**Harmonic Planetary**

**HPG Right Angle Series**

**Size**
- 32, 50, 65

**Peak torque**
- 150Nm – 2200Nm

**Reduction ratio**
- Single Stage: 5:1, Two Stage: 11:1 to 50:1

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

**High efficiency**
- Up to 92%

**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® coupling

---

**CONTENTS**

- Rating Table ........................................... 53
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- Outline Dimensions ................................. 56-59
- Product Sizing & Selection ......................... 60-61

---

**HPG - 32 A - 05 - J2 - RA3 - Motor Code**

<table>
<thead>
<tr>
<th>Model Name</th>
<th>Size</th>
<th>Design Revision</th>
<th>Reduction Ratio</th>
<th>Output Configuration</th>
<th>Right Angle Specification</th>
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<tr>
<td>HPG Right Angle</td>
<td>32</td>
<td>A</td>
<td>5, 11, 15, 21, 33, 45</td>
<td>F5: Flange output</td>
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<td>RA3, RA5</td>
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This code represents the motor mounting configuration. Please contact us for a unique part number based on the motor you are using.

---

**Gearhead Construction**

- Motor mounting flange
- Input rotational direction
- Mounting pilot
- Output flange
- Output rotational direction
- Output end oil seal
- Cross roller bearing
- Mounting bolt hole
- Rubber cap
- Quick Connect® coupling
- Screw plug (Nick)

(Note) Do not remove the screw plug and seal cap. Removing them may cause leakage of grease or deterioration in precision.

---

**Figure 052-1**
### Rating Table

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<tr>
<th>Size</th>
<th>Model</th>
<th>Ratio</th>
<th>Rated Torque L10</th>
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<td>2200</td>
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</tr>
</tbody>
</table>

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. 60.

3: The limit for torque during start and stop cycles. Always operate below this value.

4: The limit for torque during emergency stops or from external shock loads.

5: Max value of average input rotational speed during operation.

6: Maximum instantaneous input speed.
## Performance Table

<table>
<thead>
<tr>
<th>Size</th>
<th>Model</th>
<th>Ratio</th>
<th>Accuracy &quot;a&quot;</th>
<th>Repeatability &quot;b&quot;</th>
<th>Starting torque &quot;c&quot;</th>
<th>Backdriving torque &quot;d&quot;</th>
<th>No-load running torque &quot;e&quot;</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>arc min</td>
<td>arc sec</td>
<td>Nm</td>
<td>Nm</td>
<td>Ncm</td>
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<td>±15</td>
<td>122</td>
<td>61</td>
<td>453</td>
</tr>
</tbody>
</table>

*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 "a". The values in the table are maximum values.

*3: Starting torque is the torque 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 25°C.

*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 25°C. 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 gearhead at a given speed under a no-load condition. The values in the table are average values, and are based on 25°C at 1300 rpm for RA5 and 1500 rpm for RA3.
Backlash and Torsional Stiffness

### Right Angle

<table>
<thead>
<tr>
<th>Size</th>
<th>Model</th>
<th>Ratio</th>
<th>Backlash</th>
<th>Torsion angle in one direction at Tr X 0.15</th>
<th>Torsional stiffness</th>
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**Torsional stiffness curve**
With the input of the gear locked in place, a torque applied to the output flange will torsionally deflect in proportion to the applied torque. We generate a torsional stiffness curve by slowly applying torque to the output in the following sequence:

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

A loop of (1) > (2) > (3) > (4) > (5) will be drawn as in Fig. 055-1. The torsional stiffness in the region from “0.15 x Tr,” to “Tr,” is calculated using the average value of this slope. The torsional stiffness in the region from “zero torque” to “0.15 x Tr,” is lower. This is caused by the small amount of backlash plus engagement of the mating parts and loading of the planet gears under the initial torque applied.

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

**Calculation formula**

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

- \( \theta \)  Total torsion angle
- \( D \)  Torsion angle in one direction at output torque x 0.15 torque  See Fig. 055-1, Table 055-1
- \( T \)  Load torque
- \( Tr \)  Output torque x 0.15 torque ( = T x 0.15)  See Fig. 055-1
- \( A / B \)  Torsional stiffness  See Fig. 055-1, Table 055-1

**Backlash (Hysteresis loss)**
The vertical distance between points (2) & (4) in Fig. 055-1 is called a hysteresis loss. The hysteresis loss between “Clockwise load torque Tr,” and “Counter Clockwise load torque -Tr,” is defined as the backlash of the HPG series. Backlash of the HPG Right Angle series is less than 3 arc-min.

**Figure 055-1**

**Torque-torsion angle diagram**

- \( Tr \): Rated output torque
- \( A / B \): Torsional stiffness
- \( D \): Torsion angle in one direction at Tr x 0.15
- \( T \): Load torque
- \( Tr \): Output torque x 0.15 torque ( = T x 0.15)
**HPG-32RA 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**

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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>N</th>
<th>Mass (kg)</th>
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</thead>
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<td>Min.</td>
<td>Max.*1</td>
<td>Max.</td>
<td>Min.</td>
<td>Max.*1</td>
<td>Max.</td>
<td>Min.</td>
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<td>125</td>
<td>235</td>
<td>10</td>
<td>35</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 The mass will vary slightly depending on the ratio and on the inside diameter of the input shaft coupling.
*2 Tapped hole for mounting screw.
*3 May vary depending on motor interface dimensions.

**Moment of Inertia, Input Side**

<table>
<thead>
<tr>
<th>Coupling</th>
<th>Ratio</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 32RA</td>
<td>1</td>
<td>6.7</td>
<td>6.3</td>
<td>6.1</td>
<td>5.8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>8.09</td>
<td>7.62</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
HPG-50RA3 Outline Dimensions

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

(Unit: mm) Figure 057-1

Dimension Table

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>70</td>
<td>200</td>
<td>10</td>
<td>115</td>
<td>235</td>
<td>10</td>
<td>24</td>
<td>29</td>
<td>56</td>
<td>115</td>
<td>24</td>
<td>21</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>110</td>
<td>200</td>
<td>6.5</td>
<td>125</td>
<td>235</td>
<td>10</td>
<td>35</td>
<td>54</td>
<td>81</td>
<td>140</td>
<td>25</td>
<td>22</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 The mass will vary slightly depending on the ratio and on the inside diameter of the input shaft coupling.

*2 Tapped hole for motor mounting screw.

*3 May vary depending on motor interface dimensions.

Moment of Inertia, Input Side

(10⁻⁴ kgm²) Table 057-2

<table>
<thead>
<tr>
<th>HPG 50RA3</th>
<th>Coupling</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>-</td>
<td>9.4</td>
<td>8.8</td>
<td>7.5</td>
<td>6.4</td>
<td>6.4</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>-</td>
<td>10.8</td>
<td>10.2</td>
<td>8.9</td>
<td>7.8</td>
<td>7.73</td>
<td></td>
</tr>
</tbody>
</table>
HPG Standard Series

High-Performance Gearhead for Servomotors

HPGP Series

High-Performance Gearhead for Servomotors

HPG series (Orthogonal Shaft Type)

CSF-GH series

CSG-GH series

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.

<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>N</th>
<th>Mass (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>110</td>
<td>200</td>
<td>6.5</td>
<td>115</td>
<td>235</td>
<td>19</td>
<td>42</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 The mass will vary slightly depending on the ratio and on the inside diameter of the input shaft coupling.

*2 Tapped hole for motor mounting screw.

*3 May vary depending on motor interface dimensions.

Moment of Inertia, Input Side

(10^-4 kgm²) Table 058-2

<table>
<thead>
<tr>
<th>HPG 50RA5</th>
<th>Ratio</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></td>
<td>37.4</td>
<td>33.9</td>
<td>33.3</td>
<td>32</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
**HPG-65RA Outline Dimensions**

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

---

**Dimension Table**

(Unit: mm) **Table 059-1**

<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>N</th>
<th>P</th>
<th>Mass (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Stage</td>
<td>1</td>
<td>1</td>
<td>70</td>
<td>200</td>
<td>6.5</td>
<td>115</td>
<td>235</td>
<td>19</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>110</td>
<td>200</td>
<td>6.5</td>
<td>125</td>
<td>235</td>
<td>19</td>
<td>42</td>
</tr>
<tr>
<td>Two Stage</td>
<td>1</td>
<td>1</td>
<td>70</td>
<td>200</td>
<td>6.5</td>
<td>115</td>
<td>235</td>
<td>19</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>110</td>
<td>200</td>
<td>6.5</td>
<td>125</td>
<td>235</td>
<td>19</td>
<td>42</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 The mass will vary slightly depending on the ratio and on the inside diameter of the input shaft coupling.
2 Tapped hole for motor mounting screw.
3 May vary depending on motor interface dimensions.

---

**Moment of Inertia, Input Side**

(Unit: mkg²) **Table 059-2**

<table>
<thead>
<tr>
<th>HPG 65RA</th>
<th>5</th>
<th>12</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>40</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>48.8</td>
<td>47.8</td>
<td>37.9</td>
<td>37.3</td>
<td>32.3</td>
<td>32.1</td>
</tr>
<tr>
<td>2</td>
<td>60.6</td>
<td>49.2</td>
<td>48.2</td>
<td>38.3</td>
<td>37.7</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
### Sizing & Selection

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

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

#### Flowchart for selecting a size

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

#### Application motion profile

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

**Graph 060-I**

[Diagram showing application motion profile]

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

| Load torque | T1 to Tn (Nm) |
| Time | t1 to tn (sec) |
| Output rotational speed | n1 to n (rpm) |

**Normal operation pattern**

- Starting (acceleration): T1, t1, n1
- Steady operation (constant velocity): T2, t2, n2
- Stopping (deceleration): T3, t3, n3
- Dwell: T4, t4, n4

**Maximum rotational speed**

- Max. output rotational speed: \( n_{\text{max}} \leq \frac{n_1}{R} \)
- Max. input rotational speed: \( n_{\text{max}} = n_1 \times R \) to \( n_0 \times R \) (Restricted by motors)
- Reduction ratio: \( R = \frac{n_0}{n_1} \)

**Impact torque**

When impact torque is applied: \( T_s \)

**Required life**

\( L_{100} = \frac{T_v}{T_{av}} \times \frac{n_0}{n_{av}} \) (Hour)

**Caution**

- If any of the following conditions exist, please consider selecting the next larger speed reducer, reduce the operating loads or reduce the operating speed. If this cannot be done, please contact Harmonic Drive LLC. Exercise caution especially when the duty cycle is close to continuous operation.
  1. Actual average load torque (Tav) > Permissible maximum value of average load torque (Tavg)
  2. Actual average input rotational speed (nav) > Permissible average input rotational speed (n)
  3. Gearhead housing temperature > 70°C

**Example of model number Selection**

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPG-32A-5-RA3</td>
<td>( T_{av} = 35 \text{ Nm} )</td>
</tr>
<tr>
<td>HPG-32A-5-RA3</td>
<td>( n_{av} = 46.2 \text{ rpm} )</td>
</tr>
<tr>
<td>HPG-32A-5-RA3</td>
<td>( T_{r} = 30.2 \text{ Nm} )</td>
</tr>
<tr>
<td>HPG-32A-5-RA3</td>
<td>( T_{s} = 180 \text{ Nm} )</td>
</tr>
</tbody>
</table>

**Graph 060-1**

[Graph showing operation conditions, size, and reduction ratio]

**The model number is confirmed.**
**Example of model number Selection**

<table>
<thead>
<tr>
<th>Load torque $T_n$ (Nm)</th>
<th>Time $t_n$ (sec)</th>
<th>Output rotational speed $n_o$ (rpm)</th>
<th>Maximum rotational speed</th>
<th>Emergency stop torque</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$T_s = 180$ Nm</td>
</tr>
</tbody>
</table>

- **Normal operation pattern**
  - Starting (acceleration): $T_1 = 70$ Nm, $t_1 = 0.3$ sec, $n_1 = 60$ rpm
  - Steady operation (constant velocity): $T_2 = 18$ Nm, $t_2 = 3$ sec, $n_2 = 120$ rpm
  - Stopping (deceleration): $T_3 = 35$ Nm, $t_3 = 0.4$ sec, $n_3 = 60$ rpm
  - Dwell: $T_4 = 0$ Nm, $t_4 = 5$ sec, $n_4 = 0$ rpm

- **Maximum rotational speed**
  - Max. output rotational speed $n_{o\text{ max}} = 120$ rpm
  - Max. input rotational speed $n_{i\text{ max}} = 5,000$ rpm

- **Required life**
  - $L_{50} = 30,000$ (hours)

**Calculations**

1. **Calculate the average load torque applied to the output side based on the application motion profile: $T_{av}$ (Nm).**

   \[ T_{av} = \frac{1}{3} | \frac{60N\cdot 0.3sec + 70N\cdot 120rpm + 18N\cdot 3sec + 35N\cdot 0.4sec + 0N\cdot 5sec}{60N\cdot 0.3sec + 120N\cdot 3sec + 70N\cdot 120rpm + 35N\cdot 0.4sec + 0N\cdot 5sec} | \]

2. **Calculate the average output speed based on the application motion profile: $n_{o\text{ av}}$ (rpm).**

   \[ n_{o\text{ av}} = \frac{1}{3} | \frac{60rpm + 120rpm + 60rpm}{0.3sec + 3sec + 120rpm + 35N\cdot 0.4sec + 0N\cdot 5sec} | \]

3. **Make a preliminary model selection with the following conditions.** $T_{av} = 30.2$ Nm $\leq 120$ Nm. (HPG-32A-5-RA3 is tentatively selected based on the average load torque (see the rating table) of size 32 and reduction ratio of 5.)

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

   \[ \text{Reduction ratio } R = \frac{5,000 \text{ rpm}}{120 \text{ rpm}} = 41.7 \geq 5 \]

5. **Calculate the maximum input speed (ni max) from the maximum output speed (no max) and reduction ratio (R):** $n_{i\text{ max}} = 120$ rpm $\times 5 = 600$ rpm

6. **Calculate the average input speed (ni av) from the average output speed (no av) and reduction ratio (R):**

   \[ n_{i\text{ av}} = \frac{46.2 \text{ rpm} \times 5 = 1,025 \text{ rpm}}{600 \text{ rpm} \times 5} \leq 1,500 \text{ rpm} \]

7. **Check whether the maximum input speed is equal to or less than the values specified in the rating table.**

   $n_{i\text{ max}} = 3,960$ rpm $\leq 600$ rpm (maximum input speed of size 32)

8. **Check whether $T_1$ and $T_3$ are within peak torques (Nm) on start and stop in the rating table.**

   - $T_1 = 70$ Nm $\leq 35$ Nm (size 32)
   - $T_3 = 35$ Nm $\leq 70$ Nm (size 32)

9. **Check whether $T_s$ is less than limit for momentary torque (Nm) in the rating table.**

   $T_s = 180$ Nm $\leq 200$ Nm (momentary max. torque of size 32)

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

    \[ L_{50} = 20,000 \cdot \left( \frac{120 \text{ Nm}}{30.2 \text{ Nm}} \right)^{1100} \cdot \left( \frac{3,000 \text{ rpm}}{231 \text{ rpm}} \right) = 25,932,572 \text{ (hours)} \geq 30,000 \text{ (hours)} \]

**The selection of model number HPG-32A-5-RA3 is confirmed from the above calculations.**
Harmonic Drive's expertise in the field of elasto-mechanics of metals is applied to the internal gear of the HPG, HPGP and HPF Series to provide the gearhead with continuous backlash compensation. Planetary gears have simultaneous meshing between the sun gear, planet gears, and the internal ring gear. Most manufacturers try to reduce the backlash by controlling the dimensional precision of the parts. However, this causes interference of meshing parts due to dimensional errors, resulting in uneven input torque, vibration, higher noise and premature wear (increase in backlash).

Harmonic Planetary® gears use a precision engineered elastic ring gear which compensates for interference between meshing parts. This proprietary Harmonic Planetary® gear design provides smooth and quiet motion and maintains ultra-low backlash for the life of the reducer.

- Low backlash: Less than 3 arc-min (Less than 1 arc-min also available)
- Low gear ratios, 3:1 to 50:1
- High efficiency
- High load capacity by integrating structure with cross roller bearing
- High-torque capacity
Harmonic Drive's expertise in the field of elasto-mechanics of metals is applied to the internal gear of the HPG, HPGP and HPF Series to provide the gearhead with continuous backlash compensation. Planetary gears have simultaneous meshing between the sun gear, planet gears, and the internal ring gear. Most manufacturers try to reduce the backlash by controlling the dimensional precision of the parts. However, this causes interference of meshing parts due to dimensional errors, resulting in uneven input torque, vibration, higher noise, and premature wear (increase in backlash).

Harmonic Planetary® gears use a precision engineered elastic ring gear which compensates for interference between meshing parts. This proprietary Harmonic Planetary® gear design provides smooth and quiet motion and maintains ultra-low backlash for the life of the reducer.

- Low backlash: Less than 3 arc-min (Less than 1 arc-min also available)
- Low gear ratios, 3:1 to 50:1
- High efficiency
- High load capacity by integrating structure with cross roller bearing
- High-torque capacity

The cross roller bearing output flange serves as the second stage carrier for a rugged, compact design.

Robust cross roller bearing and output flange are integrated to provide high moment stiffness, high load capacity, and precise positioning accuracy.

Shielded or sealed input bearing

Quick Connect® coupling for easy mounting of any servomotor

Backlash compensating internal gear

Motor mounting flange
Technical Information

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Output Bearing Specifications and Checking Procedure ........................................... 141
Input Bearing Specifications and Checking Procedure ........................................... 145

Product Handling

Assembly ........................................................... 147
Mechanical Tolerances ............................................ 150
Lubrication .......................................................... 151
Warranty, Disposal .................................................. 153
Safety ................................................................. 154

The rated value and performance vary depending on the product series. Be sure to check the usage conditions and refer to the items conforming to the related product.
### Efficiency

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

#### Measurement condition

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

#### Efficiency compensated for low temperature

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

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

---

**Graph 122-1**

---

**Graph 122-2**

---
Checking maximum load

Checking the life

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

Input Bearing Specifications and Checking Procedure

Technical Information / Handling Explanation

Graph 122-2

Graph 123-1

Graph 123-2

Graph 123-3

Graph 123-4

Graph 123-5

Graph 123-6

Graph 123-7

Size 11 : Gearhead

HPGP

Reduction Ratio = 5

TRi

TRi

TRi

TRi

TRi

TRi

Efficiency %

Efficiency %

Efficiency %

Efficiency %

Efficiency %

Efficiency %

0
0
0
0
0
0

1
1
1
1

2
2
2
2

Tin

Tin

Tin

Tin

Tin

Tin

Input torque Nm

Graph 123-1

Graph 123-2

Graph 123-3

Graph 123-4

Graph 123-5

Graph 123-6

Graph 123-7

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

Reduction Ratio = 37, 45

TRi

TRi

TRi

TRi

TRi

TRi

Efficiency %

Efficiency %

Efficiency %

Efficiency %

Efficiency %

Efficiency %

0
0
0
0
0
0

0.5
0.5
0.5
0.5

1
1
1
1

2
2
2
2

Tin

Tin

Tin

Tin

Tin

Tin

Input torque Nm

Graph 123-3

Graph 123-4

Graph 123-5

Graph 123-6

Graph 123-7

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

Reduction Ratio = 21

TRi

TRi

TRi

TRi

TRi

TRi

Efficiency %

Efficiency %

Efficiency %

Efficiency %

Efficiency %

Efficiency %

0
0
0
0
0
0

0.1
0.1
0.1
0.1

0.2
0.2
0.2
0.2

0.3
0.3
0.3
0.3

0.4
0.4
0.4
0.4

0.5
0.5
0.5
0.5

Tin

Tin

Tin

Tin

Tin

Tin

Input torque Nm

Graph 123-2

Graph 123-5

Graph 123-7

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

Reduction Ratio = 11

TRi

TRi

TRi

TRi

TRi

TRi

Efficiency %

Efficiency %

Efficiency %

Efficiency %

Efficiency %

Efficiency %

0
0
0
0
0
0

0.5
0.5
0.5
0.5

1
1
1
1

1.5
1.5
1.5
1.5

2
2
2
2

2.5
2.5
2.5
2.5

Tin

Tin

Tin

Tin

Tin

Tin

Input torque Nm

Graph 123-5

Graph 123-7

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

Reduction Ratio = 15, 21

TRi

TRi

TRi

TRi

TRi

TRi

Efficiency %

Efficiency %

Efficiency %

Efficiency %

Efficiency %

Efficiency %

0
0
0
0
0
0

0.5
0.5
0.5
0.5

1
1
1
1

1.5
1.5
1.5
1.5

2
2
2
2

Tin

Tin

Tin

Tin

Tin

Tin

Input torque Nm

Graph 123-6

Graph 123-7

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

Reduction Ratio = 33, 45

TRi

TRi

TRi

TRi

TRi

TRi

Efficiency %

Efficiency %

Efficiency %

Efficiency %

Efficiency %

Efficiency %

0
0
0
0
0
0

0.2
0.2
0.2
0.2

0.4
0.4
0.4
0.4

0.6
0.6
0.6
0.6

0.8
0.8
0.8
0.8

1
1
1
1

Tin

Tin

Tin

Tin

Tin

Tin

Input torque Nm

Graph 123-6

Graph 123-7

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

#### Input Bearing Specifications and Checking Procedure

**Table 145-1**

<table>
<thead>
<tr>
<th>Size</th>
<th>Gearhead (standard item)</th>
<th>Gearhead with D bearing (double sealed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reduction ratio = 5</th>
<th>Reduction ratio = 11</th>
</tr>
</thead>
</table>

- **Reduction ratio = 11**
- **Reduction ratio = 15, 21**
- **Reduction ratio = 33, 45**

**Efficiency %**

<table>
<thead>
<tr>
<th>Size</th>
<th>Gearhead (standard item)</th>
<th>Gearhead with D bearing (double sealed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reduction ratio = 5**

<table>
<thead>
<tr>
<th>Size</th>
<th>Gearhead (standard item)</th>
<th>Gearhead with D bearing (double sealed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reduction ratio = 15, 21**

<table>
<thead>
<tr>
<th>Size</th>
<th>Gearhead (standard item)</th>
<th>Gearhead with D bearing (double sealed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reduction ratio = 33, 45**

<table>
<thead>
<tr>
<th>Size</th>
<th>Gearhead (standard item)</th>
<th>Gearhead with D bearing (double sealed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Checking Procedure

- **Checking the life of the bearing on the input side**
- **Input shaft**

**Average input speed (N_i)**

### Calculations

- **Allowable moment load (M_{ci})**
- **Allowable axial load (F_{ai})**
- **Allowable radial load (F_{ri})**

**Graphs**

- **Graph 124-1**
- **Graph 124-2**
- **Graph 124-3**
- **Graph 124-4**
- **Graph 124-5**
- **Graph 124-6**
- **Graph 124-7**
- **Graph 124-8**

---

*Only one line is shown because the difference between the gearhead and a bearing assembled on the input side is small.*
**Input Bearing Specifications and Checking Procedure**

<table>
<thead>
<tr>
<th>Size</th>
<th>: Gearhead</th>
<th>HPGP</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Maximum radial load (Frmax)**

Calculate:

- Average input speed (Niav)
- Average axial load (Fai)

Reduction ratio = 15, 21

**Efficiency %**

<table>
<thead>
<tr>
<th>Size</th>
<th>: Gearhead</th>
<th>HPGP</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Graph 124-7

**Technical Data**

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

**Reduction ratio = 5**

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

Graph 125-1

**Reduction ratio = 11**

Graph 125-2

**Reduction ratio = 15, 21**

Graph 125-3

**Reduction ratio = 33, 45**

Graph 125-4

**Graph 124-6**

**Graph 125-1**

**Graph 125-2**

**Graph 125-3**

**Graph 125-4**

**Graph 125-5**

**Graph 125-6**

**Graph 125-7**

**Graph 125-8**

*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.
Technical Data

Reduction ratio = 5

Reduction ratio = 9

Reduction ratio = 21

Reduction ratio = 37, 45

Reduction ratio = 3, 5

Reduction ratio = 11

Reduction ratio = 15, 21

Reduction ratio = 33, 45

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

Size 11 :: Gearhead & Input Shaft Unit  HPG

Size 14 :: Gearhead & Input Shaft Unit  HPG

--- Technical Information / Handling Explanation ---

Input Bearing Specifications and Checking Procedure

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

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

--- Technical Information / Handling Explanation ---

Input Bearing Specifications and Checking Procedure

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

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

--- Technical Information / Handling Explanation ---

Input Bearing Specifications and Checking Procedure

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

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

--- Technical Information / Handling Explanation ---

Input Bearing Specifications and Checking Procedure

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

Check the maximum load and life of the bearing on the input side if the reducer is an HPG input shaft unit or an HPF hollow shaft unit.
Size 20 : Gearhead & Input Shaft Unit  

**Technical Data**

### Gearhead & Input Shaft Unit

**HPG**

**Reduction ratio = 3, 5**

**Reduction ratio = 11**

**Reduction ratio = 15, 21**

**Reduction ratio = 33, 45**

---

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

**Reduction ratio = 4, 5**

*Reduction ratio = 4*

*Reduction ratio = 5*

**Input torque corresponding to output torque (TRi)**

**Efficiency %**

<table>
<thead>
<tr>
<th>Size</th>
<th>Reduction ratio</th>
<th>TRi</th>
<th>Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>3</td>
<td>TRi</td>
<td>100</td>
</tr>
<tr>
<td>50</td>
<td>4</td>
<td>TRi</td>
<td>90</td>
</tr>
<tr>
<td>50</td>
<td>5</td>
<td>TRi</td>
<td>80</td>
</tr>
</tbody>
</table>

**Allowable moment load (Mc)**

<table>
<thead>
<tr>
<th>Size</th>
<th>Mc</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

**Efficiency %**

<table>
<thead>
<tr>
<th>Size</th>
<th>Reduction ratio</th>
<th>Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>3</td>
<td>90</td>
</tr>
<tr>
<td>50</td>
<td>4</td>
<td>80</td>
</tr>
<tr>
<td>50</td>
<td>5</td>
<td>70</td>
</tr>
</tbody>
</table>

**Allowable axial load (Fai)**

<table>
<thead>
<tr>
<th>Size</th>
<th>Fai</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>10</td>
</tr>
</tbody>
</table>

**Allowable radial load (Frc)**

<table>
<thead>
<tr>
<th>Size</th>
<th>Frc</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>0</td>
</tr>
</tbody>
</table>

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

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

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

**Note**

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

---

**Size 65**

**Reduction ratio = 4, 5**

*Reduction ratio = 4*

*Reduction ratio = 5*

**Input torque corresponding to output torque (TRi)**

**Efficiency %**

<table>
<thead>
<tr>
<th>Size</th>
<th>Reduction ratio</th>
<th>TRi</th>
<th>Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>3</td>
<td>TRi</td>
<td>100</td>
</tr>
<tr>
<td>65</td>
<td>4</td>
<td>TRi</td>
<td>90</td>
</tr>
<tr>
<td>65</td>
<td>5</td>
<td>TRi</td>
<td>80</td>
</tr>
</tbody>
</table>

**Allowable moment load (Mc)**

<table>
<thead>
<tr>
<th>Size</th>
<th>Mc</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>100</td>
</tr>
</tbody>
</table>

**Efficiency %**

<table>
<thead>
<tr>
<th>Size</th>
<th>Reduction ratio</th>
<th>Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>3</td>
<td>90</td>
</tr>
<tr>
<td>65</td>
<td>4</td>
<td>80</td>
</tr>
<tr>
<td>65</td>
<td>5</td>
<td>70</td>
</tr>
</tbody>
</table>

**Allowable axial load (Fai)**

<table>
<thead>
<tr>
<th>Size</th>
<th>Fai</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>10</td>
</tr>
</tbody>
</table>

**Allowable radial load (Frc)**

<table>
<thead>
<tr>
<th>Size</th>
<th>Frc</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>0</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Size</th>
<th>Gearhead</th>
<th>HPG-Helical</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Size 11: Gearhead

#### HPG-Helical

**Reduction ratio = 4**

**Reduction ratio = 5, 6**

**Reduction ratio = 7, 8**

**Reduction ratio = 9, 10**

### Technical Data

- **Input torque**
- **Efficiency %**
- **Reduction ratio**
- **Time: t**
- **Graphs**: 129-1 to 129-8

### Technical Information / Handling Explanation

- See Table 145-1 and 145-2
- See Table 146-1 and 146-2
- See Formula 146-1 to 146-6
**Technical Data**

**Input torque corresponding to output torque**

**Gearhead with Z bearing (Double sealed)**

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

### Technical Information / Handling Explanation

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

- **Checking the life**
  - shaft unit.

**Specification of input shaft bearing**

<table>
<thead>
<tr>
<th>Size 20</th>
<th>Gearhead HPG-Helical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction ratio = 3, 4</td>
<td><img src="Graph130-1" alt="" /></td>
</tr>
<tr>
<td>Reduction ratio = 5, 6</td>
<td><img src="Graph130-2" alt="" /></td>
</tr>
<tr>
<td>Reduction ratio = 7, 8</td>
<td><img src="Graph130-3" alt="" /></td>
</tr>
<tr>
<td>Reduction ratio = 9, 10</td>
<td><img src="Graph130-4" alt="" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size 32</th>
<th>Gearhead HPG-Helical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction ratio = 3, 4</td>
<td><img src="Graph130-5" alt="" /></td>
</tr>
<tr>
<td>Reduction ratio = 5, 6</td>
<td><img src="Graph130-6" alt="" /></td>
</tr>
<tr>
<td>Reduction ratio = 7, 8</td>
<td><img src="Graph130-7" alt="" /></td>
</tr>
<tr>
<td>Reduction ratio = 9, 10</td>
<td><img src="Graph130-8" alt="" /></td>
</tr>
</tbody>
</table>

**Efficiency %**

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Efficiency %</th>
<th>Input torque Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>3, 4</td>
<td></td>
<td>0, 2, 4, 6, 8, 10</td>
</tr>
<tr>
<td>5, 6</td>
<td></td>
<td>0, 2, 4, 6, 8, 10</td>
</tr>
<tr>
<td>7, 8</td>
<td></td>
<td>0, 2, 4, 6, 8, 10</td>
</tr>
<tr>
<td>9, 10</td>
<td></td>
<td>0, 2, 4, 6, 8, 10</td>
</tr>
</tbody>
</table>

**Reduction ratio = 3, 4**

**Reduction ratio = 5, 6**

**Reduction ratio = 7, 8**

**Reduction ratio = 9, 10**

---

**Technical Data**

**Input Bearing Specifications and Checking Procedure**

- See Table 145-1 and -3
- See Table 146-1 and -2
- See Formula 146-4

**How to calculate the average input speed (Ni)**

- **Graph 146-1**

**How to calculate the average axial load (Fai)**

- **Graph 146-2**

**How to calculate the average moment load (Mi)**

- **Graph 146-3**

**External load influence diagram**

- **Graph 146-4**

---

**Efficiency %**

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Efficiency %</th>
<th>Input torque Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>3, 4</td>
<td></td>
<td>0, 2, 4, 6, 8, 10</td>
</tr>
<tr>
<td>5, 6</td>
<td></td>
<td>0, 2, 4, 6, 8, 10</td>
</tr>
<tr>
<td>7, 8</td>
<td></td>
<td>0, 2, 4, 6, 8, 10</td>
</tr>
<tr>
<td>9, 10</td>
<td></td>
<td>0, 2, 4, 6, 8, 10</td>
</tr>
</tbody>
</table>

**Input Bearing Specifications and Checking Procedure**

- **Formula 146-1**
- **Formula 146-2**
- **Formula 146-3**
- **Formula 146-4**
- **Formula 146-5**
Checking the life of the shaft unit.

Specifications and Checking Procedure

Size 32 RA3: Right Angle Gearhead

<table>
<thead>
<tr>
<th>Size</th>
<th>Right Angle Gearhead</th>
<th>HPG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction ratio = 5</td>
<td>Graph 131-1</td>
<td>Tn</td>
</tr>
<tr>
<td>Reduction ratio = 11</td>
<td>Graph 131-2</td>
<td>Tn</td>
</tr>
<tr>
<td>Reduction ratio = 15, 21</td>
<td>Graph 131-3</td>
<td>Tn</td>
</tr>
<tr>
<td>Reduction ratio = 33, 45</td>
<td>Graph 131-4</td>
<td>Tn</td>
</tr>
</tbody>
</table>

Size 50 RA3: Right Angle Gearhead

<table>
<thead>
<tr>
<th>Size</th>
<th>Right Angle Gearhead</th>
<th>HPG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction ratio = 5</td>
<td>Graph 131-5</td>
<td>Tn</td>
</tr>
<tr>
<td>Reduction ratio = 11</td>
<td>Graph 131-6</td>
<td>Tn</td>
</tr>
<tr>
<td>Reduction ratio = 15, 21</td>
<td>Graph 131-7</td>
<td>Tn</td>
</tr>
<tr>
<td>Reduction ratio = 33, 45</td>
<td>Graph 131-8</td>
<td>Tn</td>
</tr>
</tbody>
</table>

Tn: Input torque corresponding to output torque
Note

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

[Technical Data]

**Input Bearing Specifications and Checking Procedure**

**Specification of input shaft bearing**

- **Size**: 20, 25, 32
- **Allowable moment load (M_{\text{ri}})**: 10, 90, 60 Nm
- **Allowable axial load (F_{\text{ai}})**: 10, 90, 80 Nm
- **Allowable radial load (F_{\text{rc}})**: 10, 90, 80 Nm

**Calculating average load**

- **Input torque (T) = Maximum radial load (F_{\text{ri}})**
- **Efficiency (%)**

**Reduction ratio**

- **Reduction ratio = 5**: 20, 25
- **Reduction ratio = 11**: 40, 50
- **Reduction ratio = 15, 21**: 5200, 590 Nm
- **Reduction ratio = 33, 45**: 20100 Nm

**Technical Information / Handling Explanation**

**Calculating maximum moment load ON input shaft**

- **Reduction ratio = 5**: 20, 25
- **Reduction ratio = 11**: 40, 50
- **Reduction ratio = 12, 15**: 2560, 1510 kgf
- **Reduction ratio = 15**: 2560 kgf

**How to calculate average load**

1. Calculate the bearing life according to Calculation Formula
2. If moment load and axial load fluctuate, they should be converted into the average load to check the life of the bearing.
3. Check that the following formulas are established in all circumstances:

   - **Basic static load rating (C_{\text{r}})**
   - **Basic dynamic load rating (C_{\text{r}})**

**External load influence diagram**

- **Reduction ratio = 5**: 20, 25
- **Reduction ratio = 11**: 40, 50
- **Reduction ratio = 15, 21**: 5200, 590 Nm
- **Reduction ratio = 33, 45**: 20100 Nm

**Tables**

- **Table 145-2**: Details not visible in the image.
- **Table 145-3**: Details not visible in the image.
- **Table 145-4**: Details not visible in the image.

**Additional Notes**

- **Input torque (T) = Maximum radial load (F_{\text{ri}})**
- **Input speed (N) = Average input speed (N_{\text{av}})**
- **Moment load (M) = Average moment load (M_{\text{av}})**
- **Axial load (A) = Average axial load (A_{\text{av}})**

**Formulas**

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

**Graphs**

- **Graph 132-1**: Efficiency % vs. Input torque (Nm)
- **Graph 132-2**: Efficiency % vs. Input torque (Nm)
- **Graph 132-3**: Efficiency % vs. Input torque (Nm)
- **Graph 132-4**: Efficiency % vs. Input torque (Nm)

**Input Speed Moment load (N_{\text{ic}})**

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

**HPG HPF HPG**
**Input Bearing Specifications and Checking Procedure**

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Efficiency %</th>
<th>Input torque Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
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<tr>
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<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Size 11A**

**Gearhead**

**Reduction ratio = 4**

**Reduction ratio = 5**

**Reduction ratio = 7**

**Reduction ratio = 10**

**Reduction ratio = 16**

**Reduction ratio = 20**

**Reduction ratio = 30**

**Size 14A**

**Gearhead**

**Reduction ratio = 3**

**Reduction ratio = 4**

**Reduction ratio = 5**

**Reduction ratio = 7**

**Reduction ratio = 10**

**Reduction ratio = 13**

**Reduction ratio = 21**

**Reduction ratio = 31**
### Technical Data

**Table 145-1: Specification of input bearing**

<table>
<thead>
<tr>
<th>Size</th>
<th>Maximum radial load (F_{ri})</th>
<th>Maximum moment load (M_{i})</th>
<th>Allowable (F_{ai})</th>
<th>Allowable (F_{ri})</th>
<th>Allowable (M_{i})</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>19 N</td>
<td>10 N</td>
<td>3.2 N</td>
<td>3.2 N</td>
<td>0.016 kgfm</td>
</tr>
<tr>
<td>50</td>
<td>10 N</td>
<td>6.5 N</td>
<td>2.2 N</td>
<td>2.2 N</td>
<td>0.010 kgfm</td>
</tr>
<tr>
<td>20</td>
<td>10 N</td>
<td>6.5 N</td>
<td>2.2 N</td>
<td>2.2 N</td>
<td>0.010 kgfm</td>
</tr>
<tr>
<td>25</td>
<td>20 N</td>
<td>13.5 N</td>
<td>4.5 N</td>
<td>4.5 N</td>
<td>0.016 kgfm</td>
</tr>
<tr>
<td>32</td>
<td>10 N</td>
<td>6.5 N</td>
<td>2.2 N</td>
<td>2.2 N</td>
<td>0.010 kgfm</td>
</tr>
<tr>
<td>14</td>
<td>10 N</td>
<td>6.5 N</td>
<td>2.2 N</td>
<td>2.2 N</td>
<td>0.010 kgfm</td>
</tr>
</tbody>
</table>

**Technical Information / Handling Explanation**

- **Note 1**: The allowable axial load is the value of an axial load applied along the axis of rotation.
- **Note 2**: The allowable radial load of HPG series is the value of a radial load applied at the mid-point of the input shaft.
- **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).

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.
Technical Data

Size 25: Hollow Shaft Unit [HPF]

Reduction ratio = 11

Graph 136-1

Size 32: Hollow Shaft Unit [HPF]

Reduction ratio = 11

Graph 136-2

Technical Information / Handling Explanation

Note

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

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

(1) Checking maximum load

(2) Checking the life of the bearing

Calculating maximum moment load ON input shaft

\[ F_{rc} \times 20 \leq F_{ri} \times \frac{L_{ri}}{d_{ri}} \]

How to calculate average load

Average moment load (\( F_{m\text{av}} \))

\[ F_{m\text{av}} = \frac{1}{n} \sum_{i=1}^{n} F_{mi} \]

Average axial load (\( F_{a\text{av}} \))

\[ F_{a\text{av}} = \frac{1}{n} \sum_{i=1}^{n} F_{ai} \]

Average input speed (\( n_{i\text{av}} \))

\[ n_{i\text{av}} = \frac{1}{n} \sum_{i=1}^{n} n_i \]

Basic dynamic load rating (\( C_r \))

Basic static load rating (\( C_s \))

Allowable moment load (\( M_{c\text{av}} \))

Allowable axial load (\( F_{a\text{av}} \))

Allowable radial load (\( F_{r\text{av}} \))

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

See Table 145-1 and -3

See Formula 146-4

See Table 145-2 and 145-4
Note

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 size.

### Specification of input bearing

<table>
<thead>
<tr>
<th>Size 14</th>
<th>Gearhead</th>
<th>CSG-GH</th>
<th>CSF-GH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction ratio = 50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Graph 137-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Efficiency %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input torque Ncm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input rotational speed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500 rpm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000 rpm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000 rpm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3500 rpm</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Reduction ratio = 80 |
| | Graph 137-2 |
| Efficiency % |
| Input torque Ncm |

| Reduction ratio = 100 |
| | Graph 137-3 |
| Efficiency % |
| Input torque Ncm |

### Technical Data

- **Gearhead**
- **HPG**
- **HPF**

<table>
<thead>
<tr>
<th>Size 20</th>
<th>Gearhead</th>
<th>CSG-GH</th>
<th>CSF-GH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction ratio = 50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Graph 137-4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Efficiency %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input torque Ncm</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Reduction ratio = 80 |
| | Graph 137-5 |
| Efficiency % |
| Input torque Ncm |

| Reduction ratio = 100 |
| | Graph 137-6 |
| Efficiency % |
| Input torque Ncm |

| Reduction ratio = 120 |
| | Graph 137-7 |
| Efficiency % |
| Input torque Ncm |

| Reduction ratio = 160 |
| | Graph 137-8 |
| Efficiency % |
| Input torque Ncm |

### Table 145-1

- **Reduction ratio = 100**
  - **Efficiency %**
    - 100
    - 100
    - 100
    - 90
    - 70
    - 50
    - 30
    - 10
  - **Input torque Ncm**
    - 0
    - 50
    - 100
    - 150
    - 200
    - 250
    - 300
    - 350

### Technical Information / Handling Explanation

See Table 145-1 and -3

See Table 146-1 and -2

Input Bearing Specifications and Checking Procedure

### Formula

- Formula 146-1
- Formula 146-2
- Formula 146-3
- Formula 146-4
- Formula 146-5
Technical Data

Size 32: Gearhead

Reduction ratio = 50

Graph 138-1

Reduction ratio = 80

Graph 138-2

Reduction ratio = 100

Graph 138-3

Reduction ratio = 120

Graph 138-4

Reduction ratio = 160

Graph 138-5

Input rotational speed

500 rpm
1000 rpm
2000 rpm
3500 rpm

Size 45: Gearhead

Reduction ratio = 50

Graph 138-6

Reduction ratio = 80

Graph 138-7

Reduction ratio = 100

Graph 138-8

Reduction ratio = 120

Graph 138-9

Reduction ratio = 160

Graph 138-10

Input rotational speed

500 rpm
1000 rpm
2000 rpm
3500 rpm

Technical Information / Handling Explanation

Note 1

The allowable axial load is the value of an axial load applied along the axis of rotation.
Input Bearing Specifications and Checking Procedure

**Reduction ratio = 80**

![Graph 139-1](image1)

**Reduction ratio = 100**

![Graph 139-2](image2)

**Reduction ratio = 120**

![Graph 139-3](image3)

**Reduction ratio = 160**

![Graph 139-4](image4)

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

Note: The graphs above illustrate the efficiency and input torque for different reduction ratios. The efficiency percentage varies with the input torque and rotational speed. The graphs are labeled to indicate the specific reduction ratios for each case.
Output Shaft Bearing Load Limits

HPN Series Output Shaft Load Limits are plotted below.

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

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

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

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

### Checking procedure

1. **Checking the maximum moment load (M \( \text{max} \))**

   Calculate the maximum moment load (\( M_{\text{max}} \)).
   
   Maximum moment load (\( M_{\text{max}} \)) ≤ Permissible moment (\( M_{c} \))

2. **Checking the life**

   Calculate the average radial load (\( F_{\text{av}} \)) and the average axial load (\( F_{\text{av}} \)).
   
   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 coefficient (\( P_{\text{ci}} \)).
   
   Check the static safety coefficient (\( F_{\text{sa}} \)).

### Specification of output bearing

#### HPGP/HPG Series

Table 141-1, -2 and -3 indicate the cross roller bearing specifications for in-line, right angle and input shaft gears.

![Table 141-1](image)

![Table 141-2](image)

![Table 141-3](image)

* The ratio specified in parentheses is for the HPG Series.

(Note: Table 141-1, -2 and -3, Table 142-1 and -2)

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

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

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

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

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

CSG-GH/CSF-GH Series

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

<table>
<thead>
<tr>
<th>Size</th>
<th>Pitch circle (dp)</th>
<th>Offset amount (R)</th>
<th>Load rating</th>
<th>Allowable moment load (Mc) \times 10^4 Nm</th>
<th>Moment stiffness (Km) kgf/arcmin</th>
<th>Allowable radial load (Frc) kgf</th>
<th>Allowable axial load (Fac) kgf</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>0.0405</td>
<td>0.011</td>
<td>5110</td>
<td>27</td>
<td>3.0</td>
<td>732</td>
<td>1093</td>
</tr>
<tr>
<td>20</td>
<td>0.064</td>
<td>0.0115</td>
<td>10600</td>
<td>27</td>
<td>3.0</td>
<td>732</td>
<td>1093</td>
</tr>
<tr>
<td>32</td>
<td>0.085</td>
<td>0.014</td>
<td>20500</td>
<td>258</td>
<td>26.3</td>
<td>96</td>
<td>8899</td>
</tr>
<tr>
<td>45</td>
<td>0.123</td>
<td>0.019</td>
<td>41600</td>
<td>797</td>
<td>81.3</td>
<td>100</td>
<td>96</td>
</tr>
<tr>
<td>65</td>
<td>0.170</td>
<td>0.0225</td>
<td>81600</td>
<td>2156</td>
<td>220</td>
<td>323</td>
<td>11693</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size</th>
<th>Pitch circle (dp)</th>
<th>Offset amount (R)</th>
<th>Load rating</th>
<th>Allowable moment load (Mc) \times 10^4 Nm</th>
<th>Moment stiffness (Km) kgf/arcmin</th>
<th>Allowable radial load (Frc) kgf</th>
<th>Allowable axial load (Fac) kgf</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>0.085</td>
<td>0.0153</td>
<td>11400</td>
<td>410</td>
<td>41.8</td>
<td>37.9</td>
<td>1330</td>
</tr>
<tr>
<td>32</td>
<td>0.1115</td>
<td>0.015</td>
<td>22500</td>
<td>39900</td>
<td>4071</td>
<td>932</td>
<td>2640</td>
</tr>
</tbody>
</table>

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

### HPF Series

<table>
<thead>
<tr>
<th>Size</th>
<th>Pitch circle (dp)</th>
<th>Offset amount (R)</th>
<th>Load rating</th>
<th>Allowable moment load (Mc) \times 10^4 Nm</th>
<th>Moment stiffness (Km) kgf/arcmin</th>
<th>Allowable radial load (Frc) kgf</th>
<th>Allowable axial load (Fac) kgf</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>0.085</td>
<td>0.0153</td>
<td>11400</td>
<td>410</td>
<td>41.8</td>
<td>37.9</td>
<td>1330</td>
</tr>
<tr>
<td>32</td>
<td>0.1115</td>
<td>0.015</td>
<td>22500</td>
<td>39900</td>
<td>4071</td>
<td>932</td>
<td>2640</td>
</tr>
</tbody>
</table>

(Note: Table 141-1, 2 and 3 Table 142-1 and -2)

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

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

\[
M_{\text{max}} = Fr_{\text{av}} \cdot (L_r + R) + Fa_{\text{av}} \cdot L_a
\]

\(Fr_{\text{av}}\) Max. radial load \(N\) (kgf)
\(Fa_{\text{av}}\) Max. axial load \(N\) (kgf)
\(L_r, L_a\) — \(m\)
\(R\) Offset amount \(m\)
\(dp\) Circular pitch of roller \(m\)

How to calculate the radial and the axial load coefficient

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

\[
X = \frac{Fr_{\text{av}}}{Fr_{\text{av}} + 2(Fa_{\text{av}}/L_r + Fa_{\text{av}}/L_a)} \leq 1.5
\]

\[
Y = \frac{Fr_{\text{av}}}{Fr_{\text{av}} + 2(Fa_{\text{av}}/L_r + Fa_{\text{av}}/L_a)} > 1.5
\]

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

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

How to obtain the average radial load \((F_{\text{av}})\)

\[
F_{\text{av}} = \frac{Fr_{1} \cdot n_{t1} + Fr_{2} \cdot n_{t2} + \cdots + Fr_{n} \cdot n_{tn}}{n_{t1} + n_{t2} + \cdots + n_{tn}}
\]

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 obtain the average axial load \((F_{a\text{av}})\)

\[
F_{a\text{av}} = \frac{Fa_{1} \cdot n_{t1} + Fa_{2} \cdot n_{t2} + \cdots + Fa_{n} \cdot n_{tn}}{n_{t1} + n_{t2} + \cdots + n_{tn}}
\]

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 obtain the average output speed \((N_{\text{av}})\)

\[
N_{\text{av}} = \frac{n_{t1} + n_{t2} + \cdots + n_{tn}}{t_1 + t_2 + \cdots + t_n}
\]
**Technical Information / Handling Explanation**

## How to calculate the life

**HPGP**  **HPG**  **CSG-GH**  **CSF-GH**  **HPF**

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

**Formula 144-1**

$$ L_0 = \frac{10^6}{60 \times N_{av}} \times \left( \frac{C}{f_w \times P_C} \right)^{1/3} $$

- $L_0$: Life (hour)
- $N_{av}$: Ave. output speed (rpm)
- $C$: Basic dynamic load rating (N (kgf))
- $f_w$: Load coefficient
- $P_C$: Dynamic equivalent load (N (kgf))

**Load coefficient**

<table>
<thead>
<tr>
<th>Load status</th>
<th>$f_w$</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>

**Formula 144-2**

$$ P_C = \left( \frac{F_{r av}}{\sqrt{2}} + \frac{2(F_{r av}(Lr + R) + F_{a av} \times L_{a, max})}{dp} \right) + Y \times F_{a av} $$

- $F_{r av}$: Average radial load (N (kgf))
- $F_{a av}$: Average axial load (N (kgf))
- $L_{a, max}$: Max. axial load
- $dp$: Pitch Circle (m)
- $R$: Offset amount (m)

**HPGP**  **HPG**  **CSG-GH**  **CSF-GH**  **HPF**

## How to calculate the life during oscillating motion

**HPGP**  **HPG**  **CSG-GH**  **CSF-GH**  **HPF**

Calculate the life of the cross roller bearing during oscillating motion by Formula 144-3.

**Formula 144-3**

$$ L_{oc} = \frac{10^6 \times 90}{60 \times n_1 \times \theta} \times \left( \frac{C}{f_w \times P_C} \right)^{1/3} $$

- $L_{oc}$: Rated life under oscillating motion (hour)
- $n_1$: No. of reciprocating oscillation per min. (rpm)
- $C$: Basic dynamic load rating (N (kgf))
- $f_w$: Load coefficient
- $P_C$: Dynamic equivalent load (N (kgf))

**Note**

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

## How to calculate the static safety coefficient

**HPGP**  **HPG**  **CSG-GH**  **CSF-GH**  **HPF**

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

**Formula 144-4**

$$ f_s = \frac{C_o}{P_o} $$

- $C_o$: Basic static load (N (kgf))
- $P_o$: Static equivalent load (N (kgf))

**Static safety coefficient**

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

**Formula 144-5**

$$ P_o = F_{r max} + \frac{2M_{max}}{dp} + 0.44F_{a max} $$

- $F_{r max}$: Max. radial load (N (kgf))
- $F_{a max}$: Max. axial load (N (kgf))
- $M_{max}$: Max. moment load (Nm (kgf-m))
- $dp$: Pitch Circle (m)

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

---

**Technical Data**

**Input Bearing Specifications and Checking Procedure**

- See Table 144-2
- See Table 145-2 and 145-4
- See Formula 144-2
- See "Output Bearing Specs."

**Technical Data**

- See Fig. 143-1
- See "External load influence diagram"
- See Table 146-1 and -2
- See "External load influence diagram" and "Output Bearing Specs." of each series.
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 (Mi max)
  - Maximum axial load (Fai max)
  - Maximum radial load (Fri max)

- Maximum moment load (Mi max) ≤ Allowable moment load (Mc)
- Maximum axial load (Fai max) ≤ Allowable axial load (Fac)
- Maximum radial load (Fri max) ≤ Allowable radial load (Frc)

#### (2) Checking the life

- Calculate:
  - Average moment load (Mi av)
  - Average axial load (Fai av)
  - Average input speed (Ni av)

- Calculate the life and check it.

### Specification of input bearing

#### HPG

<table>
<thead>
<tr>
<th>Size</th>
<th>Basic load rating</th>
<th>Table 146-1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic dynamic load rating Cr</td>
<td>Basic static load rating Cor</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>11</td>
<td>2700</td>
<td>275</td>
</tr>
<tr>
<td>14</td>
<td>5800</td>
<td>590</td>
</tr>
<tr>
<td>20</td>
<td>9700</td>
<td>990</td>
</tr>
<tr>
<td>32</td>
<td>22500</td>
<td>2300</td>
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<tr>
<td>50</td>
<td>35500</td>
<td>3600</td>
</tr>
<tr>
<td>65</td>
<td>51000</td>
<td>5200</td>
</tr>
</tbody>
</table>

#### HPF

<table>
<thead>
<tr>
<th>Size</th>
<th>Allowable moment load Mc</th>
<th>Allowable axial load Fac</th>
<th>Allowable radial load Frc</th>
<th>Table 145-2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nm</td>
<td>N</td>
<td>kgf</td>
<td>kgf</td>
</tr>
<tr>
<td>11</td>
<td>0.16</td>
<td>245</td>
<td>25</td>
<td>20.6</td>
</tr>
<tr>
<td>14</td>
<td>6.3</td>
<td>1206</td>
<td>123</td>
<td>902</td>
</tr>
<tr>
<td>20</td>
<td>13.5</td>
<td>3285</td>
<td>335</td>
<td>1970</td>
</tr>
<tr>
<td>32</td>
<td>44.4</td>
<td>5540</td>
<td>565</td>
<td>3228</td>
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<td>65</td>
<td>210</td>
<td>8600</td>
<td>878</td>
<td>5267</td>
</tr>
</tbody>
</table>

### Specification of input shaft bearing

#### HPG

<table>
<thead>
<tr>
<th>Size</th>
<th>Basic load rating</th>
<th>Table 145-3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic dynamic load rating Cr</td>
<td>Basic static load rating Cor</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>25</td>
<td>14500</td>
<td>14800</td>
</tr>
<tr>
<td>32</td>
<td>29700</td>
<td>30300</td>
</tr>
</tbody>
</table>

#### HPF

<table>
<thead>
<tr>
<th>Size</th>
<th>Allowable moment load Mc</th>
<th>Allowable axial load Fac</th>
<th>Allowable radial load Frc</th>
<th>Table 146-4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nm</td>
<td>N</td>
<td>kgf</td>
<td>kgf</td>
</tr>
<tr>
<td>25</td>
<td>10</td>
<td>1538</td>
<td>157</td>
<td>522</td>
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<tr>
<td>32</td>
<td>19</td>
<td>3263</td>
<td>333</td>
<td>966</td>
</tr>
</tbody>
</table>

**Note:** Table 145-2 and 145-4

*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).
Calculating maximum moment load ON input shaft

The maximum moment load (M max) is calculated as follows.

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

Check that the following formulas are established in all circumstances:

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

\[ F_{\text{ai}} \leq F_{\text{ac}} \text{ (Allowable axial load)} \]

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

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

Calculating life of input bearing

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

Dynamic equivalent load

**HPG**

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

**HPF**

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

M iav Average moment load Nm (kgf) See Formula 146-2
Faiav Average axial load N (kgf) See Formula 146-3
Assembly

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

Motor assembly procedure

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

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

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

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

Bolt tightening torque

<table>
<thead>
<tr>
<th>Bolt size</th>
<th>M3</th>
<th>M4</th>
<th>M5</th>
<th>M6</th>
<th>M8</th>
<th>M10</th>
<th>M12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nm</td>
<td>2.0</td>
<td>4.5</td>
<td>9.0</td>
<td>15.3</td>
<td>37.2</td>
<td>73.5</td>
<td>128</td>
</tr>
<tr>
<td>kgf·m</td>
<td>0.20</td>
<td>0.48</td>
<td>0.92</td>
<td>1.56</td>
<td>3.8</td>
<td>7.5</td>
<td>13.1</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 (HPF helical). Tighten the screws to the tightening torque specified below.

Table 147-2

<table>
<thead>
<tr>
<th>Bolt size</th>
<th>M3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nm</td>
<td>0.69</td>
</tr>
<tr>
<td>kgf·m</td>
<td>0.07</td>
</tr>
</tbody>
</table>

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

Bolt* tightening torque

<table>
<thead>
<tr>
<th>Bolt size</th>
<th>M2.5</th>
<th>M3</th>
<th>M4</th>
<th>M5</th>
<th>M6</th>
<th>M8</th>
<th>M10</th>
<th>M12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nm</td>
<td>0.59</td>
<td>1.4</td>
<td>3.2</td>
<td>6.3</td>
<td>10.7</td>
<td>26.1</td>
<td>51.5</td>
<td>89.9</td>
</tr>
<tr>
<td>kgf·m</td>
<td>0.06</td>
<td>0.14</td>
<td>0.32</td>
<td>0.64</td>
<td>1.09</td>
<td>2.66</td>
<td>5.25</td>
<td>9.17</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)
To properly mount the motor to the gearhead, follow the procedure outlined below, refer to figure 147-1:

1. Insert the rubber cap provided. This completes the assembly. (Size 11: Fasten screws with a gasket in two places)
2. Fasten the motor to the gearhead flange with bolts.

**Motor assembly procedure**

- Insert the motor shaft into the coupling of the speed reducer, then tighten the motor bolts evenly until the motor flange and gearhead flange are aligned with the speed reducer. Slide the motor shaft without letting it drop down. If the speed reducer cannot be positioned upright, slowly insert it.

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

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

**Two setscrews need to be tightened on size 11.** See the outline dimensions on page 22 (HPGP) and page 34 (HPG standard) and adjust according to the tightening torque.

### Tightening torque

<table>
<thead>
<tr>
<th>Size</th>
<th>HPN</th>
<th>HPGP / HPG / CSG-GH / CSF-GH</th>
<th>HPF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>11</td>
<td>14</td>
<td>20</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</td>
<td>mm</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td>Tightening torque</td>
<td>Nm</td>
<td>1.4</td>
<td>6.3</td>
</tr>
<tr>
<td>Transmission torque</td>
<td>kgfm</td>
<td>0.14</td>
<td>0.64</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 flange (Part A in the diagram below)**

<table>
<thead>
<tr>
<th>Size</th>
<th>HPN</th>
<th>HPGP / HPG / CSG-GH / CSF-GH</th>
<th>HPF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>11</td>
<td>14</td>
<td>20</td>
</tr>
<tr>
<td>Number of bolts</td>
<td>4</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Bolt size</td>
<td>M4</td>
<td>M4</td>
<td>M4</td>
</tr>
<tr>
<td>Mounting PCD</td>
<td>mm</td>
<td>18</td>
<td>30</td>
</tr>
<tr>
<td>Tightening torque</td>
<td>Nm</td>
<td>4.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Transmission torque</td>
<td>kgfm</td>
<td>0.46</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 flange (Part B in the Figure 148-1)**

<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</td>
<td>mm</td>
</tr>
<tr>
<td>Tightening torque</td>
<td>Nm</td>
</tr>
<tr>
<td>Transmission torque</td>
<td>kgfm</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 148-1)**  

<table>
<thead>
<tr>
<th>Size</th>
<th>14</th>
<th>20</th>
<th>32</th>
<th>45</th>
<th>65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of bolts</td>
<td>8</td>
<td>8</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Bolt size</td>
<td>M4</td>
<td>M6</td>
<td>M8</td>
<td>M12</td>
<td>M16</td>
</tr>
<tr>
<td>Mounting PCD</td>
<td>mm</td>
<td>30</td>
<td>45</td>
<td>60</td>
<td>94</td>
</tr>
<tr>
<td>Tightening torque</td>
<td>Nm</td>
<td>4.5</td>
<td>15.3</td>
<td>37</td>
<td>128</td>
</tr>
<tr>
<td>kgf</td>
<td>0.46</td>
<td>1.56</td>
<td>3.8</td>
<td>3.1</td>
<td>32.5</td>
</tr>
<tr>
<td>Transmission torque</td>
<td>Nm</td>
<td>84</td>
<td>287</td>
<td>867</td>
<td>3067</td>
</tr>
<tr>
<td>kgf</td>
<td>8.6</td>
<td>29.3</td>
<td>88.5</td>
<td>313</td>
<td>763</td>
</tr>
</tbody>
</table>

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

---

**Gearheads with an output shaft**

---

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

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

### Output Flange: F0 (flange)

![Output Flange Diagram]

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

![Output Shaft Diagram]

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

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

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

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

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

**Prevention of grease and oil leakage**

(Common to all models)
- Only use the recommended greases.
- Provisions for proper sealing to prevent grease leakage are incorporated into the gearheads. However, please note that some leakage may occur depending on the application or operating condition. Discuss other sealing options with our applications engineers.
- When mounting the gearhead horizontally, position the gearhead so that the rubber 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 65 under the provision that corrosion from the ambient atmosphere (condensation, liquids or gases) at the running surface of the output shaft seal is prevented. If necessary, the adapter flange can be sealed by means of a surface seal (e.g. Loctite 515).
* D type: Bearing with a rubber contact seal on both sides

**HPG/HPGP/HPF/HPN Series**
- Using the double sealed bearing (D type) for the 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-U) and HPF series hollow shaft reducer. An option for an oil seal with a spring is available for improved seal reliability, however, the efficiency will be slightly lower (available for HPF and HPG series for sizes 14 and larger).
- Do not remove the screw plug and seal cap of the HPG series right angle gearhead. Removing them may cause leakage of grease or affect the precision of the gear.

**Standard Lubricants**

**HPG/HPGP/HPF/HPN Series**

The standard lubrication for the HPG/HPGP/HPF/HPN series gearheads is grease.

All gearheads are lubricated at the factory prior to shipment and additional application of grease during assembly is not required. The gearheads are lubricated for the life of the gear and do not require re-lubrication.

High efficiency is achieved through the unique planetary gear design and grease selection.

**Lubricants**

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

**EPNOC Grease AP (N) 2** (HPG/HPGP-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
Dropping point: 200°C
Color: Light brown

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

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

**Ambient operating temperature range: −10°C to +40°C**

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

The temperature rise of the gear depends upon the operating cycle, ambient temperature and heat conduction and radiation based on the consumers 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 CGS-GH / CSF-GH series gearheads is grease. All gearheads are lubricated at the factory prior to shipment and additional application of grease during assembly is not necessary.

Lubricants

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

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

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

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

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

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

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

When to change the grease

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

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

\[ L_{gt} = L_{gtm} \times \left( \frac{T_r}{T_{av}} \right)^3 \]  

Formula symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>L_{gt}</td>
<td>Grease change interval when ( T_{av} &gt; T_r )</td>
</tr>
<tr>
<td>L_{gtm}</td>
<td>Grease change interval when ( T_{av} = T_r )</td>
</tr>
<tr>
<td>( T_r )</td>
<td>Output torque at 2000 rpm (Nm, kgfm)</td>
</tr>
<tr>
<td>( T_{av} )</td>
<td>Average load torque (Nm, kgfm)</td>
</tr>
</tbody>
</table>

Precautions when changing the grease

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

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

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

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

- **Disposal**

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

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

- **Trademark**

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

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

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

Application Restrictions

This product cannot be used for the following applications:

- Space flight hardware
- Aircraft equipment
- Nuclear power equipment
- Equipment and apparatus used in residential dwellings
- Vacuum environments
- Automotive equipment
- Personal recreation equipment
- Equipment that directly works on human bodies
- 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 properly.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Carry out the assembly and installation precisely as specified in the catalog.</td>
</tr>
<tr>
<td></td>
<td>Observe our recommended fastening methods (including bolts used and tightening torques).</td>
</tr>
<tr>
<td></td>
<td>Operating the equipment without precise assembly can cause problems such as vibration, reduction in life, deterioration of precision and product failure.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Caution</th>
<th>Use the specified lubricant.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Using other than our recommended lubricant can reduce the life of the product. Replace the lubricant as recommended.</td>
</tr>
<tr>
<td></td>
<td>Gearheads are factory lubricated. Do not mix installed lubricant with other kinds of grease.</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Caution</th>
<th>Operate within the allowable torque range.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Do not apply torque exceeding the momentary peak torque. Applying excess torque can cause problems such as loosened bolts, generation of backlash and product failure.</td>
</tr>
<tr>
<td></td>
<td>An arm attached directly to the output shaft that strikes a solid object can damage the arm or cause the output of the gearhead to fail.</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Caution</th>
<th>Stop operating the system if any abnormality occurs.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Shut down the system promptly if any abnormal sound or vibration is detected, the rotation has stopped, an abnormally high temperature is generated, an abnormal motor current value is observed or any other anomalies are detected. Continuing to operate the system may adversely affect the product or equipment.</td>
</tr>
<tr>
<td></td>
<td>Please contact our sales office or distributor if any anomaly is detected.</td>
</tr>
<tr>
<td></td>
<td>Rust-proofing was applied before shipping. However, please note that rusting may occur depending on the customers’ storage environment. Although black oxide finish is applied to some of our products, it does not guarantee that rust will not form.</td>
</tr>
</tbody>
</table>

**Handling Lubricant**

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

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

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

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

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

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* HarmonicPlanetary® is a registered trademark of Harmonic Drive LLC.
* HarmonicDrive® is a registered trademark of Harmonic Drive LLC.
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
Space Flight Hardware
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
Experts in Precision Motion Control

![Diagram of motion control system](image)

**Other Products**

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

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

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

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

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**Major Applications of Our Products**

- Metal Working Machines
- Processing Machine Tools
- Measurement, Analytical and Test Systems
- Crating and Packaging Machines
- Communication Equipment
- Glass and Ceramic Manufacturing Systems
- Medical Equipment
- Telescopes
- Source: National observatory of Inter-University Research Institute Corporation
- Energy
- Source: Honda Motor Co., Ltd.
- Space Flight Hardware
- Rover image created by Dan Maas, copyrighted to Cornell and provided courtesy NASA/JPL-Caltech.
- Robotics
- Printing, Bookbinding and Paper Machines
- Paper-making Machines
- Flat Panel Display Manufacturing Equip.
- Printed Circuit Board Manufacturing Machines
- Semiconductor Manufacturing Equip.
- Machine Tools
- Optical Equipment
- Aerospace
- Courtesy of Haliiburton/Sperry Drilling Services

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**HarmonicDrive® Speed Reducer**

Delivers precise motion control by utilizing the strain wave gearing principle.

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Combine precision lead screw and HarmonicDrive® gear. Versatile actuators deliver ultra precise positioning and high torque.

**Rotary Actuators**

Combine performance matched servomotors with HarmonicDrive® gears for excellent dynamic control characteristics.

**CSF Mini Gearheads**

Provide high positioning accuracy in a super-compact package.
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