**HarmonicPlanetary®**  
**HPG Input Shaft**

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

### Peak torque
3.9Nm – 2200Nm

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

### High efficiency
Up to 97%

### Low backlash
Standard: <3 arc-min  Optional: <1 arc-min

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

### High 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.

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**CONTENTS**
- Rating Table..............................................111
- Performance..............................................112
- Backlash and Torsional Stiffness.......................113
- Outline Dimensions......................................114-117
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**HPG** - **20** - **A** - **05** - **BL3** - **J2** - **U1** - **SP1**

<table>
<thead>
<tr>
<th>Model Name</th>
<th>Size</th>
<th>Design Revision</th>
<th>Reduction Ratio</th>
<th>Backlash</th>
<th>Output Configuration</th>
<th>Input Configuration</th>
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<td>U1: Input shaft (with key, no center tapped hole)</td>
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**Gearhead Construction**  
[Figure 110-1]  
[Diagram of Gearhead Construction]

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[Image: Diagram of Gearhead Construction]
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*1: Rated torque is based on life of 20,000 hours at max average input speed.
*2: Average load torque calculated based on the application motion profile must not exceed values shown in the table.
*3: See p. 118.
*4: Average load torque calculated based on the application motion profile must not exceed values shown in the table.
*5: Rated torque is based on life of 20,000 hours at max average input speed.
*6: Rated torque is based on life of 20,000 hours at max average input speed.
*7: Size 65 is built-to-order.
### Performance Table

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<th>Accuracy *1</th>
<th>Repeatability *2</th>
<th>Starting torque *3</th>
<th>Backdriving torque *4</th>
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*1: Accuracy values represent the difference between the theoretical angle and the actual angle of output for any given input. The values in the table are maximum values.

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

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

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

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

### Table 113-1

<table>
<thead>
<tr>
<th>Size</th>
<th>Ratio</th>
<th>Backlash (arc min)</th>
<th>Torque angle in one direction at T = 0.15 Nm</th>
<th>Torsional stiffness D/A/B (Nm/arc min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>5:3</td>
<td>3</td>
<td>2.5</td>
<td>0.59</td>
</tr>
<tr>
<td></td>
<td>7:5</td>
<td></td>
<td>3.0</td>
<td>0.64</td>
</tr>
<tr>
<td>14</td>
<td>5:3</td>
<td>3</td>
<td>2.2</td>
<td>1.27</td>
</tr>
<tr>
<td></td>
<td>7:5</td>
<td></td>
<td>2.7</td>
<td>1.37</td>
</tr>
<tr>
<td>20</td>
<td>5:3</td>
<td>3</td>
<td>1.5</td>
<td>4.9</td>
</tr>
<tr>
<td></td>
<td>7:5</td>
<td></td>
<td>2.0</td>
<td>5.39</td>
</tr>
<tr>
<td>32</td>
<td>5:3</td>
<td>3</td>
<td>1.3</td>
<td>18.6</td>
</tr>
<tr>
<td></td>
<td>7:5</td>
<td></td>
<td>1.7</td>
<td>21.56</td>
</tr>
<tr>
<td>50</td>
<td>5:3</td>
<td>3</td>
<td>1.3</td>
<td>82.71</td>
</tr>
<tr>
<td></td>
<td>7:5</td>
<td></td>
<td>1.7</td>
<td>137.2</td>
</tr>
<tr>
<td>65</td>
<td>5:3</td>
<td>3</td>
<td>1.3</td>
<td>270</td>
</tr>
<tr>
<td></td>
<td>7:5</td>
<td></td>
<td>1.7</td>
<td>362.6</td>
</tr>
</tbody>
</table>

### Table 113-2

<table>
<thead>
<tr>
<th>Size</th>
<th>Ratio</th>
<th>Backlash (arc min)</th>
<th>Torque angle in one direction at T = 0.15 Nm</th>
<th>Torsional stiffness D/A/B (Nm/arc min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>3:1</td>
<td></td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.27</td>
</tr>
<tr>
<td>14</td>
<td>3:1</td>
<td></td>
<td>1</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.37</td>
</tr>
<tr>
<td>20</td>
<td>3:1</td>
<td></td>
<td>1</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.9</td>
</tr>
<tr>
<td>32</td>
<td>3:1</td>
<td></td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21.56</td>
</tr>
<tr>
<td>50</td>
<td>3:1</td>
<td></td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>82.71</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>137.2</td>
</tr>
<tr>
<td>65</td>
<td>3:1</td>
<td></td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>270</td>
</tr>
</tbody>
</table>

### Torsional stiffness curve

With the input of the gear locked in place, a torque applied to the output flange will torsionally deflect in proportion to the applied torque. We generate a torsional stiffness curve by slowly applying torque to the output in the following sequence:

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

A loop of (1) > (2) > (3) > (4) > (5) will be drawn as in Fig. 113-1. The torsional stiffness in the region from "0.15 x \( T_R \)" to "\( T_R \)" is calculated using the average value of this slope. The torsional stiffness in the region from "zero torque" to "0.15 x \( T_R \)" is lower. This is caused by the small amount of backlash plus engagement of the mating parts and loading of the planet gears under the initial torque applied.

### Calculation of total torsion angle

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

\[ \theta = D \times \frac{T-T_R}{A/B} \]

Where:
- \( \theta \) = Total torsion angle
- \( D \) = Torsion angle in one direction at output torque \( x 0.15 \) torque
- \( T \) = Load torque
- \( T_R \) = Output torque \( x 0.15 \) torque \( (=TRX0.15) \)
- \( A/B \) = Torsional stiffness

### Backlash (Hysteresis loss)

The vertical distance between points (2) & (4) in Fig. 113-1 is called a hysteresis loss. The hysteresis loss between "Clockwise load torque \( T_R \)" and "Counter Clockwise load torque \(-T_R\)" is defined as the backlash of the HPG series. The backlash of the HPG series is less than 3 arc-min (1 arc-min or less available for sizes 14-65).

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

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

HPG-11 Outline Dimensions

[Reduction Ratio = 5, 9]

(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.

[Reduction Ratio = 21, 37, 45]

(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.
Outline Dimensions

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

HPG-14 Outline Dimensions

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

HPG-20 Outline Dimensions

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

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

HPG-32 Outline Dimensions

![Diagram of HPG-32 Outline Dimensions](image1)

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

HPG-50 Outline Dimensions

![Diagram of HPG-50 Outline Dimensions](image2)

(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.
Outline Dimensions

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

**HPG-65 Outline Dimensions**

**[Reduction Ratio = 4, 5]**

(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.

**[Reduction Ratio = 12, 15, 20, 25, 40, 50]**

(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.
Sizing & Selection

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

Check your operating conditions against the following application motion profile and select a suitable size based on the flowchart shown on the right. Also check the life and static safety coefficient of the cross roller bearing and input side main bearing (input shaft type only).

Application motion profile

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

Obtain the value of each application motion profile
Load torque \( T_1 \) to \( T_n \) (Nm)
Time \( t_1 \) to \( t_n \) (sec)
Output rotational speed \( n_1 \) to \( n_n \) (rpm)

Normal operation pattern
Starting (acceleration) \( T_1, t_1, n_1 \)
Steady operation (constant velocity) \( T_2, t_2, n_2 \)
Stopping (deceleration) \( T_3, t_3, n_3 \)
Dwell \( T_4, t_4, n_4 \)

Maximum rotational speed
Max. output rotational speed \( n_0 \) max. \( \leq n_1 \) to \( n_n \)
Max. input rotational speed \( n_1 \) max. \( n_1 \times R \) to \( n_n \times R \)
(Restricted by motors)

Emergency stop torque
When impact torque is applied \( T_5 \)

Required life \( L_{10} = L \) (hours)

Flowchart for selecting a size

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

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:

i) Actual average load torque \( T_{av} \) > Limit for average torque (Nm)
ii) Actual average input rotational speed \( n_{av} \) > Maximum average input speed \( n_{r} \)
iii) Gearhead housing temperature \( > 70^\circ \text{C} \).
Example of size selection

<table>
<thead>
<tr>
<th>Normal operation pattern</th>
<th>Normal operation pattern</th>
<th>Normal operation pattern</th>
<th>Normal operation pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starting (acceleration)</td>
<td>Starting (acceleration)</td>
<td>Starting (acceleration)</td>
<td>Starting (acceleration)</td>
</tr>
<tr>
<td>Time t1 (sec)</td>
<td>T1 = 70 Nm,</td>
<td>T1 = 70 Nm,</td>
<td>T1 = 70 Nm,</td>
</tr>
<tr>
<td>Output rotational speed</td>
<td>Output rotational speed</td>
<td>Output rotational speed</td>
<td>Output rotational speed</td>
</tr>
<tr>
<td>n1 = 60 rpm</td>
<td>n1 = 60 rpm</td>
<td>n1 = 60 rpm</td>
<td>n1 = 60 rpm</td>
</tr>
<tr>
<td>Normal operation pattern</td>
<td>Normal operation pattern</td>
<td>Normal operation pattern</td>
<td>Normal operation pattern</td>
</tr>
<tr>
<td>Steady operation</td>
<td>Steady operation</td>
<td>Steady operation</td>
<td>Steady operation</td>
</tr>
<tr>
<td>(constant velocity)</td>
<td>T2 = 18 Nm,</td>
<td>T2 = 18 Nm,</td>
<td>T2 = 18 Nm,</td>
</tr>
<tr>
<td>Time t2 (sec)</td>
<td>t2 = 3 sec,</td>
<td>t2 = 3 sec,</td>
<td>t2 = 3 sec,</td>
</tr>
<tr>
<td>Output rotational speed</td>
<td>Output rotational speed</td>
<td>Output rotational speed</td>
<td>Output rotational speed</td>
</tr>
<tr>
<td>n2 = 120 rpm</td>
<td>n2 = 120 rpm</td>
<td>n2 = 120 rpm</td>
<td>n2 = 120 rpm</td>
</tr>
<tr>
<td>Normal operation pattern</td>
<td>Normal operation pattern</td>
<td>Normal operation pattern</td>
<td>Normal operation pattern</td>
</tr>
<tr>
<td>Stopping (deceleration)</td>
<td>Stopping (deceleration)</td>
<td>Stopping (deceleration)</td>
<td>Stopping (deceleration)</td>
</tr>
<tr>
<td>Time t3 (sec)</td>
<td>t3 = 0.4 sec,</td>
<td>t3 = 0.4 sec,</td>
<td>t3 = 0.4 sec,</td>
</tr>
<tr>
<td>Output rotational speed</td>
<td>Output rotational speed</td>
<td>Output rotational speed</td>
<td>Output rotational speed</td>
</tr>
<tr>
<td>n3 = 60 rpm</td>
<td>n3 = 60 rpm</td>
<td>n3 = 60 rpm</td>
<td>n3 = 60 rpm</td>
</tr>
<tr>
<td>Normal operation pattern</td>
<td>Normal operation pattern</td>
<td>Normal operation pattern</td>
<td>Normal operation pattern</td>
</tr>
<tr>
<td>Dwell</td>
<td>Dwell</td>
<td>Dwell</td>
<td>Dwell</td>
</tr>
<tr>
<td>Time t4 (sec)</td>
<td>t4 = 5 sec,</td>
<td>t4 = 5 sec,</td>
<td>t4 = 5 sec,</td>
</tr>
<tr>
<td>Output rotational speed</td>
<td>Output rotational speed</td>
<td>Output rotational speed</td>
<td>Output rotational speed</td>
</tr>
<tr>
<td>n4 = 0 rpm</td>
<td>n4 = 0 rpm</td>
<td>n4 = 0 rpm</td>
<td>n4 = 0 rpm</td>
</tr>
</tbody>
</table>

Maximum rotational speed
Max. output rotational speed: no max = 120 rpm
Max. input rotational speed: ni max = 6,000 rpm
(Required by motors)

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

Required lifespan
L10 = 30,000 (hours)

Load torque: T1 = 70 Nm
Time: t1 = 0.3 sec, n1 = 60 rpm
Output rotational speed: n1 = 60 rpm

Maximum load torque: T1 = 70 Nm
Time: t1 = 0.3 sec, n1 = 60 rpm
Output rotational speed: n1 = 60 rpm

Normal operation pattern
Starting (acceleration)
Time: t1 = 0.3 sec, n1 = 60 rpm
Output rotational speed: n1 = 60 rpm

Steady operation (constant velocity)
Time: t2 = 3 sec, n2 = 120 rpm
Output rotational speed: n2 = 120 rpm

Stopping (deceleration)
Time: t3 = 0.4 sec, n3 = 60 rpm
Output rotational speed: n3 = 60 rpm

Dwell
Time: t4 = 5 sec, n4 = 0 rpm
Output rotational speed: n4 = 0 rpm

Make a preliminary model selection with the following conditions. Tav = 30.2 Nm ≥ 60 Nm. (HPG-20A-33 is tentatively selected based on the average load torque (see the rating table on page 111) of size 20 and reduction ratio of 33.)

Determine a reduction ratio (R) from the maximum output speed (no av) and maximum input speed (ni max).
R = 5,000 rpm / 120 rpm = 41.7 ≥ 33

Calculate the maximum input speed (ni max) from the maximum output speed (no av) and reduction ratio (R): ni max = 120 rpm * 33 = 3,960 rpm

Calculate the average load torque applied on the output side based on the application motion profile: Tav (Nm).
Tav = 160 Nm / 0.3 sec = 533.3 (Nm)

Calculate the average output speed based on the application motion profile: no av (rpm)
no av = 160 rpm / 0.3 sec = 533.3 rpm

Calculate the average input rotational speed (ni av) from the average output speed (no av) and reduction ratio (R): ni av = 120 rpm * 33 = 3,960 rpm

Check whether the maximum input speed is equal to or less than the values specified in the rating table. ni max = 3,960 rpm ≥ 6,000 rpm (maximum input rotational speed of size 20)

Check whether the maximum input speed is equal to or less than the values specified in the rating table. ni max = 3,960 rpm ≥ 6,000 rpm (maximum input rotational speed of size 20)

Review the operation conditions, size and reduction ratio.

Refer to the Caution note at the bottom of page 118.

The selection of model number HPG-20A-33 is confirmed from the above calculations.

Refer to the Caution note below. Review the operation conditions, size and reduction ratio.
Technical Information

Efficiency .................................................. 122
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>CSG-GH / CSF-GH: Indicated on each efficiency graph.</td>
<td></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.
**Technical Data**

### Gearhead: HPGP

**Reduction Ratio = 5**

![Graph 123-1](#)

**Reduction Ratio = 21**

![Graph 123-2](#)

**Reduction Ratio = 37, 45**

![Graph 123-3](#)

**Reduction Ratio = 15, 21**

![Graph 123-4](#)

**Reduction Ratio = 11**

![Graph 123-5](#)

**Reduction Ratio = 33, 45**

![Graph 123-6](#)

**Reduction Ratio = 21**

![Graph 123-7](#)

---

**Specifications of Input Shaft Bearing**

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

**Note**

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

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

**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**

See Table 145-1 and -2

See Fig. 146-1.

---

**Reduction Ratio**

- Reduction Ratio = 5
- Reduction Ratio = 21
- Reduction Ratio = 37, 45
- Reduction Ratio = 15, 21
- Reduction Ratio = 11
- Reduction Ratio = 33, 45
**Technical Data**

**Input torque corresponding to output torque**

Reduction ratio = 11

---

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).

*3 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

---

**Input Bearing Specifications and Checking Procedure**

<table>
<thead>
<tr>
<th>Size</th>
<th>Bearing Specifications</th>
<th>Checking Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Gearhead with D bearing (double sealed)</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Gearhead (standard item)</td>
<td></td>
</tr>
</tbody>
</table>

---

**Reduction ratio**

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

---

**Efficiency %**

- 96.9
- 44.4
- 13.5
- 0.16

---

**Maximum axial load (Fai max)**

- 100
- 70
- 50
- 40
- 30
- 20
- 10

---

**Average moment load (Mi av)**

- 19
- 12
- 7
- 5
- 3
- 2
- 1

---

**Allowable radial load (Frc)**

- 100
- 70
- 50
- 40
- 30
- 20
- 10

---

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

---

*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).
**Technical Data**

**Size 50**: Gearhead  |  **HPGP**

**Reduction ratio = 5**

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

![Graph 125-1](Image)

- Efficiency %
- Input torque Nm

Calculating maximum moment load ON input shaft

\[ P_{ci} = 0.137 \times M_{i} \]

\[ P_{ci} = 0.053 \times M_{i} \]

\[ P_{ci} = 2.7 \times F_{ai} \]

\[ P_{ci} = 1.232 \times F_{ai} \]

\[ P_{ci} = 2 \times F_{ri} \]

\[ P_{ci} = 1 \times F_{ri} \]

\[ P_{ci} = 0.5 \times F_{ri} \]

\[ P_{ci} = 0.3 \times F_{ri} \]

1. \[ M_{i} \text{ (Allowable moment load)} \]
2. \[ F_{ri} \text{ (Allowable radial load)} \]
3. \[ F_{ai} \text{ (Allowable axial load)} \]

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

**Size 65**: Gearhead  |  **HPGP**

**Reduction ratio = 5**

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

![Graph 125-5](Image)

- Efficiency %
- Input torque Nm

Calculating maximum moment load ON input shaft

\[ P_{ci} = 0.137 \times M_{i} \]

\[ P_{ci} = 0.053 \times M_{i} \]

\[ P_{ci} = 2.7 \times F_{ai} \]

\[ P_{ci} = 1.232 \times F_{ai} \]

\[ P_{ci} = 2 \times F_{ri} \]

\[ P_{ci} = 1 \times F_{ri} \]

\[ P_{ci} = 0.5 \times F_{ri} \]

\[ P_{ci} = 0.3 \times F_{ri} \]

1. \[ M_{i} \text{ (Allowable moment load)} \]
2. \[ F_{ri} \text{ (Allowable radial load)} \]
3. \[ F_{ai} \text{ (Allowable axial load)} \]

*Only one line is shown because the difference between the gearhead and a bearing assembled on the input side is small.*
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)  
Tn: Input torque corresponding to output torque

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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Tn: Input torque corresponding to output torque

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Tn: Input torque corresponding to output torque

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Tn: Input torque corresponding to output torque

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Tn: Input torque corresponding to output torque

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Tn: Input torque corresponding to output torque

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Tn: Input torque corresponding to output torque

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Tn: Input torque corresponding to output torque

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Size 20 : Gearhead & Input Shaft Unit  

- **Reduction ratio = 3, 5**

  ![Graph 127-1](image)

  - Reduction ratio = 3
  - Reduction ratio = 5

- **Reduction ratio = 11**

  ![Graph 127-2](image)

  - Reduction ratio = 11

Size 32 : Gearhead & Input Shaft Unit  

- **Reduction ratio = 3, 5**

  ![Graph 127-4](image)

  - Reduction ratio = 3
  - Reduction ratio = 5

- **Reduction ratio = 11**

  ![Graph 127-5](image)

  - Reduction ratio = 11

---

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

### Gearhead & Input Shaft Unit - HPG

#### Reduction ratio = 3, 5\(^2\)

- **Graph 128-1**
- Efficiency % vs. Input torque (Nm)
- Reduction ratio = 3
- Reduction ratio = 5

#### Reduction ratio = 11\(^2\)

- **Graph 128-2**
- Efficiency % vs. Input torque (Nm)
- Reduction ratio = 11

#### Reduction ratio = 15, 21\(^2\)

- **Graph 128-3**
- Efficiency % vs. Input torque (Nm)
- Reduction ratio = 15
- Reduction ratio = 21

#### Reduction ratio = 33, 45

- **Graph 128-4**
- Efficiency % vs. Input torque (Nm)
- Reduction ratio = 33
- Reduction ratio = 45

---

**Size 65**

### Gearhead & Input Shaft Unit - HPG

#### Reduction ratio = 4, 5\(^3\)

- **Graph 128-5**
- Efficiency % vs. Input torque (Nm)
- Reduction ratio = 4
- Reduction ratio = 5

#### Reduction ratio = 12

- **Graph 128-6**
- Efficiency % vs. Input torque (Nm)
- Reduction ratio = 12

#### Reduction ratio = 15, 20

- **Graph 128-7**
- Efficiency % vs. Input torque (Nm)
- Reduction ratio = 15
- Reduction ratio = 20

#### Reduction ratio = 25

- **Graph 128-8**
- Efficiency % vs. Input torque (Nm)
- Reduction ratio = 25

#### Reduction ratio = 40\(^3\)

- **Graph 128-9**
- Efficiency % vs. Input torque (Nm)
- Reduction ratio = 40

#### Reduction ratio = 50

- **Graph 128-10**
- Efficiency % vs. Input torque (Nm)
- Reduction ratio = 50

---

* 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

### Technical Information / Handling Explanation

#### Note

**25**

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

- 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 shaft unit.

### Input Bearing Specifications and Checking Procedure

#### Table 145-2 and 145-4

<table>
<thead>
<tr>
<th>Size</th>
<th>Gearhead Specifications</th>
<th>HPF</th>
<th>Gearhead</th>
<th>HPF</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>20</td>
<td>25</td>
<td>32</td>
<td>11</td>
</tr>
<tr>
<td>65</td>
<td>20</td>
<td>25</td>
<td>32</td>
<td>11</td>
</tr>
<tr>
<td>96.9</td>
<td>44.4</td>
<td>29700 Nm</td>
<td>14500 Nm</td>
<td>51000 Nm</td>
</tr>
</tbody>
</table>

- Allowable radial load \( F_{rc} \)
- Allowable moment load \( M_{c} \)
- Allowable axial load \( F_{a} \)

#### Reduction ratio

- Reduction ratio = 4
- Reduction ratio = 5, 6
- Reduction ratio = 7, 8
- Reduction ratio = 9, 10

### Graph 129-1

Graph showing efficiency vs. input torque for different reduction ratios.

### Graph 129-2

Graph showing efficiency vs. input torque for different reduction ratios.

### Gearheads

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

### Efficiency

- Efficiency %

Graphs and formulas for calculating efficiency and life expectancy are provided in the document.
Technical Data

**Size 20**

**Gearhead**

**HPG-Helical**

**Technical Information / Handling Explanation**

**Reduction ratio = 3, 4**

**Reduction ratio = 5, 6**

**Reduction ratio = 7, 8**

**Reduction ratio = 9, 10**

---

---

---

---
Technical Data

**Size 50 RA5** : Right Angle Gearhead  

**HPG**

**Reduction ratio = 5**

<table>
<thead>
<tr>
<th>Reduction ratio = 5</th>
<th>Reduction ratio = 11</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="#" alt="Graph 132-1" /></td>
<td><img src="#" alt="Graph 132-2" /></td>
</tr>
</tbody>
</table>

**Reduction ratio = 15, 21**

<table>
<thead>
<tr>
<th>Reduction ratio = 15, 21</th>
<th>Reduction ratio = 33, 45</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="#" alt="Graph 132-3" /></td>
<td><img src="#" alt="Graph 132-4" /></td>
</tr>
</tbody>
</table>

**Reduction ratio = 11, 12, 15, 20, 25, 30, 40, 50**

**Reduction ratio = 11**

<table>
<thead>
<tr>
<th>Reduction ratio = 11</th>
<th>Reduction ratio = 11</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="#" alt="Graph 132-5" /></td>
<td><img src="#" alt="Graph 132-6" /></td>
</tr>
</tbody>
</table>

**Reduction ratio = 20, 25**

<table>
<thead>
<tr>
<th>Reduction ratio = 20, 25</th>
<th>Reduction ratio = 40, 50</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="#" alt="Graph 132-7" /></td>
<td><img src="#" alt="Graph 132-8" /></td>
</tr>
</tbody>
</table>

\( T_i \) Input torque corresponding to output torque

---

**Technical Information / Handling Explanation**

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

**Specification of input shaft bearing**

- Size 25
- Size 32

**Specification of input bearing**

- Size 25
- Size 32

**Input Bearing Specifications and Checking Procedure**

- Calculate: Average input speed (**Ni**) and Average moment load (**Mi**) and Efficiency (%)

\[
\begin{align*}
\text{Efficiency} \% &= \frac{N_i}{N} \\
N_i &= \frac{R_i T_i}{R_i T_i} \\
R_i &= \frac{R_i T_i}{R_i T_i} \\
M_i &= \frac{M_i T_i}{M_i T_i} \\
N &= \frac{N T_i}{N T_i} \\
R &= \frac{R T_i}{R T_i}
\end{align*}
\]

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

**Graph 132-1**

- Reduction ratio = 5
- Reduction ratio = 11

**Graph 132-2**

- Reduction ratio = 15
- Reduction ratio = 21

**Graph 132-3**

- Reduction ratio = 15
- Reduction ratio = 21

**Graph 132-4**

- Reduction ratio = 33
- Reduction ratio = 45

**Graph 132-5**

- Reduction ratio = 5

**Graph 132-6**

- Reduction ratio = 12
- Reduction ratio = 15

**Graph 132-7**

- Reduction ratio = 20
- Reduction ratio = 25

**Graph 132-8**

- Reduction ratio = 40
- Reduction ratio = 50
Technical Data

**Input Bearing Specifications and Checking Procedure**

**Size**

- Gearhead HPG
- Gearhead HPF

**Specification of Input Shaft Bearing**

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

**Checking procedure**

1. Calculate the average moment load (Mi):
   
   \[ Mi = \frac{1}{n} \sum_{i=1}^{n} M_i \]

2. Check that the following formulas are established in all circumstances:

   \[ Fai \leq MC \]

   \[ Fac \leq Frc \]

**Graphs**

- **Graph 135-1**: Efficiency vs. Input Torque (Reduction ratio = 3)
- **Graph 135-2**: Efficiency vs. Input Torque (Reduction ratio = 4)
- **Graph 135-3**: Efficiency vs. Input Torque (Reduction ratio = 5)
- **Graph 135-4**: Efficiency vs. Input Torque (Reduction ratio = 7)
- **Graph 135-5**: Efficiency vs. Input Torque (Reduction ratio = 10)
- **Graph 135-6**: Efficiency vs. Input Torque (Reduction ratio = 13)

**Technical Information / Handling Explanation**

1. The allowable axial load is the value of an axial load applied along the axis of rotation.
2. The allowable radial load of HPG series is the value of a radial load applied to the point of 20 mm from the shaft edge (input flange edge).
Technical Information / Handling Explanation

Right Angle Gearhead

Reduction ratio = 11

Reduction ratio = 25

Reduction ratio = 21

Reduction ratio = 15

Reduction ratio = 12

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.

Graph 132-3

Specification of input shaft bearing

Specification of input bearing

Allowable moment load, Fac *1

Allowable radial load, Frc *2

Maximum axial load, Fai

Maximum moment load, Mc

Maximum radial load, Fri

Average axial load, Fac

Average moment load, Mc

Input speed

Moment load

Dynamic equivalent load

Formula 146-4

Formula 146-3

Formula 146-2

See Table 146-1

See Table 145-1

See Table 145-2

See Fig. 146-1.

See Fig. 146-1.

See Fig. 146-1.

How to calculate average load

How to calculate average axial load

How to calculate average moment load

Table 145-3

Table 145-2

Table 145-1

Technical Data

HPG HPF
Reduction ratio = 50

Reduction ratio = 80

Reduction ratio = 100

Reduction ratio = 120

Reduction ratio = 160

Input rotational speed

500 rpm

1000 rpm

2000 rpm

3500 rpm

Size 14

Gearhead

CSG-GH

CSF-GH

Technical Information / Handling Explanation

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

Specification of input shaft bearing

Input Bearing Specifications and Checking Procedure

Size

25

65

20

32

11

32

14

11

Maximum axial load (Fai max)

Allowable moment load (Mc)

Allowable axial load (Fac)

Allowable radial load (Frc)

Basic load rating

Basic dynamic load rating

Basic static load rating

Allowable moment load (Mc)

Allowable axial load (Fac)

Allowable radial load (Frc)

Size 14:

HPG

HPF

3030

878

2.1

333

20.6

966

500

92

51

98.5

537

201

132

5.4

21.4

5640

5540

2.5

657

245

14.5

21.4

5640

5540

2.5

657

245

14.5

21.4

5640

5540

2.5

657

245

14.5

21.4
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 Data
Technical Data

Size 65 Gearhead

Reduction ratio = 80

Graph 139-1

Reduction ratio = 100

Graph 139-2

Reduction ratio = 120

Graph 139-3

Reduction ratio = 160

Graph 139-4

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

Input torque Ncm

Graphs show efficiency % vs. input torque Ncm for different reduction ratios and input rotational speeds.

NOTES
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_{max})**
   
   Calculate the maximum moment load (M_{max}).
   
   Maximum moment load (M_{max}) ≤ Permissible moment (M_{c})

2. **Checking the life**
   
   Calculate the average radial load (F_{av}) and the axial load coefficient (Y).
   
   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_{o}).
   
   Check the static safety coefficient (f_s).

### Specification of output bearing

#### HPG/HPG Series

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

<table>
<thead>
<tr>
<th>Size</th>
<th>Pitch circle</th>
<th>Offset amount</th>
<th>Basic rated load</th>
<th>Allowable moment load (M_{c})</th>
<th>Moment stiffness (K_{m})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>dp (mm)</td>
<td>R (mm)</td>
<td>Basic dynamic load rating C*1</td>
<td>Basic static load rating C*2</td>
<td>Nm</td>
</tr>
<tr>
<td>11</td>
<td>0.0275</td>
<td>0.006</td>
<td>3116</td>
<td>318</td>
<td>4087</td>
</tr>
<tr>
<td>14</td>
<td>0.0405</td>
<td>0.011</td>
<td>5110</td>
<td>521</td>
<td>7060</td>
</tr>
<tr>
<td>20</td>
<td>0.054</td>
<td>0.0115</td>
<td>10600</td>
<td>1082</td>
<td>17300</td>
</tr>
<tr>
<td>32</td>
<td>0.085</td>
<td>0.014</td>
<td>20500</td>
<td>2092</td>
<td>32800</td>
</tr>
<tr>
<td>50</td>
<td>0.123</td>
<td>0.019</td>
<td>41600</td>
<td>4245</td>
<td>76000</td>
</tr>
<tr>
<td>65</td>
<td>0.170</td>
<td>0.023</td>
<td>90600</td>
<td>9245</td>
<td>148000</td>
</tr>
</tbody>
</table>

#### Tables 141-2 and 141-3

<table>
<thead>
<tr>
<th>Size</th>
<th>Reduction ratio</th>
<th>Allowable radial load (N)</th>
<th>Allowable axial load (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>5</td>
<td>280</td>
<td>430</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>340</td>
<td>510</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>440</td>
<td>660</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>520</td>
<td>780</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>550</td>
<td>830</td>
</tr>
<tr>
<td></td>
<td>37</td>
<td>400</td>
<td>600</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>470</td>
<td>700</td>
</tr>
<tr>
<td>14</td>
<td>11</td>
<td>600</td>
<td>890</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>650</td>
<td>980</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>720</td>
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<td></td>
<td>33</td>
<td>830</td>
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<td></td>
<td>45</td>
<td>910</td>
<td>1360</td>
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<td></td>
<td>65</td>
<td>840</td>
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</tr>
<tr>
<td>20</td>
<td>5</td>
<td>980</td>
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</tr>
<tr>
<td></td>
<td>11</td>
<td>1240</td>
<td>1850</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>1360</td>
<td>2090</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>1510</td>
<td>2250</td>
</tr>
<tr>
<td></td>
<td>33</td>
<td>1729</td>
<td>2580</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>1890</td>
<td>2830</td>
</tr>
</tbody>
</table>

**Note:** Table 141-1, -2 and -3

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

* The ratio specified in parentheses is for the HPG Series.
### 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>Basic dynamic load rating Co</th>
<th>Basic static load rating C0</th>
<th>Allowable moment load Mc</th>
<th>Moment stiffness Km</th>
<th>Allowable axial load Fa</th>
<th>Allowable radial load Fr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>m m N kgf N kgf</td>
<td></td>
<td>N m kgf/ Nm(rad)</td>
<td>N</td>
<td></td>
<td>N kgf/arc min</td>
<td>N kgf</td>
<td>N kgf</td>
</tr>
<tr>
<td>14</td>
<td>0.0405 0.011 5110 521 7060 720</td>
<td>27 2.76 3.0 0.89</td>
<td>732 1093</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>0.064  0.0115 10600 1082 17300 1765</td>
<td>145 14.8 17 5.0</td>
<td>1519 2267</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>0.085  0.014 20500 2092 32800 3347</td>
<td>258 26.3 42 12</td>
<td>2938 4385</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>0.123  0.019 41600 4245 76000 7755</td>
<td>797 81.3 100 30</td>
<td>5962 8899</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>0.170  0.0225 81600 8327 149000 15204</td>
<td>2156 220 323 96</td>
<td>11693 17454</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Size</th>
<th>Pitch circle dp</th>
<th>Offset amount R</th>
<th>Basic dynamic load rating Co</th>
<th>Basic static load rating C0</th>
<th>Allowable moment load Mc</th>
<th>Moment stiffness Km</th>
<th>Allowable axial load Fa</th>
<th>Allowable radial load Fr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>m m N kgf N kgf</td>
<td></td>
<td>N m kgf/ Nm(rad)</td>
<td>N</td>
<td></td>
<td>N kgf/arc min</td>
<td>N kgf</td>
<td>N kgf</td>
</tr>
<tr>
<td>25</td>
<td>0.085 0.0153 11400 1163 20300 2071</td>
<td>410 41.8 37.9 11.3</td>
<td>1330 1990</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>0.1115 0.015 22500 2296 39900 4071</td>
<td>932 95 86.1 25.7</td>
<td>2640 3940</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></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. \( \text{Lr} + R = 0 \text{ mm for radial load and } La = 0 \text{ mm for axial load} \) 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 \( M_{\text{max}} \leq Mc \).

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

<table>
<thead>
<tr>
<th>Fr (_{max})</th>
<th>Max. radial load N (kgf)</th>
<th>See Fig. 143-1.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fa (_{max})</td>
<td>Max. axial load N (kgf)</td>
<td>See Fig. 143-1.</td>
</tr>
<tr>
<td>Lr, La</td>
<td>m</td>
<td>See Fig. 143-1.</td>
</tr>
<tr>
<td>R</td>
<td>Offset amount m</td>
<td>See Fig. 143-1.</td>
</tr>
</tbody>
</table>

Note: \( Lr + R \) and \( Fa \cdot La \) depend on the position of the shaft edge. See "Output Bearing Specifications" of each series, p. 141 & 142.

How to calculate the radial and the axial load coefficient

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

\[
X = \frac{F_r \cdot av}{R \cdot av + 2 / (R \cdot av + Lr + R) + Fa \cdot av \cdot La / dp}
\]

\[
Y = \frac{F_a \cdot av}{R \cdot av + 2 / (R \cdot av + Lr + R) + Fa \cdot av \cdot La / dp}
\]

<table>
<thead>
<tr>
<th>Fr (_{av})</th>
<th>Average radial load N (kgf)</th>
<th>See &quot;How to calculate the average load below.&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fa (_{av})</td>
<td>Average axial load N (kgf)</td>
<td>See &quot;How to calculate the average load below.&quot;</td>
</tr>
<tr>
<td>Lr, La</td>
<td>m</td>
<td>See Fig. 143-1.</td>
</tr>
<tr>
<td>R</td>
<td>Offset amount m</td>
<td>See Fig. 143-1.</td>
</tr>
<tr>
<td>dp</td>
<td>Circular pitch of roller m</td>
<td>See Fig. 143-1.</td>
</tr>
</tbody>
</table>

Note: \( R \cdot av \) and \( Fa \cdot La \) depend on the position of the shaft edge. See "Output Bearing Specifications" of each series, p. 141 & 142.

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 \( (F_{rav}) \)

\[
F_{rav} = \left( \frac{\sum_{i=1}^{n} F_{r_i} \cdot (F_{r_i})^{10/3} + \sum_{i=1}^{n} (F_{r_i})^{10/3} \cdot t_i}{n \cdot t_1 + n_2 + \ldots + n_t} \right)^{3/10}
\]

Note that the maximum radial load within the \( t_1 \) section is \( F_{r1} \) and the maximum radial load within the \( t_2 \) section is \( F_{r2} \).

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

\[
F_{av} = \left( \frac{\sum_{i=1}^{n} F_{a_i} \cdot (F_{a_i})^{10/3} + \sum_{i=1}^{n} (F_{a_i})^{10/3} \cdot t_i}{n \cdot t_1 + n_2 + \ldots + n_t} \right)^{3/10}
\]

Note that the maximum axial load within the \( t_1 \) section is \( F_{a1} \) and the maximum axial load within the \( t_2 \) section is \( F_{a2} \).

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

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

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

\[ L_{oc} = \frac{10^8}{60 \times n_{av}} \times \left( \frac{C \times (f_w \times Pc)}{18/3} \right) \]

Where:
- \( L_{oc} \) = Life under oscillating motion, hour
- \( n_{av} \) = Average output speed, rpm
- \( C \) = Basic dynamic load rating, N (kgf)
- \( f_w \) = Load coefficient

\[ P_c = X \left( \frac{F_{rav} + 2(F_{rav}(L_r + R) + F_{sav}(L_s + L_d))}{dp} \right) + Y \cdot F_{sav} \]

Where:
- \( F_{rav} \) = Average radial load, N (kgf)
- \( F_{sav} \) = Average axial load, N (kgf)
- \( X \) = Radial load coefficient
- \( Y \) = Axial load coefficient
- \( R \) = Offset amount, m
- \( dp \) = Pitch Circle, m
- \( L_r, L_s \) = See Figure 143-1.

\[ \text{Table 144-1} \]

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

How to calculate the life during oscillating motion

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

\[ L_{oc} = \frac{10^8}{60 \times n_1} \times \frac{90}{\theta} \times \left( \frac{C \times (f_w \times Pc)}{18/3} \right) \]

Where:
- \( L_{oc} \) = 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
- \( \theta \) = Oscillating angle, deg.

Note: When it is used for a long time while the rotation speed of the output shaft is in the ultra-low operation range (0.02 rpm 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

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

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

Where:
- \( Co \) = Basic static load, N (kgf)
- \( Po \) = Static equivalent load, N (kgf)

Static safety coefficient

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

Technical Data

| Table 144-2 | |
|-------------| |
| Load status | fs  |
| When high precision is required         | ≥ 3 |
| When impact or vibration is expected    | ≥ 2 |
| Under normal operating condition        | ≥ 1.5 |
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

<table>
<thead>
<tr>
<th>(1) Checking maximum load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculate:</td>
</tr>
<tr>
<td>Maximum moment load (Mimax)</td>
</tr>
<tr>
<td>Maximum axial load (Faimax)</td>
</tr>
<tr>
<td>Maximum radial load (Frimax)</td>
</tr>
</tbody>
</table>

Maximum moment load (Mimax) ≤ Allowable moment load (Mc)
Maximum axial load (Faimax) ≤ Allowable axial load (Fac)
Maximum radial load (Frimax) ≤ Allowable radial load (Frc)

<table>
<thead>
<tr>
<th>(2) Checking the life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculate:</td>
</tr>
<tr>
<td>Average moment load (Miam)</td>
</tr>
<tr>
<td>Average axial load (Faim)</td>
</tr>
<tr>
<td>Average input speed (Niam)</td>
</tr>
</tbody>
</table>

Calculate the life and check it.

### Specification of input bearing

#### Table 145-1

<table>
<thead>
<tr>
<th>Size</th>
<th>Basic load rating</th>
<th>Table 145-1</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 (kgf)</td>
<td>N (kgf)</td>
</tr>
<tr>
<td>11</td>
<td>2700</td>
<td>275</td>
</tr>
<tr>
<td>14</td>
<td>5800</td>
<td>590</td>
</tr>
<tr>
<td>20</td>
<td>9700</td>
<td>990</td>
</tr>
<tr>
<td>32</td>
<td>22500</td>
<td>2300</td>
</tr>
<tr>
<td>50</td>
<td>35500</td>
<td>3600</td>
</tr>
<tr>
<td>65</td>
<td>51000</td>
<td>5200</td>
</tr>
</tbody>
</table>

#### Table 145-2

<table>
<thead>
<tr>
<th>Size</th>
<th>Allowable moment load Mc</th>
<th>Allowable axial load Fac</th>
<th>Allowable radial load Frc</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nm (kgf)</td>
<td>kgfm</td>
<td>N (kgf)</td>
</tr>
<tr>
<td>11</td>
<td>0.16</td>
<td>0.016</td>
<td>245</td>
</tr>
<tr>
<td>14</td>
<td>6.3</td>
<td>0.64</td>
<td>657</td>
</tr>
<tr>
<td>20</td>
<td>13.5</td>
<td>1.38</td>
<td>1206</td>
</tr>
<tr>
<td>32</td>
<td>44.4</td>
<td>4.53</td>
<td>3285</td>
</tr>
<tr>
<td>50</td>
<td>96.9</td>
<td>9.88</td>
<td>5540</td>
</tr>
<tr>
<td>65</td>
<td>210</td>
<td>21.4</td>
<td>8600</td>
</tr>
</tbody>
</table>

#### Table 145-3

<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 (kgf)</td>
<td>N (kgf)</td>
</tr>
<tr>
<td>25</td>
<td>14500</td>
<td>1480</td>
</tr>
<tr>
<td>32</td>
<td>29700</td>
<td>3030</td>
</tr>
</tbody>
</table>

#### Table 145-4

<table>
<thead>
<tr>
<th>Size</th>
<th>Allowable moment load Mc</th>
<th>Allowable axial load Fac</th>
<th>Allowable radial load Frc</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nm (kgf)</td>
<td>kgfm</td>
<td>N (kgf)</td>
</tr>
<tr>
<td>25</td>
<td>10</td>
<td>1.02</td>
<td>1538</td>
</tr>
<tr>
<td>32</td>
<td>19</td>
<td>1.93</td>
<td>3263</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 HPG 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 (Mimax) is calculated as follows.
Check that the following formulas are established in all circumstances:

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

\[ M_{i\text{ max}} \leq M_c \text{ (Allowable moment load)} \]
\[ F_{a i\text{ max}} \leq F_{\text{ac}} \text{ (Allowable axial load)} \]

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.

How to calculate the average moment load (Miav)

\[ M_{i\text{av}} = \frac{n_1(M_{i1})^3 + n_2(M_{i2})^3 + \cdots + n_t(M_{it})^3}{n_1 + n_2 + \cdots + n_t} \]

How to calculate the average axial load (Faiav)

\[ F_{a\text{av}} = \frac{n_1(F_{a1})^3 + n_2(F_{a2})^3 + \cdots + n_t(F_{at})^3}{n_1 + n_2 + \cdots + n_t} \]

How to calculate the average input speed (Niav)

\[ N_{i\text{av}} = \frac{n_1 + n_2 + \cdots + n_t}{t_1 + t_2 + \cdots + t_n} \]

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

\[ L_{10} = \frac{10^6}{60 \times N_{i\text{av}}} \times \left( \frac{C_r}{P_{ci}} \right)^5 \]

Dynamic equivalent load

HPG

<table>
<thead>
<tr>
<th>Size</th>
<th>Pci</th>
<th>Table 146-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>0.444 \times M_{i\text{av}} + 1.426 \times F_{a\text{av}}</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>0.137 \times M_{i\text{av}} + 1.232 \times F_{a\text{av}}</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>0.090 \times M_{i\text{av}} + 1.232 \times F_{a\text{av}}</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>0.071 \times M_{i\text{av}} + 1.232 \times F_{a\text{av}}</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>0.053 \times M_{i\text{av}} + 1.232 \times F_{a\text{av}}</td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>0.041 \times M_{i\text{av}} + 1.232 \times F_{a\text{av}}</td>
<td></td>
</tr>
</tbody>
</table>

HPF

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

\[ M_{i\text{av}} \text{ Average moment load Nm (kgf) \ See Formula 146-2} \]
\[ F_{a\text{av}} \text{ Average axial load N (kgf) \ See Formula 146-3} \]
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>kgfm</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 (HPG helical). Tighten the screws to the tightening torque specified below.

   **Bolt tightening torque**

<table>
<thead>
<tr>
<th>Bolt size</th>
<th>M3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nm</td>
<td>0.69</td>
</tr>
<tr>
<td>kgfm</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>69.9</td>
</tr>
<tr>
<td>kgfm</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.
2. Bolt tightening torque

   - Fasten screws with a gasket in two places.
   - Check that the bolts are already inserted into the input coupling when delivered. Check the bolt size on the confirmation drawing provided.
   - Tighten the motor shaft into the coupling of speed reducer, then tighten the motor bolts evenly until the motor flange and gearhead flange are aligned.

   **Caution:** Be sure to tighten the bolts to the tightening torques specified in the table. Recommended bolt: JIS B 1176 Hexagon socket head bolt, Strength: JIS B 1051 12.9 or higher.

3. Recommended tightening torques

   - Size 11: 2.66 Nm
   - Size 14: 2.66 Nm
   - Size 20: 2.66 Nm
   - Size 32: 2.66 Nm
   - Size 40: 2.66 Nm
   - Size 45/50: 2.66 Nm
   - Size 50: 2.66 Nm
   - Size 65: 2.66 Nm

   *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

**Table 148-1**

<table>
<thead>
<tr>
<th>Size</th>
<th>HPN</th>
<th>HPGP / HPG / CSG-GH / CSF-GH</th>
<th>HPG</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>Nm</td>
<td>27.9</td>
<td>110</td>
</tr>
<tr>
<td>Transmission torque</td>
<td>kgf</td>
<td>2.85</td>
<td>11.3</td>
</tr>
</tbody>
</table>

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

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

**Table 148-2**

<table>
<thead>
<tr>
<th>Size</th>
<th>HPN</th>
<th>HPGP / HPG / CSG-GH / CSF-GH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>Number of bolts</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Bolt size</td>
<td>M4</td>
<td>M4</td>
</tr>
<tr>
<td>Mounting PCD</td>
<td>mm</td>
<td>18</td>
</tr>
<tr>
<td>Tightening torque</td>
<td>Nm</td>
<td>4.5</td>
</tr>
<tr>
<td>Transmission torque</td>
<td>Nm</td>
<td>25.3</td>
</tr>
<tr>
<td>Transmission torque</td>
<td>kgf</td>
<td>2.58</td>
</tr>
</tbody>
</table>

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

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

**Table 148-3**

<table>
<thead>
<tr>
<th>Size</th>
<th>HPN</th>
<th>HPG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>Number of bolts</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Bolt size</td>
<td>M4</td>
<td>M4</td>
</tr>
<tr>
<td>Mounting PCD</td>
<td>mm</td>
<td>18</td>
</tr>
<tr>
<td>Tightening torque</td>
<td>Nm</td>
<td>4.5</td>
</tr>
<tr>
<td>Transmission torque</td>
<td>Nm</td>
<td>19.0</td>
</tr>
<tr>
<td>Transmission torque</td>
<td>kgf</td>
<td>1.9</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) - CSG-GH

<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>

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

<table>
<thead>
<tr>
<th>Size</th>
<th>14</th>
<th>20</th>
<th>32</th>
<th>45</th>
<th>65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of bolts</td>
<td>6</td>
<td>6</td>
<td>16</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Bolt size</td>
<td>M4</td>
<td>M6</td>
<td>M8</td>
<td>M8</td>
<td>M16</td>
</tr>
<tr>
<td>Mounting PCD</td>
<td>mm</td>
<td>30</td>
<td>45</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>Tightening torque</td>
<td>Nm</td>
<td>4.5</td>
<td>15.3</td>
<td>37.2</td>
<td>37.2</td>
</tr>
<tr>
<td>kgf</td>
<td>0.46</td>
<td>1.56</td>
<td>3.8</td>
<td>3.8</td>
<td>32.5</td>
</tr>
<tr>
<td>Transmission torque</td>
<td>Nm</td>
<td>83</td>
<td>215</td>
<td>524</td>
<td>2328</td>
</tr>
<tr>
<td>kgf</td>
<td>6.5</td>
<td>21.9</td>
<td>53.4</td>
<td>237</td>
<td>610</td>
</tr>
</tbody>
</table>

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

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

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

---

**Gearheads with an output shaft**

### HPN | HPG | HPGP | CSG-GH | CSF-GH | HPF

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

<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>0.060</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>

* 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 seal in the adapter flange is facing upwards.

#### Sealing

(Common to all models)
- Provisions for proper sealing to prevent grease leakage from the input shaft are incorporated into the gearhead.
- A double lip Teflon oil seal is used for the output shaft (HPG/HPG uses a single lip seal), gaskets or o-rings are used on all mating surfaces, and non contact shields 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-1U) and HPF series hollow shaft reducer. An option for an oil seal with a spring is available for improved seal reliability, however, the efficiency will be slightly lower (available for HPF and HPG series for sizes 14 and larger).
- Do not remove the screw plug and seal cap of the HPG series right angle gearhead. Removing them may cause leakage of grease or affect the precision of the gear.

#### Standard Lubricants

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

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

**Lubricants**

**Harmonic Grease SK-2** (HPG/HPG-14, 20, 32)
Manufacturer: Harmonic Drive Systems Inc.

- Base oil: Refined mineral oil
- Thickening agent: Lithium soap
- Additive: Extreme pressure agent and other
- Standard: NLGI No. 2
- Consistency: 265 to 295 at 25°C
- Color: Green

**EPNOC Grease AP (N) 2** (HPG/HPG-11, 50, 65 / HPF-25, 32)
Manufacturer: Nippon Oil Co.

- Base oil: Refined mineral oil
- Thickening agent: Lithium soap
- Additive: Extreme pressure agent and other
- Standard: NLGI No. 2
- Consistency: 282 at 25°C
- Color: Light brown

**PYRONOC UNIVERSAL 00** (HPG right angle gearhead/HPN)
Manufacturer: Nippon Oil Co.

- Base oil: Refined mineral oil
- Thickening agent: Urea
- Standard: NLGI No. 00
- Consistency: 420 at 25°C
- 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
- Color: Black viscose

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

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

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

### Technical Information / Handling Explanation
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

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

Base oil: Refined mineral oil
Additive: Extreme pressure agent and other
Standard: NLGI No. 2

| 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 |
| 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

\[ L_{gt} = L_{gt\text{in}} \times \left( \frac{T_{r}}{T_{av}} \right)^{3} \]

Formula symbols

- \( L_{gt} \): Grease change interval when \( T_{av} > T_{r} \) and \( T_{av} \leq T_{r} \)
- \( L_{gt\text{in}} \): Grease change interval when \( T_{av} \leq T_{r} \), see Graph Table 152-1
- \( T_{r} \): Output torque at 2000 rpm, Nm, kgfm
- \( T_{av} \): Average load torque, Nm, kgfm

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.

Reference values for grease refill amount

<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>Amount (g)</td>
<td>0.8</td>
<td>3.2</td>
<td>6.6</td>
<td>11.6</td>
<td>78.6</td>
</tr>
</tbody>
</table>

Figure 152-1: Variation of life with grease change interval

**Formula 146-1**

\[ \frac{L_{gt}}{L_{gt\text{in}}} \times \left( \frac{T_{r}}{T_{av}} \right)^{3} \]

**L10 Life of wave generator bearing**

**Graph 152-1**

**Table 152-1**

**Table 152-2**

<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>Amount (g)</td>
<td>0.8</td>
<td>3.2</td>
<td>6.6</td>
<td>11.6</td>
<td>78.6</td>
</tr>
</tbody>
</table>
Warranty

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

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

Disposal

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

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

Trademark

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

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

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

### Application Restrictions

This product cannot be used for the following applications:

- Space flight hardware
- Aircraft equipment
- Nuclear power equipment
- Equipment and apparatus used in residential dwellings
- Vacuum environments
- Automotive equipment
- Personal recreation equipment
- Equipment that directly works on human bodies
- Equipment for transport of humans
- 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>Use only in the proper environment.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Please ensure to comply with the following environmental conditions:</td>
</tr>
<tr>
<td></td>
<td>- Ambient temperature 0 to 40˚C</td>
</tr>
<tr>
<td></td>
<td>- Do not expose to corrosive or explosive gas</td>
</tr>
<tr>
<td></td>
<td>- Do not hit the gear or any part with a hammer</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Caution</th>
<th>Install the equipment with the required precision.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Design and assemble parts to keep all catalog recommended tolerances for installation.</td>
</tr>
<tr>
<td></td>
<td>Failure to hold the recommended tolerances 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>Use caution when handling the product and parts.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Do not hit the gear or any part with a hammer.</td>
</tr>
<tr>
<td></td>
<td>Do not use the equipment in a damaged condition, the gearhead may not perform to catalog specifications. It can also cause problems including product failure.</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Warning</th>
<th>Do not use your finger to turn the gear.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Do not insert your finger into the gear under any circumstances. The finger may get caught in the gear causing an injury.</td>
</tr>
<tr>
<td></td>
<td>Large sizes (45, 50 mm) are heavy. Use caution when handling.</td>
</tr>
<tr>
<td></td>
<td>They are heavy and may cause a lower-back injury or an injury if dropped on a hand or foot. Wear protective shoes and back support when handling the product.</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>
</tbody>
</table>

### Handling Lubricant

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

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

Size 65:

- Gearhead: CSG-GH, CSF-GH

Input rotational speeds:
- 500 rpm
- 1000 rpm
- 2000 rpm
- 3500 rpm

Efficiency %:
- Graph 139-1
- Graph 139-2
- Graph 139-3
- Graph 139-4
NOTES
Major Applications of Our Products

- Metal Working Machines
- Processing Machine Tools
- Measurement, Analytical and Test Systems
- Medical Equipment
- Telescopes
- Energy
- Crating and Packaging Machines
- Communication Equipment
- Glass and Ceramic Manufacturing Systems
- Robots
- Space Flight Hardware
- 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

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.