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

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

### Measurement condition

<table>
<thead>
<tr>
<th>Input rotational speed</th>
<th>HPGP / HPG / HPF / HPN: 3000rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CSG-GH / CSF-GH: Indicated on each efficiency graph.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ambient temperature</th>
<th>25°C</th>
</tr>
</thead>
</table>

| Lubricant | Use standard lubricant for each model. (See pages 151-152 for details.) |

### 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](image_url)

![Graph 122-2](image_url)
**Note**

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

2. Checking maximum load
3. Checking life

**Technical Information / Handling Explanation**

**Specification of input shaft bearing**

**Input Bearing Specifications and Checking Procedure**

- **Size**
  - 50
  - 25
  - 32
- **Specification of input bearing**
  - 65
  - 50
  - 20
  - 11
  - 14

**Measurement condition**

- **Efficiency compensated for low temperature**
- **Lubricant**
- **Ambient Temperature**

**Technical Data**

- **Input torque corresponding to output torque**
- **CSG-GH**
- **HPGP**

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

- **Calculate the efficiency at an ambient temperature of 25°C**

- **Graphs**

1. **Reduction Ratio = 5**
2. **Reduction Ratio = 21**
3. **Reduction Ratio = 37, 45**
4. **Reduction Ratio = 5**
5. **Reduction Ratio = 15, 21**
6. **Reduction Ratio = 33, 45**

**How to calculate average load**

1. **Calculating maximum moment load ON input shaft**
   - Reduction Ratio = 5
   - Reduction Ratio = 21
   - Reduction Ratio = 37, 45

2. **Reduction Ratio = 5**
3. **Reduction Ratio = 15, 21**
4. **Reduction Ratio = 33, 45**

**Gearheads**

- **Size 11**: Gearhead
- **Size 14**: Gearhead

**Gearhead with D bearing (double sealed)**
### Technical Data

#### Technical Information / Handling Explanation

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

### Specification of Input Bearing

<table>
<thead>
<tr>
<th>Size</th>
<th>Reduction ratio</th>
<th>Gearhead with D bearing (double sealed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>5</td>
<td>Gearhead (standard item)</td>
</tr>
<tr>
<td>32</td>
<td>5</td>
<td>Gearhead with D bearing (double sealed)</td>
</tr>
</tbody>
</table>

#### Checking the life

1. 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. Calculate the life and check it.

#### Efficiency

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>90</td>
</tr>
<tr>
<td>11</td>
<td>60</td>
</tr>
<tr>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>21</td>
<td>30</td>
</tr>
<tr>
<td>33</td>
<td>100</td>
</tr>
<tr>
<td>45</td>
<td>80</td>
</tr>
</tbody>
</table>

#### Allowable loads

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Allowable load</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Maximum radial load ((F_{\text{rc}}))</td>
</tr>
<tr>
<td></td>
<td>Maximum axial load ((F_{\text{ai}}))</td>
</tr>
<tr>
<td></td>
<td>Average moment load ((M_{\text{i}}))</td>
</tr>
</tbody>
</table>

### Input torque corresponding to output torque

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Input torque (Nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>210</td>
</tr>
<tr>
<td>11</td>
<td>22500</td>
</tr>
<tr>
<td>15</td>
<td>3800</td>
</tr>
<tr>
<td>21</td>
<td>9000</td>
</tr>
<tr>
<td>33</td>
<td>20800</td>
</tr>
<tr>
<td>45</td>
<td>36000</td>
</tr>
</tbody>
</table>

---

**Note:**

- Graphs 124-1 to 124-8 show efficiency and input torque for different reduction ratios. The graphs display the relationship between input torque and efficiency, with separate lines for different gearhead types and bearing configurations.

---

**Table 145-2 and 145-4**

See Table 146-1 and -2

---

**Graph 125-1 to 125-8**

See Fig. 146-1.
The allowable radial load of HPG series is the value of a radial load applied to the point of 20 mm from the shaft edge (input flange edge).

**Checking the life**

**Specification of input shaft bearing**

Input Bearing Specifications and Checking Procedure

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

**Reduction ratio = 5**

![Graph 125-1](Graph 124-1)

**Reduction ratio = 15, 21**

![Graph 125-3](Graph 124-3)

**Reduction ratio = 11**

![Graph 125-2](Graph 124-2)

**Reduction ratio = 33, 45**

![Graph 125-4](Graph 124-4)

**Reduction ratio = 4, 5**

![Graph 125-5](Graph 124-5)

**Reduction ratio = 12**

![Graph 125-6](Graph 124-6)

**Reduction ratio = 15, 20**

![Graph 125-7](Graph 124-7)

**Reduction ratio = 25**

![Graph 125-8](Graph 124-8)

*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.
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

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

Maximum radial load ($F_{rad}$)
Maximum axial load ($F_{ax}$)
Maximum moment load ($M_{moment}$)
Average axial load ($F_{avg}$)
Average moment load ($M_{avg}$)

Calculate:

Table 145-2 and 145-4:

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>3, 5</th>
<th>11</th>
<th>33, 45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency (%)</td>
<td>44.4</td>
<td>100</td>
<td>86.0</td>
</tr>
</tbody>
</table>

Allowable moment load ($M_{allow}$)
Allowable axial load ($F_{allow}$)
Allowable radial load ($F_{rad}$)

Gearhead (standard item) —— Gearhead with D bearing (double sealed) —— Input shaft

Input torque ($T_{in}$) corresponding to output torque

Technical Data

*1 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

**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.

#### Specification of input bearing

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Input torque (Nm)</th>
<th>Basic load rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>50</td>
<td>500</td>
</tr>
<tr>
<td>12</td>
<td>60</td>
<td>600</td>
</tr>
<tr>
<td>15</td>
<td>80</td>
<td>800</td>
</tr>
<tr>
<td>20</td>
<td>100</td>
<td>1000</td>
</tr>
</tbody>
</table>

**Efficiency %**

- **Efficiency %**
- **Input torque**
- **Efficiency %**

**Allowable moment load (Mc)**

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

**Gearhead & Input Shaft Unit**

**Reduction ratio = 3, 5**

- Reduction ratio = 3
- Reduction ratio = 5

**Reduction ratio = 15, 21**

- Reduction ratio = 15
- Reduction ratio = 21

**Reduction ratio = 33, 45**

- Reduction ratio = 33
- Reduction ratio = 45

**Reduction ratio = 4, 5**

- Reduction ratio = 4
- Reduction ratio = 5

**Reduction ratio = 12**

- Reduction ratio = 12

**Reduction ratio = 15, 20**

- Reduction ratio = 15
- Reduction ratio = 20

**Reduction ratio = 40**

- Reduction ratio = 40

**Reduction ratio = 50**

- Reduction ratio = 50

---

*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.
Input Bearing Specifications and Checking Procedure

<table>
<thead>
<tr>
<th>Size</th>
<th>Gearhead</th>
<th>HPG-Helical</th>
</tr>
</thead>
</table>

**Reduction ratio = 4**

Graph 129-1

**Reduction ratio = 5, 6**

Graph 129-2

**Reduction ratio = 7, 8**

Graph 129-3

**Reduction ratio = 9, 10**

Graph 129-4

---

**Technical Data**

Table 145-1

<table>
<thead>
<tr>
<th>Size</th>
<th>Gearhead</th>
<th>HPG-Helical</th>
</tr>
</thead>
</table>

---

**Technical Information / Handling**

- Graph 129-1
- Graph 129-2
- Graph 129-3
- Graph 129-4

---

**Formula 146-4**

See Table 145-1 and -3

---

**Formula 146-3**

See Table 146-1 and -2

---

**Formula 146-2**

See Formula 146-4

---

**Graph 146-1**

See Table 146-1

---

**Graph 146-2**

See Formula 146-3

---

**Graph 146-3**

See Table 146-2

---

**Graph 146-4**

See Formula 146-2
Technical Data

Input torque corresponding to output torque

Graph 130-1

Graph 130-2

Graph 130-3

Graph 130-4

Graph 130-5

Graph 130-6

Graph 130-7

Graph 130-8

---

Size 20 Gearhead

HPG-Helical

Size 32 Gearhead

HPG-Helical

---

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

Checking the life

Specifications of input bearing

- Size 65
- Size 50

Checking procedure

1. Calculate average input speed ($N_{i\text{av}}$), average axial load ($F_{ai\text{av}}$), and average moment load ($M_{i\text{av}}$).

2. Use Formula 146-2 to calculate:
   - Average input speed ($N_{i\text{av}}$)
   - Average axial load ($F_{ai\text{av}}$)
   - Average moment load ($M_{i\text{av}}$)

3. Check that the following formulas are established in all circumstances:
   - $F_{ai\text{max}} \leq F_{ai\text{av}}$
   - $M_{i\text{max}} \leq M_{i\text{av}}$
   - $F_{ai\text{max}} \leq F_{ai\text{av}}$

4. Use Table 145-2 and 145-4 to calculate:
   - Maximum moment load ($M_{i\text{max}}$)
   - Maximum axial load ($F_{ai\text{max}}$)
   - Allowable moment load ($M_{c}$)
   - Allowable axial load ($F_{a}$)
   - Allowable radial load ($F_{r}$)

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

Efficiency %

- Average input speed ($N_{i\text{av}}$)
- Average axial load ($F_{ai\text{av}}$)
- Average moment load ($M_{i\text{av}}$)

Graphs 128-3 to 128-8

Technical Data

- Gearheads
- Table 145-2
- Table 145-3
- Table 146-1
- Table 146-2

Input torque corresponding to output torque ($T_{r}$)

Efficiency %

- Reduction ratio = 5
- Reduction ratio = 11
- Reduction ratio = 15, 21
- Reduction ratio = 33, 45

Table 145-3

- HPG
- HPG

Efficiency %

- Reduction ratio = 3
- Reduction ratio = 5
- Reduction ratio = 11
- Reduction ratio = 15
- Reduction ratio = 21
- Reduction ratio = 25
- Reduction ratio = 33
- Reduction ratio = 45
- Reduction ratio = 50

Graphs 131-1, 131-2, 131-4, 131-5, 131-6, 131-7, 131-8

Technical Information / Handling Explanation
Technical Data

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

**Reduction ratio = 5**

![Graph 132-1](image)

**Reduction ratio = 11**

![Graph 132-2](image)

**Reduction ratio = 15, 21**

![Graph 132-3](image)

**Reduction ratio = 33, 45**

![Graph 132-4](image)

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

**Reduction ratio = 5**

![Graph 132-5](image)

**Reduction ratio = 12, 15**

![Graph 132-6](image)

**Reduction ratio = 20, 25**

![Graph 132-7](image)

**Reduction ratio = 40, 50**

![Graph 132-8](image)

\( T_i \): Input torque corresponding to output torque
Technical Data

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

#### Gearheads

**Size 20A:**

- **Reduction ratio = 3**
  - Graph 134-1
  - Efficiency % vs. Input torque (Nm)

- **Reduction ratio = 4**
  - Graph 134-2
  - Efficiency % vs. Input torque (Nm)

- **Reduction ratio = 5**
  - Graph 134-3
  - Efficiency % vs. Input torque (Nm)

- **Reduction ratio = 7**
  - Graph 134-4
  - Efficiency % vs. Input torque (Nm)

- **Reduction ratio = 10**
  - Graph 134-5
  - Efficiency % vs. Input torque (Nm)

- **Reduction ratio = 13**
  - Graph 134-6
  - Efficiency % vs. Input torque (Nm)

- **Reduction ratio = 21**
  - Graph 134-7
  - Efficiency % vs. Input torque (Nm)

- **Reduction ratio = 31**
  - Graph 134-8
  - Efficiency % vs. Input torque (Nm)

#### Gearheads

**Size 32A:**

- **Reduction ratio = 3**
  - Graph 134-9
  - Efficiency % vs. Input torque (Nm)

- **Reduction ratio = 4**
  - Graph 134-10
  - Efficiency % vs. Input torque (Nm)

- **Reduction ratio = 5**
  - Graph 134-11
  - Efficiency % vs. Input torque (Nm)

- **Reduction ratio = 7**
  - Graph 134-12
  - Efficiency % vs. Input torque (Nm)

- **Reduction ratio = 10**
  - Graph 134-13
  - Efficiency % vs. Input torque (Nm)

- **Reduction ratio = 13**
  - Graph 134-14
  - Efficiency % vs. Input torque (Nm)

- **Reduction ratio = 21**
  - Graph 134-15
  - Efficiency % vs. Input torque (Nm)

- **Reduction ratio = 31**
  - Graph 134-16
  - Efficiency % vs. Input torque (Nm)
Technical Data

Reduction ratio = 3

Graph 135-1

Efficiency %

Input torque Nm

100

80

60

40

20

0

Input torque Nm

100

80

60

40

20

0

Efficiency %

Reduction ratio = 4

Graph 135-2

Efficiency %

Input torque Nm

100

80

60

40

20

0

Input torque Nm

100

80

60

40

20

0

Efficiency %

Reduction ratio = 5

Graph 135-3

Efficiency %

Input torque Nm

100

80

60

40

20

0

Input torque Nm

100

80

60

40

20

0

Efficiency %

Reduction ratio = 7

Graph 135-4

Efficiency %

Input torque Nm

100

80

60

40

20

0

Input torque Nm

100

80

60

40

20

0

Efficiency %

Reduction ratio = 10

Graph 135-5

Efficiency %

Input torque Nm

100

80

60

40

20

0

Input torque Nm

100

80

60

40

20

0

Efficiency %

Reduction ratio = 13

Graph 135-6

Efficiency %

Input torque Nm

100

80

60

40

20

0

Input torque Nm

100

80

60

40

20

0

Efficiency %

Reduction ratio = 21

Graph 135-7

Efficiency %

Input torque Nm

100

80

60

40

20

0

Input torque Nm

100

80

60

40

20

0

Efficiency %

Reduction ratio = 31

Graph 135-8

Efficiency %

Input torque Nm

100

80

60

40

20

0

Input torque Nm

100

80

60

40

20

0

Efficiency %

Efficiency %
Technical Information / Handling Explanation

**Input torque corresponding to output torque**

**Efficiency %**

<table>
<thead>
<tr>
<th>Reduction ratio</th>
<th>Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td>15</td>
<td>80</td>
</tr>
<tr>
<td>20</td>
<td>70</td>
</tr>
<tr>
<td>25</td>
<td>60</td>
</tr>
<tr>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td>60</td>
<td>20</td>
</tr>
<tr>
<td>80</td>
<td>10</td>
</tr>
<tr>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>

**Reduction ratio = 25**

**Reduction ratio = 21**

**Reduction ratio = 15**

**Reduction ratio = 11**

**Reduction ratio = 5**

**Reduction ratio = 20**

**Reduction ratio = 40**

**Right Angle Gearhead**

**Input bearing specifications and checking procedure**

- **Allowable radial load of HPG series:**
  - Size 25: The allowable radial load is the value of a radial load applied to the point of 20 mm from the shaft edge (input flange edge).
  - Size 32: The allowable radial load is the value of a radial load applied at the mid-point of the input shaft.

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

**Calculating life of input bearing**

How to calculate average load:

- **Average input speed (Ni):**
  
- **Average moment load (Mi):**

- **Average axial load (Fai):**

**Formula 146-2**

\[
rac{P_{ci}}{N (kgf)} = \frac{M_{1}}{M_{2}}
\]

Where:
- 

**Formula 146-1**

\[
\frac{L_{10}}{L_{ri,Lai}} = \frac{1}{F_{ri} + F_{ai}}
\]

Where:
- 

**Checking procedure**

- **Maximum moment load (Mi):**
  
- **Allowable moment load (Mc):**

- **Allowable axial load (Fac):**

**Table 145-1 and -3**

**Table 146-1 and -2**
(1) Checking maximum load
Check the maximum load and life of the bearing on the input side if the reducer is an HPG input shaft unit or an HPF hollow.

<table>
<thead>
<tr>
<th>Specification of input bearing</th>
<th>Max. axial load (F_{ai})</th>
<th>Allowable moment load (M_{c})</th>
<th>Allowable axial load (F_{aci})</th>
<th>Allowable radial load (F_{arc})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size 20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gearhead</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduction ratio = 50</td>
<td>0.83</td>
<td>100</td>
<td>0.83</td>
<td>30</td>
</tr>
<tr>
<td>Reduction ratio = 80</td>
<td>1.02</td>
<td>50</td>
<td>1.02</td>
<td>60</td>
</tr>
<tr>
<td>Reduction ratio = 100</td>
<td>1.38</td>
<td>200</td>
<td>1.38</td>
<td>90</td>
</tr>
<tr>
<td>Reduction ratio = 120</td>
<td>1.63</td>
<td>300</td>
<td>1.63</td>
<td>120</td>
</tr>
<tr>
<td>Reduction ratio = 160</td>
<td>1.92</td>
<td>400</td>
<td>1.92</td>
<td>160</td>
</tr>
</tbody>
</table>

---

**Table 145-2**

<table>
<thead>
<tr>
<th>Input rotational speed</th>
<th>Efficiency %</th>
<th>Input torque Ncm</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 rpm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000 rpm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000 rpm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3500 rpm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Table 145-3**

<table>
<thead>
<tr>
<th>Input rotational speed</th>
<th>Efficiency %</th>
<th>Input torque Ncm</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 rpm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000 rpm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000 rpm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3500 rpm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Graph 137-1**

- Reduction ratio = 50
- Graph 137-1
- Efficiency % vs. Input torque Ncm
- Input rotational speed: 500 rpm, 1000 rpm, 2000 rpm, 3500 rpm

---

**Graph 137-2**

- Reduction ratio = 80
- Graph 137-2
- Efficiency % vs. Input torque Ncm
- Input rotational speed: 500 rpm, 1000 rpm, 2000 rpm, 3500 rpm

---

**Graph 137-3**

- Reduction ratio = 100
- Graph 137-3
- Efficiency % vs. Input torque Ncm
- Input rotational speed: 500 rpm, 1000 rpm, 2000 rpm, 3500 rpm

---

**Graph 137-4**

- Reduction ratio = 50
- Graph 137-4
- Efficiency % vs. Input torque Ncm
- Input rotational speed: 500 rpm, 1000 rpm, 2000 rpm, 3500 rpm

---

**Graph 137-5**

- Reduction ratio = 80
- Graph 137-5
- Efficiency % vs. Input torque Ncm
- Input rotational speed: 500 rpm, 1000 rpm, 2000 rpm, 3500 rpm

---

**Graph 137-6**

- Reduction ratio = 100
- Graph 137-6
- Efficiency % vs. Input torque Ncm
- Input rotational speed: 500 rpm, 1000 rpm, 2000 rpm, 3500 rpm

---

**Graph 137-7**

- Reduction ratio = 120
- Graph 137-7
- Efficiency % vs. Input torque Ncm
- Input rotational speed: 500 rpm, 1000 rpm, 2000 rpm, 3500 rpm

---

**Graph 137-8**

- Reduction ratio = 160
- Graph 137-8
- Efficiency % vs. Input torque Ncm
- Input rotational speed: 500 rpm, 1000 rpm, 2000 rpm, 3500 rpm
Reduction ratio = 120

Graph 138-4

Input rotational speed  
500 rpm  1000 rpm  2000 rpm  3500 rpm

Reduction ratio = 160

Graph 138-5

Technical Data

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>CSG-GH</th>
<th>CSF-GH</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Input rotational speed  
500 rpm  1000 rpm  2000 rpm  3500 rpm

Average axial load (F_{ai})

Average moment load (M_{i})

Dynamic equivalent load

How to calculate the average input speed (N_{i})

Input torque

Efficiency %
Technical Information / Handling Explanation

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

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

(2) Checking the life

Shaft unit.

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

### Specification of input bearing

<table>
<thead>
<tr>
<th>Size</th>
<th>65</th>
<th>50</th>
<th>20</th>
<th>25</th>
<th>32</th>
<th>32</th>
<th>14</th>
<th>11</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;max</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum radial load (Frc)</td>
<td>35500</td>
<td>29700</td>
<td>14500</td>
<td>51000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allowable moment load (Mc)</td>
<td>2100</td>
<td>1000</td>
<td>700</td>
<td>1200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allowable axial load (Fai)</td>
<td>0.16</td>
<td>0.16</td>
<td>0.16</td>
<td>0.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average input speed (Ni)</td>
<td>6.3</td>
<td>6.3</td>
<td>6.3</td>
<td>6.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average moment load (Mi)</td>
<td>160</td>
<td>160</td>
<td>160</td>
<td>160</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average axial load (Fai)</td>
<td>160</td>
<td>160</td>
<td>160</td>
<td>160</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### How to calculate average load

- Maximum moment load (Mi) is calculated as follows.
- Maximum axial load (Fai) is calculated as follows.
- Maximum radial load (Frc) is calculated as follows.

#### Reduction ratio = 80

Graph 139-1

Graph 139-2

#### Reduction ratio = 120

Graph 139-3

Graph 139-4

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

### Technical Data

<table>
<thead>
<tr>
<th>Gearheads</th>
<th>CSG-GH</th>
<th>CSF-GH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gearheads</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

See Table 145-1 and -2

See Formula 146-4

See Fig. 146-1.
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 (Mmax)**
   
   Calculate the maximum moment load (Mmax).  
   
   - Maximum moment load (Mmax) ≤ Permissible moment (Mc)

2. **Checking the life**
   
   Calculate the average radial load (Fra) and the axial load (Fac).

3. **Checking the static safety coefficient**
   
   Calculate the static equivalent radial load coefficient (Po).

### Specification of output bearing

#### HPGP/HPG Series

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

### Technical Data

<table>
<thead>
<tr>
<th>Size</th>
<th>Reduction ratio</th>
<th>Allowable radial load</th>
<th>Allowable axial load</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N N</td>
<td>N N</td>
</tr>
<tr>
<td>11</td>
<td>5</td>
<td>280 430</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(9)</td>
<td>340 510</td>
<td></td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>440 660</td>
<td></td>
</tr>
<tr>
<td></td>
<td>37</td>
<td>520 780</td>
<td></td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>550 830</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3)</td>
<td>400 600</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>470 700</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>11</td>
<td>600 890</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>650 980</td>
<td></td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>720 1080</td>
<td></td>
</tr>
<tr>
<td></td>
<td>33</td>
<td>830 1240</td>
<td></td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>910 1360</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3)</td>
<td>840 1250</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>5</td>
<td>980 1460</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>1240 1850</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>1360 2030</td>
<td></td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>1510 2250</td>
<td></td>
</tr>
<tr>
<td></td>
<td>33</td>
<td>1729 2580</td>
<td></td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>1890 2830</td>
<td></td>
</tr>
</tbody>
</table>

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

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

**CSG-GH/CSF-GH Series**  
Table 142-1 indicates the specifications for cross roller bearing.

<table>
<thead>
<tr>
<th>Size</th>
<th>Pitch circle</th>
<th>Offset amount</th>
<th>Basic load rating</th>
<th>Allowable moment load ( C^{*1} )</th>
<th>Moment stiffness ( K_{m}^{*4} )</th>
<th>Allowable radial load ( F_{Rc}^{*2} )</th>
<th>Allowable axial load ( F_{Ac}^{*1} )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( dp )</td>
<td>( R )</td>
<td>( C^{*1} )</td>
<td>( C^{*2} )</td>
<td>( x10^4 )</td>
<td>( \text{Nm} )</td>
<td>( \text{kgf} )</td>
</tr>
<tr>
<td>14</td>
<td>0.0405</td>
<td>0.0111</td>
<td>5110</td>
<td>521</td>
<td>7060</td>
<td>720</td>
<td>27</td>
</tr>
<tr>
<td>20</td>
<td>0.064</td>
<td>0.0115</td>
<td>10600</td>
<td>1082</td>
<td>17500</td>
<td>1765</td>
<td>145</td>
</tr>
<tr>
<td>32</td>
<td>0.085</td>
<td>0.014</td>
<td>20500</td>
<td>2092</td>
<td>32800</td>
<td>3347</td>
<td>258</td>
</tr>
<tr>
<td>45</td>
<td>0.123</td>
<td>0.019</td>
<td>41600</td>
<td>4245</td>
<td>76000</td>
<td>7755</td>
<td>797</td>
</tr>
<tr>
<td>65</td>
<td>0.170</td>
<td>0.0225</td>
<td>81600</td>
<td>8327</td>
<td>149000</td>
<td>15204</td>
<td>2156</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Size</th>
<th>Pitch circle</th>
<th>Offset amount</th>
<th>Basic load rating</th>
<th>Allowable moment load ( C^{*1} )</th>
<th>Moment stiffness ( K_{m}^{*4} )</th>
<th>Allowable radial load ( F_{Rc}^{*2} )</th>
<th>Allowable axial load ( F_{Ac}^{*1} )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( dp )</td>
<td>( R )</td>
<td>( C^{*1} )</td>
<td>( C^{*2} )</td>
<td>( x10^4 )</td>
<td>( \text{Nm} )</td>
<td>( \text{kgf} )</td>
</tr>
<tr>
<td>25</td>
<td>0.085</td>
<td>0.0153</td>
<td>11400</td>
<td>1163</td>
<td>20300</td>
<td>2071</td>
<td>410</td>
</tr>
<tr>
<td>32</td>
<td>0.1115</td>
<td>0.015</td>
<td>22500</td>
<td>2296</td>
<td>39900</td>
<td>4071</td>
<td>932</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. (\( L_r + R = 0 \text{ mm} \) 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.)
How to calculate the maximum moment load

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

\[
M_{max} = Fr_{max}(L_r+R) + Fa_{max}La
\]

<table>
<thead>
<tr>
<th>Formula 143-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fr(_{max})</td>
</tr>
<tr>
<td>Fa(_{max})</td>
</tr>
<tr>
<td>L(_r), La</td>
</tr>
</tbody>
</table>

| R | Offset amount (m) | See Fig. 143-1. | 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 \((Y)\)

<table>
<thead>
<tr>
<th>Formula 143-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fr(_{av})</td>
</tr>
<tr>
<td>Fa(_{av})</td>
</tr>
<tr>
<td>L(_r), La</td>
</tr>
<tr>
<td>R</td>
</tr>
<tr>
<td>dp</td>
</tr>
</tbody>
</table>

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

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

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

#### Formula 144-1

\[
L_{oc} = \frac{10^6 \times 60 \times N_{av}}{L_{av}} \times \left( \frac{C}{fw \times Pc} \right)^{15/3}
\]

- \(L_{oc}\): Rated life under oscillating motion (hour)
- \(N_{av}\): Average output speed (rpm)
- \(C\): Basic dynamic load rating (N (kgf))
- \(Pc\): Dynamic equivalent load (N (kgf))
- \(fw\): Load coefficient — See Table 144-1.

### How to calculate the life during oscillating motion

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

#### Formula 144-3

\[
L_{oc} = \frac{10^6 \times 60 \times n_1}{L_{oc}} \times \left( \frac{C}{fw \times Pc} \right)^{15/3}
\]

- \(L_{oc}\): Rated life under oscillating motion (hour)
- \(n_1\): No. of reciprocating oscillations per min. (rpm)
- \(C\): Basic dynamic load rating (N (kgf))
- \(Pc\): Dynamic equivalent load (N (kgf))
- \(fw\): Load coefficient — See Table 144-1.
- \(\theta\): Oscillating angle (Deg.)

### How to calculate the average input speed

\[
\bar{N}_{i} = \frac{\bar{F}_{i}}{C_{r}} \times \frac{C_{f}}{C_{p}}
\]

#### Formula 144-4

\[
f_s = \frac{C_o}{P_o}
\]

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

### How to calculate the maximum moment load

\[
P_o = \frac{F_{max}}{dp} + \frac{2M_{max}}{dp} + 0.44 F_{ax}
\]

#### Formula 144-5

- \(F_{max}\): Max. radial load (N (kgf))
- \(F_{ax}\): Max. axial load (N (kgf))
- \(M_{max}\): Max. moment load (Nm (kgfm))
- \(dp\): Pitch Circle (m)

### Technical Information / Handling Explanation

- When the oscillating angle is small (5° or less), it is difficult to generate an oil film on the contact surface of the orbit ring and the rolling element, and fretting corrosion may develop.
- 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.
- \(L_{max}\) is limited to 50,000 hour for normal operation.

### Table 144-1

<table>
<thead>
<tr>
<th>Load status</th>
<th>fw</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>

### Table 144-2

<table>
<thead>
<tr>
<th>Load status</th>
<th>(fs)</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>
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

**Table 145-1**

<table>
<thead>
<tr>
<th>Size</th>
<th>Basic load rating</th>
<th>Basic load rating</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>
<thead>
<tr>
<th>Size</th>
<th>Nm</th>
<th>kgf</th>
<th>N</th>
<th>kgf</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>0.16</td>
<td>0.016</td>
<td>245</td>
<td>25</td>
</tr>
<tr>
<td>14</td>
<td>6.3</td>
<td>0.64</td>
<td>657</td>
<td>67</td>
</tr>
<tr>
<td>20</td>
<td>13.5</td>
<td>1.38</td>
<td>1206</td>
<td>123</td>
</tr>
<tr>
<td>32</td>
<td>44.4</td>
<td>4.53</td>
<td>3285</td>
<td>335</td>
</tr>
<tr>
<td>50</td>
<td>96.9</td>
<td>9.88</td>
<td>5540</td>
<td>565</td>
</tr>
<tr>
<td>65</td>
<td>210</td>
<td>21.4</td>
<td>8600</td>
<td>878</td>
</tr>
</tbody>
</table>

**Table 145-2**

**Table 145-3**

<table>
<thead>
<tr>
<th>Size</th>
<th>Basic load rating</th>
<th>Basic load rating</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>Nm</th>
<th>kgf</th>
<th>N</th>
<th>kgf</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>10</td>
<td>1.02</td>
<td>1538</td>
<td>157</td>
</tr>
<tr>
<td>32</td>
<td>19</td>
<td>1.93</td>
<td>3263</td>
<td>333</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).
**Technical Data**

### Calculating maximum moment load ON input shaft

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

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

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

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

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

### 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 maximum moment load ON input shaft**

\[
M_{\text{av}} = \frac{n_{\text{t}} \times (M_{\text{i}})^{3} + n_{\text{t}} \times (M_{\text{i}})^{2} + \cdots + n_{\text{t}} \times (M_{\text{i}})^{n}}{n_{\text{t}} + n_{\text{t}} + \cdots + n_{\text{t}}}
\]

- $M_{\text{i}}$: moment load Nm
- $n_{\text{t}}$: time t

**How to calculate average moment load ($M_{\text{av}}$)**

\[
F_{\text{av}} = \frac{n_{\text{t}} \times (F_{\text{a}})^{3} + n_{\text{t}} \times (F_{\text{a}})^{2} + \cdots + n_{\text{t}} \times (F_{\text{a}})^{n}}{n_{\text{t}} + n_{\text{t}} + \cdots + n_{\text{t}}}
\]

- $F_{\text{a}}$: axial load N

**How to calculate average input speed ($N_{\text{av}}$)**

\[
N_{\text{av}} = \frac{n_{\text{t}} + n_{\text{t}} + \cdots + n_{\text{t}}}{t_{1} + t_{2} + \cdots + t_{n}}
\]

### Calculating life of input bearing

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

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

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

**Dynamic equivalent load**

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

### HPG HPF

**External load influence diagram**

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

**How to calculate the average load**

- **HPG**
  - $M_{\text{av}} = \frac{10^{6}}{60 \times N_{\text{av}}} \times \left( \frac{C_{\text{r}}}{P_{\text{ci}}} \right)^{3}$
- **HPF**

**Dynamic equivalent load**

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

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

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

- **Motor assembly procedure**

To properly mount the motor to the gearhead, follow the procedure outlined below, refer 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>Tightening torque</td>
<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>
</tr>
<tr>
<td></td>
<td>kgfm</td>
<td>0.20</td>
<td>0.46</td>
<td>0.92</td>
<td>1.56</td>
<td>3.8</td>
<td>7.5</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.

   **Table 147-2**

<table>
<thead>
<tr>
<th>Bolt size</th>
<th>M3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tightening torque</td>
<td>Nm</td>
</tr>
<tr>
<td></td>
<td>kgfm</td>
</tr>
</tbody>
</table>

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

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

**Speed reducer assembly**

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

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

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

<table>
<thead>
<tr>
<th>Size</th>
<th>HN</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 mm</td>
<td>50</td>
<td>70</td>
<td>100</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>kgf</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 output flange (Part B in the Figure 148-1)

<table>
<thead>
<tr>
<th>Size</th>
<th>HPGP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of bolts</td>
<td>4</td>
</tr>
<tr>
<td>Bolt size</td>
<td>M4</td>
</tr>
<tr>
<td>Mounting PCD mm</td>
<td>18</td>
</tr>
<tr>
<td>Tightening torque</td>
<td>Nm</td>
</tr>
<tr>
<td>Transmission torque</td>
<td>Nm</td>
</tr>
<tr>
<td>Transmission torque</td>
<td>kgf</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Size</th>
<th>HPG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of bolts</td>
<td>3</td>
</tr>
<tr>
<td>Bolt size</td>
<td>M4</td>
</tr>
<tr>
<td>Mounting PCD mm</td>
<td>18</td>
</tr>
<tr>
<td>Tightening torque</td>
<td>Nm</td>
</tr>
<tr>
<td>Transmission torque</td>
<td>Nm</td>
</tr>
<tr>
<td>Transmission torque</td>
<td>kgf</td>
</tr>
</tbody>
</table>

* Recommended bolts: JIS B 1176 "Hexagon socket head bolts." Strength classification 12.9 or higher in JIS B 1051.
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 (mm)</td>
<td>30</td>
<td>45</td>
<td>60</td>
<td>94</td>
<td>120</td>
</tr>
<tr>
<td>Tightening torque (Nm)</td>
<td>4.5</td>
<td>15.3</td>
<td>37</td>
<td>128</td>
<td>319</td>
</tr>
<tr>
<td>Transmission torque (kgf)</td>
<td>0.46</td>
<td>1.56</td>
<td>3.8</td>
<td>3.1</td>
<td>32.5</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Size</th>
<th>14</th>
<th>20</th>
<th>32</th>
<th>45</th>
<th>65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of bolts</td>
<td>6</td>
<td>6</td>
<td>8</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>Bolt size</td>
<td>M4</td>
<td>M6</td>
<td>M8</td>
<td>M16</td>
<td>M16</td>
</tr>
<tr>
<td>Mounting PCD (mm)</td>
<td>30</td>
<td>45</td>
<td>60</td>
<td>100</td>
<td>120</td>
</tr>
<tr>
<td>Tightening torque (Nm)</td>
<td>4.5</td>
<td>15.3</td>
<td>37.2</td>
<td>37.2</td>
<td>319</td>
</tr>
<tr>
<td>Transmission torque (kgf)</td>
<td>0.46</td>
<td>1.56</td>
<td>3.80</td>
<td>3.80</td>
<td>32.5</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Size</th>
<th>14</th>
<th>20</th>
<th>32</th>
<th>45</th>
<th>65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of bolts</td>
<td>12</td>
<td>12</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Bolt size</td>
<td>M4</td>
<td>M5</td>
<td>M5</td>
<td>M5</td>
<td>M5</td>
</tr>
<tr>
<td>Mounting PCD (mm)</td>
<td>77</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Tightening torque (Nm)</td>
<td>4.5</td>
<td>9.0</td>
<td>9.0</td>
<td>9.0</td>
<td>9.0</td>
</tr>
<tr>
<td>Transmission torque (kgf)</td>
<td>0.46</td>
<td>0.92</td>
<td>0.92</td>
<td>0.92</td>
<td>0.92</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.

#### Specifications of Input Shaft Bearing

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

#### Specifications of Output Shaft Bearing

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

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

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

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

Prevention of grease and oil leakage

(Common to all models)
- Only use the recommended greases.
- Provisions for proper sealing to prevent grease leakage are incorporated into the gearheads. However, please note that some leakage may occur depending on the application or operating condition. Discuss other sealing options with our applications engineers.
- When mounting the gearhead horizontally, position the gearhead so that the rubber washer 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/HF/HPN Series)
- Using the double sealed bearing (D type) for the HPGP/HPG series gearhead will result in a slightly lower efficiency compared to the standard product.
- An oil seal without a spring is used ON the input side of HPG series with an input shaft (HPG-1U) and HPF series hollow shaft reducer. An option for an oil seal with a spring is available for improved seal reliability, however, the efficiency will be slightly lower (available for HPF and HPG series for sizes 14 and larger).
- Do not remove the screw plug and seal cap of the HPG series right angle gearhead. Removing them may cause leakage of grease or affect the precision of the gear.

Standard Lubricants

HGP/HPGP/HF/HPN Series

The standard lubrication for the HPG/HPGP/HF/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, HPG-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-G (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 viscous

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

The lubricant may deteriorate if the ambient operating temperature is outside of recommended operating range. Please contact our sales office or distributor for operation outside of the ambient operating temperature range.
The temperature rise of the gear depends upon the operating cycle, ambient temperature and heat conduction and radiation based on the customers installation of the gear. A housing surface temperature of 70°C is the maximum allowable limit.
The gearheads are lubricated for the life of the gear and do not require re-lubrication.

Manufacturer: Harmonic Drive Systems Inc.

- Material and surface: Gearbox: Aluminum, corrosion protected roller bearing steel, carbon steel (output shaft).
- 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.
- When mounting the gearhead horizontally, position the gearhead so that the rubber cap in the adapter flange is facing upwards.
- Provisions for proper sealing to prevent grease leakage are incorporated into the gearheads. However, please note that some leakage may occur.
- Only use the recommended greases.

**Prevention of grease and oil leakage**

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

**Sealing**
- Adapter flange: (if provided by Harmonic Drive) high-strength aluminum or carbon steel. Screws: black phosphate. The ambient temperature may affect the precision of the gear.
- Load or rotating continuously in one direction.

**Standard**
- NLGI No. 00
- Thickening agent: Urea
- Base oil: Refined mineral oil

**HPG right angle gearhead/HPN**
- Color: Light yellow
- Dropping point: 198°C
- Thickening agent: Lithium soap
- Base oil: Composite hydrocarbon

**HPGP/HPG-14, 20, 32**
- Color: Black viscose
- Dropping point: 200°C
- Thickening agent: Lithium soap
- Base oil: Composite hydrocarbon

**Technical Data**

**Product Handling**

Manufacturer: KYODO YUSHI CO, LTD

Manufacturer: Nippon Oil Co.

- Thickening agent: Lithium soap
- Base oil: Composite hydrocarbon

**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**

\[
L_{GCT} = L_{GCTn} \times \left( \frac{T_{av}}{T_{av}} \right)^{3}
\]

**Formula symbols**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>L_{GCT}</td>
<td>Grease change interval when ( T_{av} &gt; T_{r} )</td>
</tr>
<tr>
<td>L_{GCTn}</td>
<td>Grease change interval when ( T_{av} = T_{r} )</td>
</tr>
<tr>
<td>Tr</td>
<td>Output torque at 2000 rpm</td>
</tr>
<tr>
<td>Tav</td>
<td>Average load torque</td>
</tr>
</tbody>
</table>

**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>
<th>Amount: g</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8</td>
<td>3.2</td>
<td>6.6</td>
<td>11.6</td>
<td>11.6</td>
<td>78.6</td>
<td></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.

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**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

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**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
- Aircraft equipment
- Personal recreation equipment
- Equipment for use in a special environment
- Equipment and apparatus used in residential dwellings
- 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>Use only in the proper environment.</th>
<th>Caution</th>
<th>Install the equipment properly.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Please ensure to comply with the following environmental conditions:</td>
<td></td>
<td>- Carry out the assembly and installation precisely as specified in the catalog.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Observe our recommended fastening methods (including bolts used and tightening torques).</td>
</tr>
<tr>
<td></td>
<td></td>
<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>
<th>Caution</th>
<th>Use the specified lubricant.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Design and assemble parts to keep all catalog recommended tolerances for installation.</td>
<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>- Failure to hold the recommended tolerances can cause problems such as vibration, reduction in life, deterioration of precision and product failure.</td>
<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>
<th>Caution</th>
<th>Operate within the allowable torque range.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Do not hit the gear or any part with a hammer.</td>
<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>- If you use the equipment in a damaged condition, the gearhead may not perform to catalog specifications. It can also cause problems including product failure.</td>
<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 alter or disassemble the product or parts.</th>
<th>Caution</th>
<th>Do not disassemble the products.</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>
<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 use your finger to turn the gear.</th>
<th>Caution</th>
<th>Stop operating the system if any abnormality occurs.</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>
<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>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Caution</th>
<th>Large sizes (45, 50 and 65) are heavy. Use caution when handling.</th>
<th>Caution</th>
<th>Rust-proofing was applied before shipping. However, please note that rusting may occur depending on the customers' storage environment.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- 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>
<td></td>
<td>- Although black oxide finish is applied to some of our products, it does not guarantee that rust will not form.</td>
</tr>
</tbody>
</table>

## Handling Lubricant

### Precautions on handling lubricants

- Lubricant in the eye can cause inflammation. Wear protective glasses to prevent it from getting into your eye.
- 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.
- Do not ingest (to avoid diarrhea and vomitting).
- Use caution when opening the container. There may be sharp edges that can cut your hand. Wear protective gloves.
- Keep lubricant out of reach of children.

### First-aid

- Inhalation: Remove exposed person to fresh air if adverse effects are observed.
- Ingestion: Seek immediate medical attention and do not induce vomitting unless directed by medical personnel.
- Eyes: Flush immediately with water for at least 15 minutes. Get immediate medical attention.
- Skin: Wash with soap and water. Get medical attention if irritation develops.

### Disposal of waste oil and containers

- Follow all applicable laws regarding waste disposal. Contact your distributor if you are unsure how to properly dispose of the material.
- Do not apply pressure to an empty container. The container may explode.
- Do not weld, heat, drill or cut the container. This may cause residual oil to ignite or cause an explosion.

### Storage

- Tightly seal the container after use. Store in a cool, dry, dark place. Keep away from open flames and high temperatures.

### Disposal

- Please dispose of as industrial waste. Please dispose of the products as industrial waste when their useful life is over.
Major Applications of Our Products

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

Source: National Observatory of Inter-University Research Institute Corporation

Source: Honda Motor Co., Ltd.

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

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

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

High-torque actuators combine performance matched servomotors with Harmonic Drive® gears to deliver excellent dynamic control characteristics.

Harmonic Drive® Gearing

Linear Actuators

Rotary Actuators

Experts in Precision Motion Control
Experts in Precision Motion Control

Other Products

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

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