive® 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.

Other Products

Experts in Precision Motion Control
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.

Other Products