HarmonicGearhead®

FINE MECHANICS & TOTAL motion CONTROL

# HarmonicPlanetary®
# HarmonicDrive®

## High-performance Gear Heads for Servo Motors series

ISO 14001
TÜV SÜD
ISO 9001
ISO14001
ISO9001

High-precision ・ Highly stiff ・High positioning precision

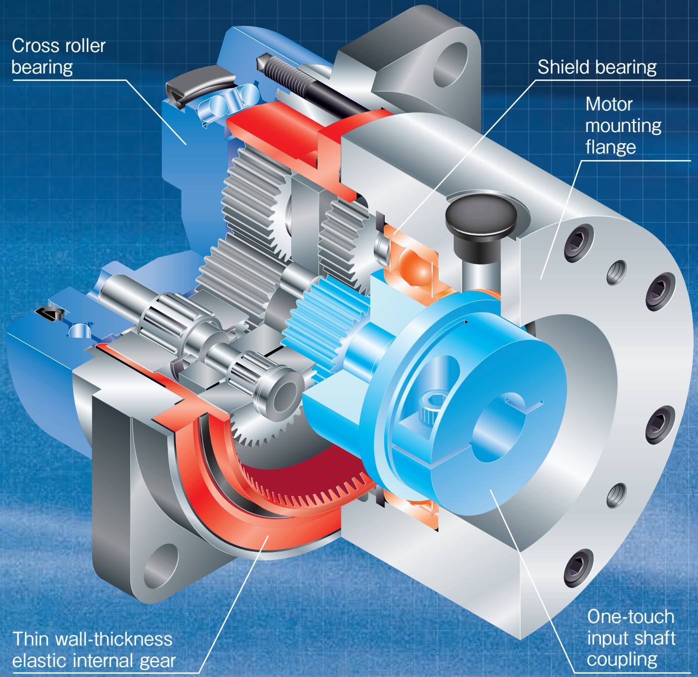
# Establishment of high-performance Gear Head Series

## High-performance Gear Heads for Servo Motors Series

The high-performance gear head for servo motors boasts wider range of reduction ratio from low reduction ratio to high reduction ratio and wider range of torque capacity similarly to Harmonic Plaetary® (high-precision planet gear speed reducer) and HarmonicDrive® (strain wave gearing device). The main bearing unit mechanism by using the cross roller bearing can directly support the external load. Only by simple one-touch installation, the high precision actuator becomes available to meet various needs in wider range of fields.

# HarmonicPlanetary® HPGP / HPG Series

The thin wall-thickness elastic gear technology of HarmonicDrive® is used in the internal gears of planet gear speed reducers. It allowed internal gears deform elastically to reduce backlash without installing an adjustment mechanism.





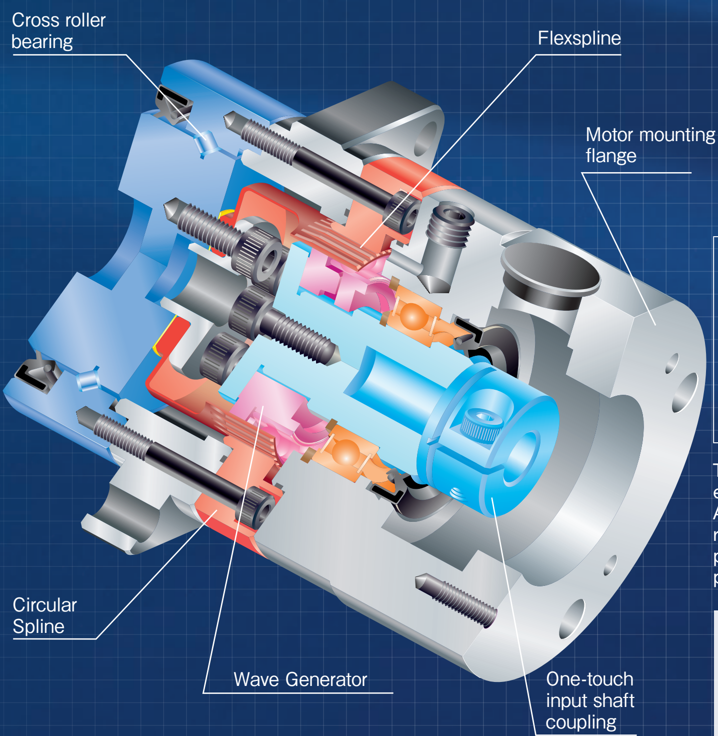
Deformation in actual equipment

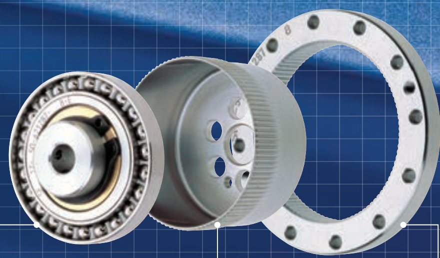
The planet gear speed reducer features simultaneous meshing between the sun gear and planet gear and between the planet gear and internal gear. Reducing backlash only by dimensional precision of parts causes interference of meshing parts due to dimensional errors, resulting in uneven rotational torque and noise. The thin wall-thickness elastic internal gear featuring a function to mitigate interference between meshing parts and an adequate strength has been developed to solve these problems. The new planet gear speed reducers in the Harmonic Planetary® series incorporate this internal gear as an epoch-making structure, scarcely causing backlash variations within the speed reducer life.

- ◆**Small backlash: Less than 3 min.**
  **(Less than 1 min. with customized products)**
- ◆**Low Reduction ratio: 1/3 to 1/50**
- ◆**High efficiency more than 90% (85% on models No. 11 and 14)**
- ◆**High load capacity by integrating structure with cross roller bearing**
- ◆**High-torque capacity**

# HarmonicDrive® CSG/CSF-GH Series

HarmonicDrive® is a strain wave gearing with a unique operating principle which applied elastic mechanics of metals, and a reducer for precision control which consists of only 3 basic parts to provide high rotational precision and positioning.



| Wave Generator | Flexspline | Circular Spline |
|---|---|---|
| The Wave Generator is a thin raced ball bearing fitted onto an elliptical hub. Inner lace of bearing is fixed to tha cam, but, outer lace deforms elastically via balls. Generally mounted onto the input shaft. | The Flexspline is a non-rigid, thin cylindrical cup with external teeth. The bottom of Flexpline (bottom of cylindrical cup) is called diaphram and generally mounted onto the output shaft. | The Circular Spline is a rigid ring with internal teeth, engaging the teeth of the Flexspline across the major axis of the Wave Generator. The Circular Spline has two more teeth than the Flexspline and is generally mounted onto housing. |

The greatest characteristic of HarmonicDrive® as "strain wave gearing" is the ease of downsizing and weight saving as it consists of only three basic parts. As it has many teeth, it generates greater torque and allows very accurate repeatability. By developing an IH tooth profile invented from our own tooth profile theory, we have improved the intensity and performance of the product.

- ◆**Non-backlash**
- ◆**High Reduction ratio: 1/50 to 1/160**
- ◆**High positioning precision (repetitive positioning ±4 to ±10arc-sec)**
- ◆**High load capacity by integrating structure with cross roller bearing**
- ◆**High-torque capacity**

## HarmonicPlanetary®

### HPGP/HPG Series (Planet gear speed reducer)

Model : 11, 14, 20, 32, 50, 65 (6 models)
Applicable motor capacity : 10W to 15kW
Permissible peak torque : 3.9N·m to 2920N·m

Flange shaft type

## HarmonicDrive®

### CSG/CSF-GH Series (HarmonicDrive® speed reducer)

Model : 14, 20, 32, 45, 65 (5 models)
Applicable motor capacity : 30W to 5kW
Permissible peak torque : 18N·m to 3419N·m

With output shaft type

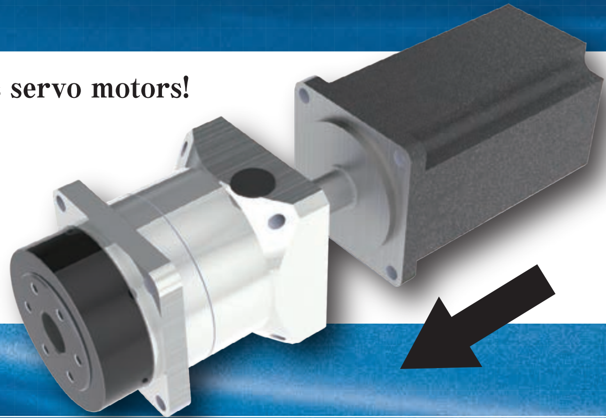
**Simple one-touch installation to each manufacturer's servo motors!**
**High-precision actuator can be provided.**

### Applicable servo motor manufacturers

For other servo motors, please feel free to contact the nearest sales office.

Yasukawa Electric, Mitsubishi Electric, Fanuc, Panasonic, Sanyo Denki, Tamagawa Seiki, Fuji Electric, Omron, Toshiba Machine, Keyence, etc.

* See the model selection tool on the web page to find matching model on each company's servo motors. (URL:https://hds-tech.jp/)



# Line up

## Gear Head Series

**HPGP Series**
**High-torque Type**
(Permissible peak torque 10N·m to 2920N·m)
Life: 20,000 hours

HarmonicPlanetary®

| Model | Delivery time (5 units or less)*1 | Dimensional outline (mm) | Reduction ratio | Backlash*2 | | Silent Spec. | Motor Small・Medium |
|---|---|---|---|---|---|---|---|
| | | | | Standard 3 min. | Special 1 min. | NR6 (6 min.) | |
| 11 | 4 weeks | □40 | 5,21,37,45 | ○ | — | — | 10W to 200W |
| 14,20,32 | | □60,□90,□120 | 5,11,15,21,33,45 | ○ | ○ | ○ | 30W to 4kW |
| 50 | | □170 | | ○ | ○ | ○ | 500W to 10kW |
| 65 | | □230 | 4,5,12,15,20,25 | ○ | ○ | — | 1.3kW to 15kW |

*1 Delivery time for catalog standard items with backlash of 3 min. For customized products (backlash of 1 min) or 6 or more units, please contact us.
*2 For details of positioning precision repeatability and angle transmission precision, refer to HPGP performance table on page 017.

**HPG Series Helical Gear Type**
(Permissible peak torque 5N·m to 400N·m)
Life: 20,000 hours

New HarmonicPlanetary®

| Model | Delivery time (5 units or less)*1 | Dimensional outline (mm) | Reduction ratio | Backlash*2 | | Motor Small・Medium |
|---|---|---|---|---|---|---|
| | | | | Standard 3 min. | Special 1 min. | |
| 11 | 1 week | □40 | 4,5,6,7,8,9,10 | ○ | — | 50W to 150W |
| 14 | | □60 | 3,4,5,6,7,8,9,10 | ○ | ○ | 100W to 400W |
| 20 | | □90 | | ○ | ○ | 200W to 1kW |
| 32 | | □120 | | ○ | ○ | 750W to 5kW |

*1 Delivery time for catalog standard items with backlash of 3 min. For customized products (backlash of 1 min) or 6 or more units, please contact us.
*2 For details of positioning precision repeatability and angle transmission precision, refer to HPG performance table on page 027.

**HPG Series**
**Standard Type**
(Permissible peak torque 3.9N·m to 2200N·m)
Life: 20,000 hours

HarmonicPlanetary®

| Model | Delivery time (5 units or less)*1 | Dimensional outline (mm) | Reduction ratio | Backlash*2 | | Silent Spec. | Motor Small・Medium |
|---|---|---|---|---|---|---|---|
| | | | | Standard 3 min. | Special 1 min. | NR6 (6 min.) | |
| 11 | 1 week | □40 | 5,9,21,37,45 | ○ | — | — | 10W to 100W |
| 14,20,32 | 1 week | □60,□90,□120 | 3,5,11,15,21,33,45 | ○ | ○ | ○ | 30W to 3.5kW |
| 50 | 2 weeks | □170 | | ○ | ○ | ○ | 500W to 10kW |
| 65 | 4 weeks | □230 | 4,5,12,15,20,25,40,50 | ○ | ○ | — | 1.3kW to 15kW |

*1 Delivery time for catalog standard items with backlash of 3 min. For customized products (backlash of 1 min) or 6 or more units, please contact us.
*2 For details of positioning precision repeatability and angle transmission precision, refer to HPG performance table on page 035.

**CSG-GH Series**
**High-torque Type**
(Permissible peak torque 23N·m to 3419N·m)
Life: 10,000 hours

HarmonicDrive®

| Model | Delivery time | Dimensional outline (mm) | Reduction ratio | Positioning precision repeatability (arc-sec)*1 | Angle transmission precision (arc-min)*1 | Motor Small・Medium |
|---|---|---|---|---|---|---|
| 14 | Made-to-order | □60 | 50,80,100 | ±10 | 1.5 | 30W to 100W |
| 20 | | □90 | 50,80,100,120,160 | ±8 | 1.0 | 100W to 400W |
| 32 | | □120 | | ±6 | | 300W to 1.5kW |
| 45 | | □170 | | ±5 | | 450W to 2kW |
| 65 | | □230 | 80,100,120,160 | ±4 | | 850W to 5kW |

*1 For details of positioning precision repeatability and angle transmission precision, refer to CSG-GH performance table on page 051.

# Variations〔Model／Reduction ratio〕

| HarmonicPlanetary® | | | | HarmonicDrive® | |
|---|---|---|---|---|---|
| **HPGP/HPG Model**【Model／□Size (mm)】 | **Reduction ratio** | | | | **CSG/CSF-GH Model**【Model／□Size (mm)】 |
| | **HPGP Series** (High-torque Type) | **HPG Series** (Helical Gear Type) | **HPG Series** (Standard Type) | **CSG/CSF-GH Series** (High-torque／Standard) | |
| 11／□40 | 5,21,37,45 | 4,5,6,7,8,9,10 | 5,9,21,37,45 | – | – |
| 14／□60 | 5,11,15,21,33,45 | 3,4,5,6,7,8,9,10 | 3,5,11,15,21,33,45 | 50,80,100 | 14／□60 |
| 20／□90 | 5,11,15,21,33,45 | 3,4,5,6,7,8,9,10 | 3,5,11,15,21,33,45 | 50,80,100,120,160 | 20／□90 |
| 32／□120 | 5,11,15,21,33,45 | 3,4,5,6,7,8,9,10 | 3,5,11,15,21,33,45 | 50,80,100,120,160 | 32／□120 |
| 50／□170 | 5,11,15,21,33,45 | – | 3,5,11,15,21,33,45 | 50,80,100,120,160 | 45／□170 |
| 65／□230 | 4,5,12,15,20,25 | – | 4,5,12,15,20,25,40,50 | 80,100,120,160 | 65／□230 |

**CSF-GH Series**
**Standard Type**
(Permissible peak torque 18N·m to 2630N·m)
Life: 7,000 hours

HarmonicDrive®

| Model | Delivery time | Dimensional outline (mm) | Reduction ratio | Positioning precision repeatability (arc-sec)*1 | Angle transmission precision (arc-min)*1 | Motor Small・Medium |
|---|---|---|---|---|---|---|
| 14 | Made-to-order | □60 | 50,80,100 | ±10 | 1.5 | 30W to 100W |
| 20 | | □90 | 50,80,100,120,160 | ±8 | 1.0 | 100W to 200W |
| 32 | | □120 | | ±6 | | 300W to 1kW |
| 45 | | □170 | | ±5 | | 450W to 2kW |
| 65 | | □230 | 80,100,120,160 | ±4 | | 850W to 5kW |

*1 For details of positioning precision repeatability and angle transmission precision, refer to CSF-GH performance table on page 059.

**HPG Series**
**Orthogonal Shaft Type**
(Permissible peak torque 150N·m to 2200N·m)
Life: 20,000 hours

HarmonicPlanetary®

| Model | Delivery time*1 | Dimensional outline (mm) | Reduction ratio | Backlash*2 | | Motor Small・Medium |
|---|---|---|---|---|---|---|
| | | | | Standard 3 min. | Special 1 min. | |
| 32,50 | 2 weeks | □120,□170 | 5,11,15,21,33,45 | ○ | – | 500W to 8kW |
| 65 | 4 weeks | □230 | 5,12,15,20,25,40,50 | ○ | – | 2kW to 8kW |

*1 Delivery time for catalog standard items.
*2 For details of positioning precision repeatability and angle transmission precision, refer to HPG Orthogonal shaft type performance table on page 071.

## HarmonicPlanetary® Unit Type

**HPF Series**
**Hollow Shaft Type**
(Permissible peak torque 100N·m to 220N·m)
Life: 20,000 hours

HarmonicPlanetary®

| Model | Delivery time*1 | Dimensional outline (mm) | Hole diameter | Reduction ratio | Backlash*2 |
|---|---|---|---|---|---|
| 25 | 2 weeks | $\phi$136 | $\phi$25 | 11 | 3 minutes |
| 32 | | $\phi$167 | $\phi$30 | | |

*1 Delivery time for catalog standard items.
*2 For details of positioning precision repeatability and angle transmission precision, refer to HPF Hollow shaft type performance table on page 082.

**HPG Series**
**Input Shaft Type**
(Permissible peak torque 3.9N·m to 2200N·m)
Life: 20,000 hours

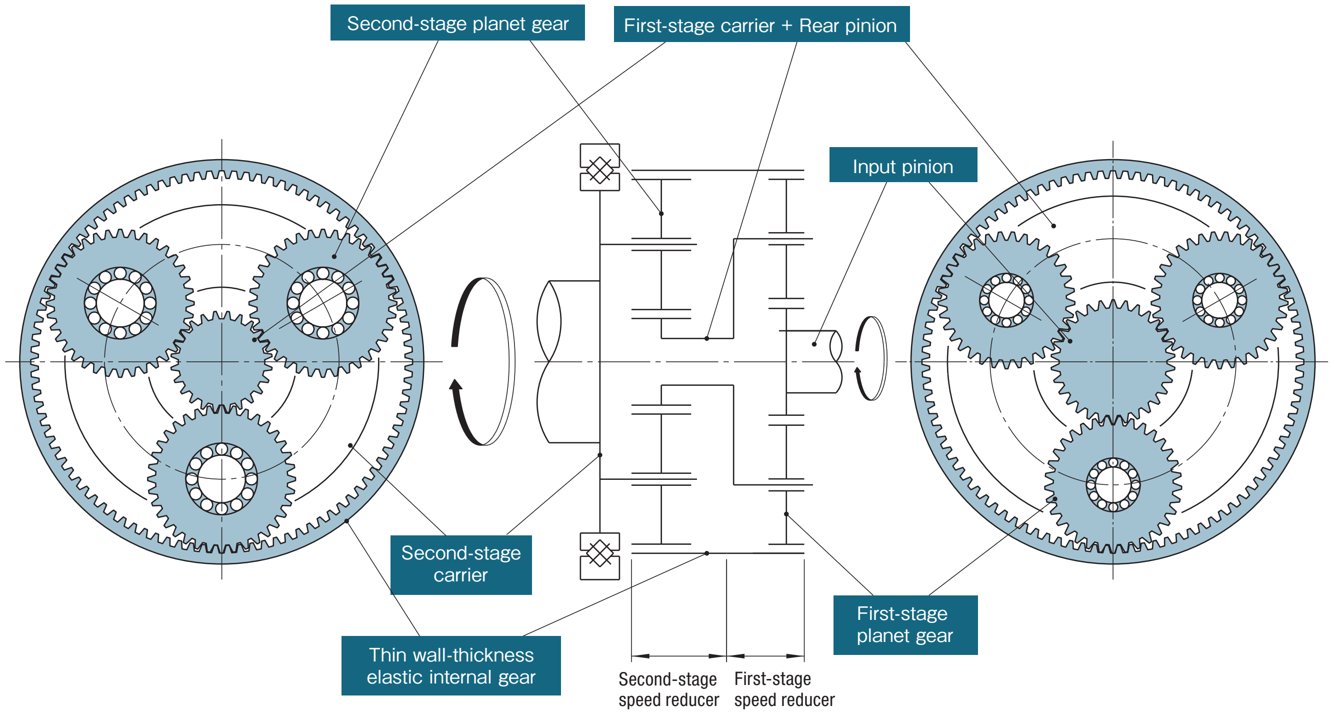
HarmonicPlanetary®

| Model | Delivery time (5 units or less)*1 | Dimensional outline (mm) | Reduction ratio | Backlash*2 | | Silent Spec. |
|---|---|---|---|---|---|---|
| | | | | Standard 3 min. | Special 1 min. | NR6 (6 min.) |
| 11 | 1 week | □40 | 5,9,21,37,45 | ○ | – | – |
| 14,20,32 | 1 week | □60,□90,□120 | 3,5,11,15,21,33,45 | ○ | ○ | ○ |
| 50 | 4 weeks | □170 | | ○ | ○ | ○ |
| 65 | 6 weeks | □230 | 4,5,12,15,20,25,40,50 | ○ | ○ | – |

*1 Delivery time for catalog standard items with backlash of 3 min. For customized products (backlash of 1 min) or 6 or more units, please contact us.
*2 For details of positioning precision repeatability and angle transmission precision, refer to HPG Input shaft type performance table on page 089.

## Operating Principle HarmonicPlanetary®

Example with the dual-stage type speed reducing mechanism (reduction ratio 11 or more) is illustrated.
The operating principles for the single-stage type speed reducing mechanism (reduction ratios 3 to 9) are for the second-stage speed reducer only.



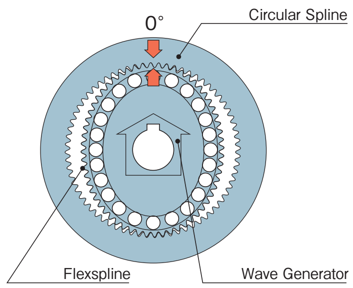

### Second-stage speed reducer: A planetary speed reducing mechanism with three or four planet gears.

The second-stage pinion coupled with the first-stage carrier is input to the second-stage speed reducer and provides revolution motion to the second-stage planet gears as in the case of the first-stage speed reducer. The revolution motion is then transferred to the second-stage carrier (internal ring of cross roller bearing) for output.
The rotation direction at this time is the same as that of the first-stage speed reducer.

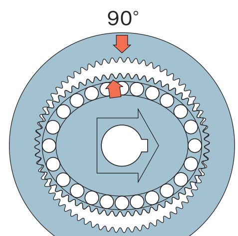
### First-stage speed reducer: A planetary speed reducing mechanism with three planet gears.

Rotations driven by the input pinion transfer revolution motion to the first-stage planet gears that mesh with it. The revolution motion is then transferred to the first-stage carrier through the planetary shaft.
The rotation direction at this time is the same as that of input rotation.

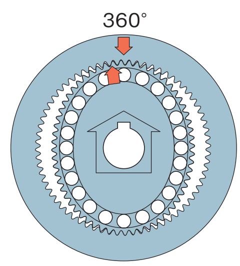
## Operating Principle HarmonicDrive®




Combine three basic parts together. The Flexspline is deformed by the Wave Generator. Thus, the teeth of the Flexspline engage with the Circular Spline at the long shaft part and disengage completely at the short shaft part.




As the Wave Generator rotates clockwise while the Circular Spline is fixed in place, the Flexspline elastically deforms and engaging points of the teeth shift sequentially.




One Turn of Wave Generator

When the wave generator rotates through one turn (360°), the Flexspline moves counterclockwise by two teeth based on the difference in the number of teeth because the Flexspline has two teeth fewer than the Circular Spline. Normally, this motion is taken out as output.

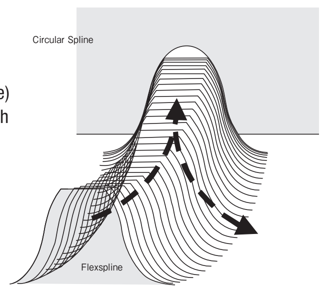
### Rotational direction

The output rotational direction of CSG/CSF-GH series is reverse of the input rotational direction.

Input: Wave Generator (Motor shaft mounting)
Fixed: Circular Spline (Casing)
Output: Flexspline (Cross roller bearing)

### Tooth behavior and engagement

Unlike motions of ordinary gearing, the unique tooth behavior (operating principle) of HarmonicDrive® achieved non-backlash motion, infinitesimal angular feeding (one-pulse feeding) and high positioning repeatability. More than 30% of all teeth simultaneously engages in two locations in 180° symmetry, thereby allowing high-torque capability.



# Form & Code

## Gear Head Type

**HPGP - 11 A - 05 - F0 XXXX - SP1**

| Model Name | Model No. | Design Order | Reduction Ratio | Output Shaft Shape | Input side Shape Symbol | Special Specification |
|---|---|---|---|---|---|---|
| **HPGP**<br>High-torque Type<br>HarmonicPlanetary® | 11 | A | 5, 21, 37, 45 | F0: Flange output<br>J20: Straight shaft (without key)<br>J60: Straight shaft (with key and center tap) | Alphabet letters 3 or 6 digits:<br>Motor flange and input shaft coupling shape symbol<br>(See the model selection tool on the web page to find matching model on each company's servo motors.<br>(URL:https://hds-tech.jp/)) | BL1: Backlash 1 minute or less, customized specification. (Models 14 to 65)<br>D: Shielded bearing on input side is contact shielded type [DDU].<br>NR6: Silent specification, backlash 6 minutes or less (Models 14 to 50)<br>None: Standard item<br>SP: Special specification |
| | 14<br>20<br>32<br>50 | | 5, 11, 15, 21, 33, 45 | F0: Flange output<br>J2: Straight shaft (without key)<br>J6: Straight shaft (with key and center tap)<br>(J2, J6 for Model 65 is customized specification) | | |
| | 65 | | 4, 5, 12, 15, 20, 25 | | | |

**HPG - 20 A - 05 - J2 XXXX - SP1**

| Model Name | Model No. | Design Order | Reduction Ratio | Output Shaft Shape | Input side Shape Symbol | Special Specification |
|---|---|---|---|---|---|---|
| **HPG**<br>Standard Type<br>HarmonicPlanetary® | 11 | B, R | B: 5, 9, 21, 37, 45<br>R: 4, 5, 6, 7, 8, 9, 10 | F0: Flange output<br>J20: Straight shaft (without key)<br>J60: Straight shaft (with key and center tap) | Alphabet letters 3 or 6 digits:<br>Motor flange and input shaft coupling shape symbol<br>(See the model selection tool on the web page to find matching model on each company's servo motors.<br>(URL:https://hds-tech.jp/)) | BL1: Backlash 1 minute or less, customized specification. (Models 14 to 65)<br>D: Shielded bearing on input side is contact shielded type [DDU].<br>NR6: Silent specification, backlash 6 minutes or less (Models 14 to 50)<br>None: Standard item<br>SP: Special specification |
| | 14<br>20<br>32 | A, R | A: 3, 5, 11, 15, 21, 33, 45<br>R: 3, 4, 5, 6, 7, 8, 9, 10 | F0: Flange output<br>J2: Straight shaft (without key)<br>J6: Straight shaft (with key and center tap)<br>(J2, J6 for Model 65 is customized specification) | | |
| | 50 | A | 3, 5, 11, 15, 21, 33, 45 | | | |
| | 65 | | 4, 5, 12, 15, 20, 25, 40, 50 | | | |

* Design order: R indicates helical gear type.

**CSG - 20 - 100 - GH - F0 XXX - SP1**

| Model Name | Model No. | Reduction Ratio | Model | Output Shaft Shape | Input side Shape Symbol | Special Specification |
|---|---|---|---|---|---|---|
| **CSG**<br>High-torque Type<br>HarmonicDrive® | 14 | 50, 80, 100 | GH:<br>Gear Head Type | F0: Flange output<br>J2: Straight shaft (without key)<br>J6: Straight shaft (with key and center tap) | Alphabet letters 3 or 4 digits:<br>Motor flange and input shaft coupling shape symbol<br>(Symbol varies in accordance with the motor to be mounted on. See the model selection tool on the web page to find matching model on each company's servo motors. (URL:https://hds-tech.jp/)) | None: Standard item<br>SP: Special specification |
| | 20<br>32<br>45 | 50, 80, 100, 120, 160 | | | | |
| | 65 | 80, 100, 120, 160 | | | | |

**CSF - 20 - 100 - GH - F0 XXX - SP1**

| Model Name | Model No. | Reduction Ratio | Model | Output Shaft Shape | Input side Shape Symbol | Special Specification |
|---|---|---|---|---|---|---|
| **CSF**<br>Standard Type<br>HarmonicDrive® | 14 | 50, 80, 100 | GH:<br>Gear Head Type | F0: Flange output<br>J2: Straight shaft (without key)<br>J6: Straight shaft (with key and center tap) | Alphabet letters 3 or 4 digits:<br>Motor flange and input shaft coupling shape symbol<br>(See the model selection tool on the web page to find matching model on each company's servo motors.<br>(URL:https://hds-tech.jp/)) | None: Standard item<br>SP: Special specification |
| | 20<br>32<br>45 | 50, 80, 100, 120, 160 | | | | |
| | 65 | 80, 100, 120, 160 | | | | |

# Form & Code

## Gear Head Type Orthogonal Shaft Type

**HPG - 32 A - 05 - J2 XXXX - RA3 SP1**

<table>
<tr><th>Model Name</th><th>Model No.</th><th>Design Order</th><th>Reduction Ratio</th><th>Output Shaft Shape</th><th>Input side Shape Symbol</th><th>Orthogonal Part Type</th><th>Special Specification</th></tr>
<tr><td rowspan="3">HPG<br>Orthogonal Shaft Type<br>HarmonicPlanetary®</td><td>32</td><td rowspan="3">A</td><td rowspan="2">5, 11, 15, 21, 33, 45</td><td rowspan="3">F0: Flange output<br>J2: Straight shaft (without key)<br>J6: Straight shaft (with key and center tap)<br>(J2, J6 for Model 65 is customized specification)</td><td rowspan="3">Alphabet letters 3 or 4 digits:<br>Motor flange and input shaft coupling shape symbol (Symbol varies in accordance with the motor to be mounted on. See the model selection tool on the web page to find matching model on each company's servo motors. (URL:https://hds-tech.jp/)</td><td rowspan="3">Orthogonal unit part shape symbol (Symbol varies in accordance with the motor to be mounted on. See the model selection tool on the web page to find matching model on each company's servo motors. (URL:https://hds-tech.jp/)<br>For details, check the dimension tables on pages 073 through 076.)</td><td rowspan="3">None: Standard item<br>SP: Special specification</td></tr>
<tr><td>50</td></tr>
<tr><td>65</td><td>5, 12, 15, 20, 25, 40, 50</td></tr>
</table>

## Unit Type

**HPF - 25 A - 11 - F0 U1 - SP1**

<table>
<tr><th>Model Name</th><th>Model No.</th><th>Design Order</th><th>Reduction Ratio</th><th>Output Shaft Shape</th><th>Input side Shape Symbol</th><th>Special Specification</th></tr>
<tr><td rowspan="2">HPF<br>Hollow Shaft Type<br>HarmonicPlanetary®</td><td>25</td><td rowspan="2">A</td><td rowspan="2">11</td><td rowspan="2">F0: Flange output</td><td rowspan="2">U1: Hollow shaft type</td><td rowspan="2">None: Standard item<br>SP: Special specification</td></tr>
<tr><td>32</td></tr>
</table>

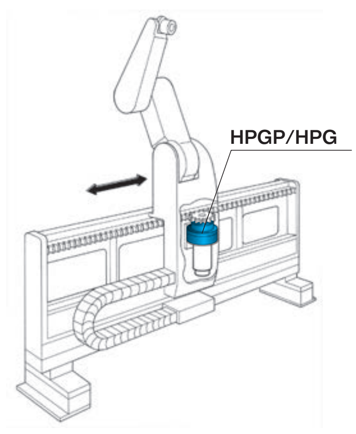
**HPG - 20 A - 05 - J2 U1 - SP1**

<table>
<tr><th>Model Name</th><th>Model No.</th><th>Design Order</th><th>Reduction Ratio</th><th>Output Shaft Shape</th><th>Input side Shape Symbol</th><th>Special Specification</th></tr>
<tr><td rowspan="6">HPG<br>Input Shaft Type<br>HarmonicPlanetary®</td><td>11</td><td>B</td><td>5, 9, 21, 37, 45</td><td>F0: Flange output<br>J20: Straight shaft (without key)<br>J60: Straight shaft (with key and center tap)</td><td>U1: Input shaft type (with key; no center tap)</td><td rowspan="6">BL1: Backlash 1 minute or less, customized specification. (Models 14 to 65)<br>NR6: Silent specification, backlash 6 minutes or less (Models 14 to 50)<br>None: Standard item<br>SP: Special specification</td></tr>
<tr><td>14</td><td rowspan="5">A</td><td rowspan="4">3, 5, 11, 15, 21, 33, 45</td><td rowspan="5">F0: Flange output<br>J2: Straight shaft (without key)<br>J6: Straight shaft (with key and center tap)<br>(J2, J6 for Model 65 is customized specification)</td><td rowspan="5">U1: Input shaft type (with key and center tap)</td></tr>
<tr><td>20</td></tr>
<tr><td>32</td></tr>
<tr><td>50</td></tr>
<tr><td>65</td><td>4, 5, 12, 15, 20, 25, 40, 50</td></tr>
</table>

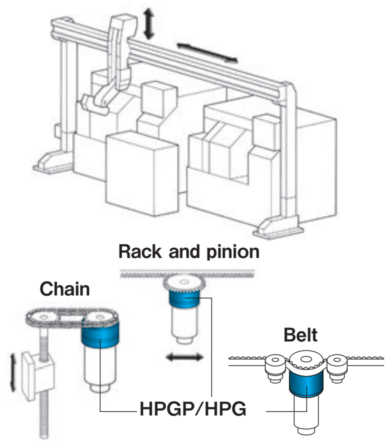
# Application Examples (HPGP/HPG Series)

The Harmonic Planetary® HPGP/HPG series is especially suitable for a wide range of high technology fields requiring precision motion control such as the semiconductor or LCD production equipment, robot and machine tool industries.

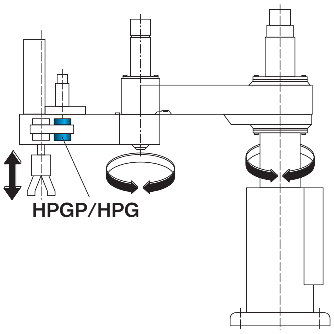
### Linear axis for robots (Racks and pinions)



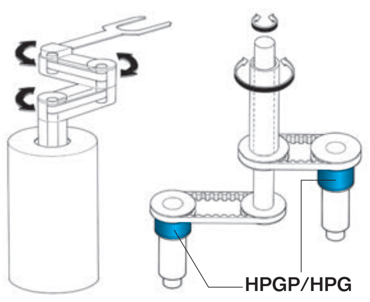

### Loading and unloading equipment



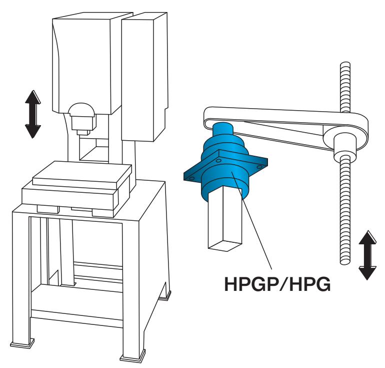

### Primary axes of scara robots



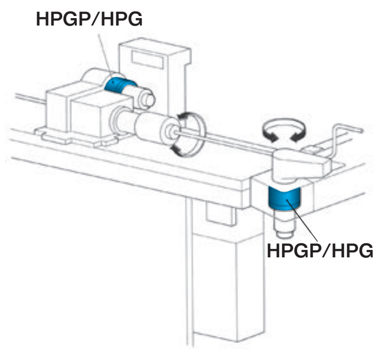

### Wafer transfer robots



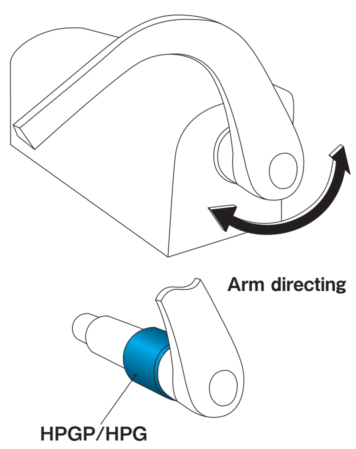

### Presses (Caulking)



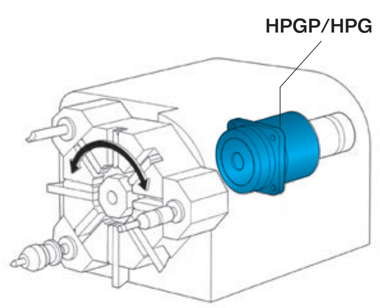

### Pipe benders



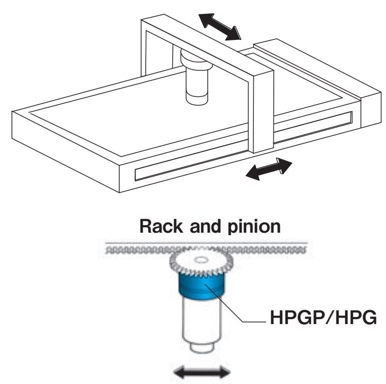

### Injection molding unloading robots




### Rotation of machine tool turret heads



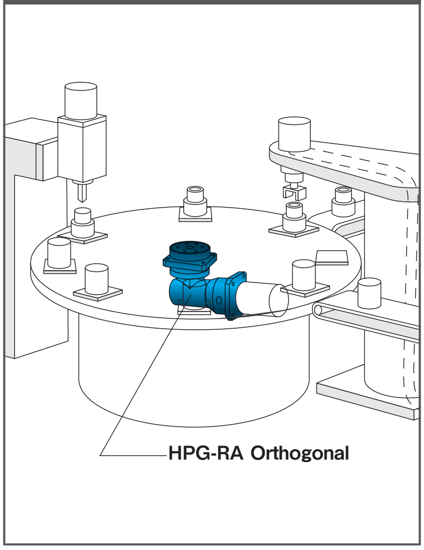

### X-Y axes of machine tools



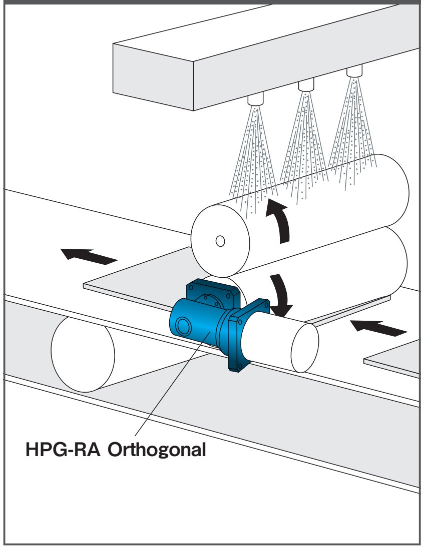
# Application Examples (HPGP/HPG Series)

The Harmonic Planetary® HPGP/HPG series is especially suitable for a wide range of high technology fields requiring precision motion control such as the semiconductor or LCD production equipment, robot and machine tool industries.

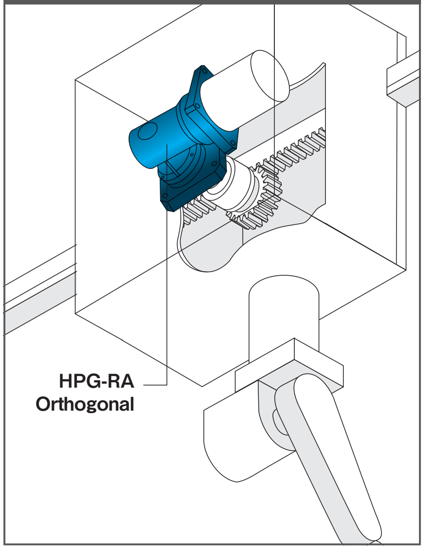
### Driving of a dividing table



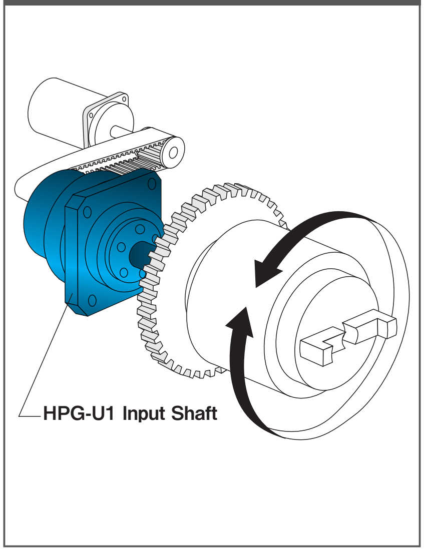

### Driving of an application roller



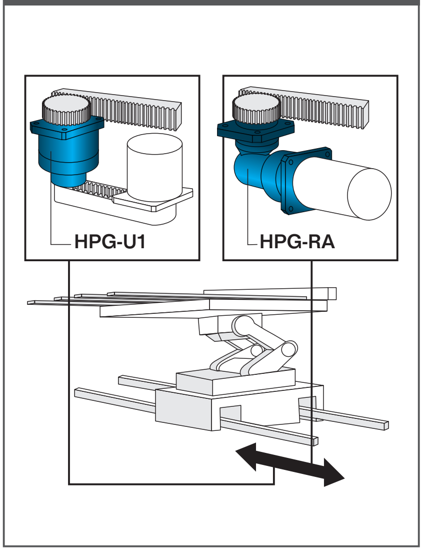

### Slider for loader



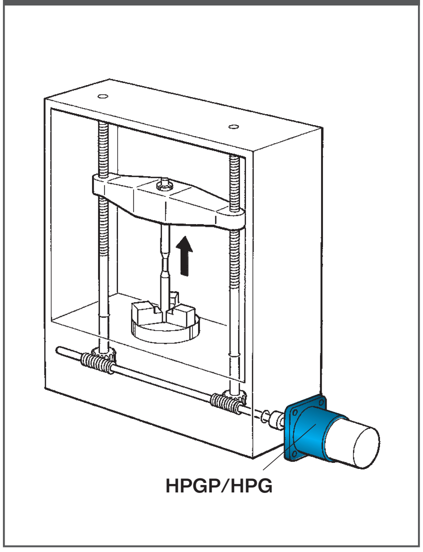

### Driving of a type belt with input shaft



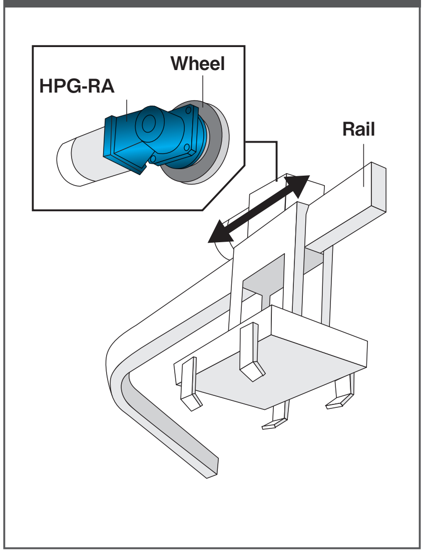

### LCD glass board transfer robots



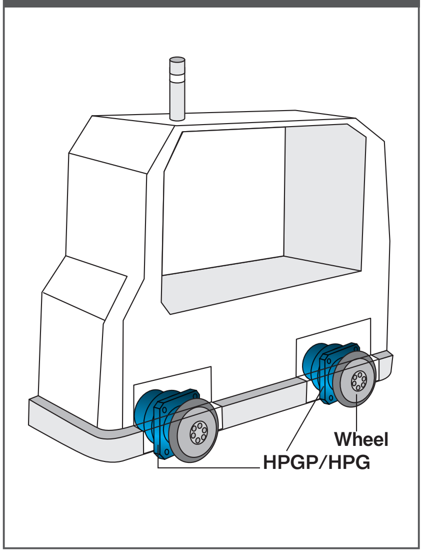

### Tensile testers



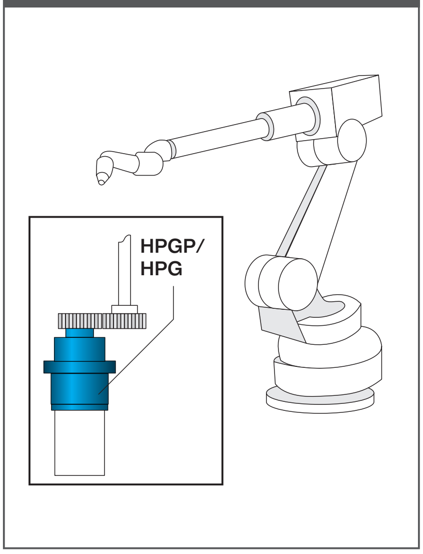

### Overhead travelling dollies




### Unmanned dollies



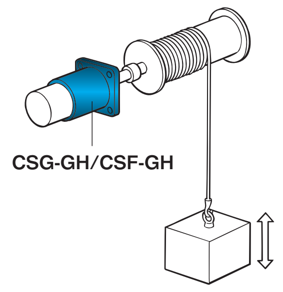

### High-speed operation robots



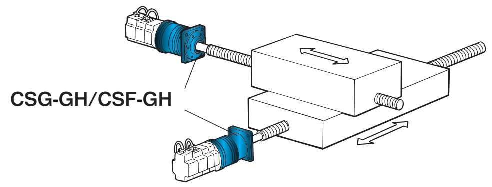
## Application Examples (CSG-GH/CSF-GH Series)

The HarmonicDrive® CSG-GH/CSF-GH series is especially suitable for a wide range of high technology fields requiring precision motion control such as the semiconductor or LCD production equipment, robot and machine tool industries.

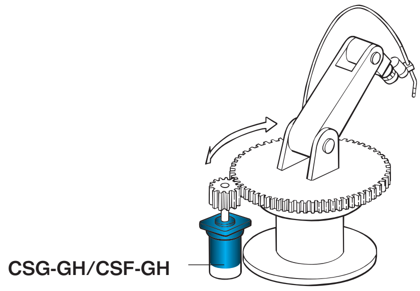
### Rolling-up



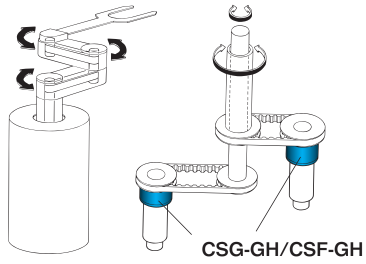

### Dual-shaft control (XY table)



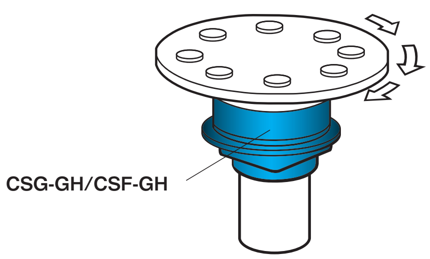

### Pivoting



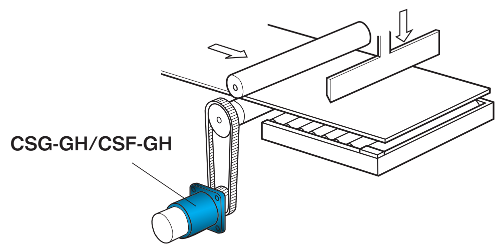

### Transfering




### Angle (positioning) control



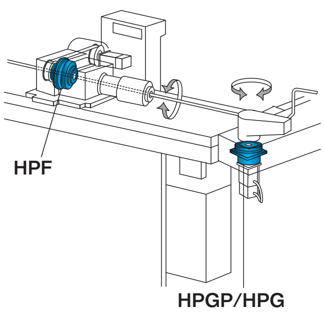

### Driving of a roller



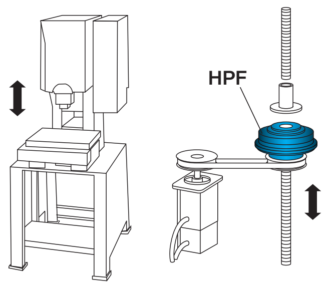

## Application Examples (HPF Series)

The superior performance and specifications of HPG series has been succeeded. Additionally, a hollow-shaft mechanism has been newly introduced to enjoy the shape advantage. The pass-through hole with the coaxial input and output shaft provides the compactly-designed devices to meet diversified customer needs, such as passing through the piping, wiring, and laser light or combining with a ball screw.

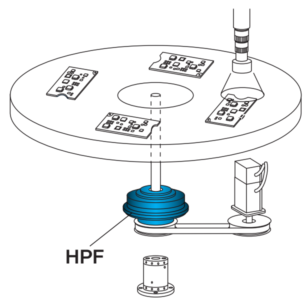
### Pipe benders




### Presses (Caulking)




### Printed board inspection device



# Gear Head Series CONTENTS

## HarmonicPlanetary® HPGP Series



## HarmonicPlanetary® HPG Series Helical Gear Type



## HarmonicPlanetary® HPG Series Standard Type



## HarmonicDrive® CSG-GH Series High-torque Type



## HarmonicDrive® CSF-GH Series Standard Type

# HarmonicPlanetary®
# HPGP/HPG Series

## Size

**6 Types**

Model: 11, 14, 20, 32, 50, 65

## Peak torque

HPGP series: 10 N·m to 2920 N·m
HPG Series (Helical Gear Type) : 5 N·m to 400 N·m
HPG series (Standard Type) : 3.9 N·m to 2200 N·m

## Reduction ratio

HPGP series: 1/5 to 1/45
HPG Series (Helical Gear Type) : 1/3 to 1/10
HPG series (Standard Type) : 1/3 to 1/50

## Small backlash

Standard: 3 min. or less
Customized: 1 min. or less

## High efficiency

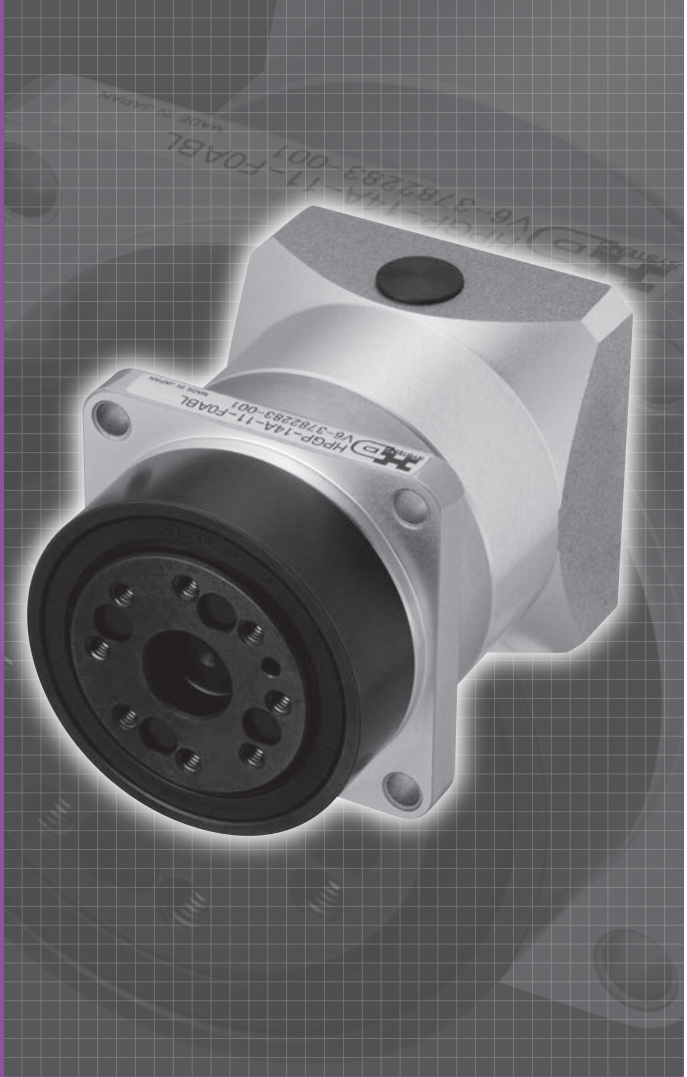
90% or higher
(85% for Models 11 and 14)

## Can be mounted to servo motors of many manufacturers

Yasukawa Electric, Mitsubishi Electric, Fanuc, Panasonic, Sanyo Denki, Tamagawa Seiki, Fuji Electric, Omron, Toshiba Machine, Keyence, and other

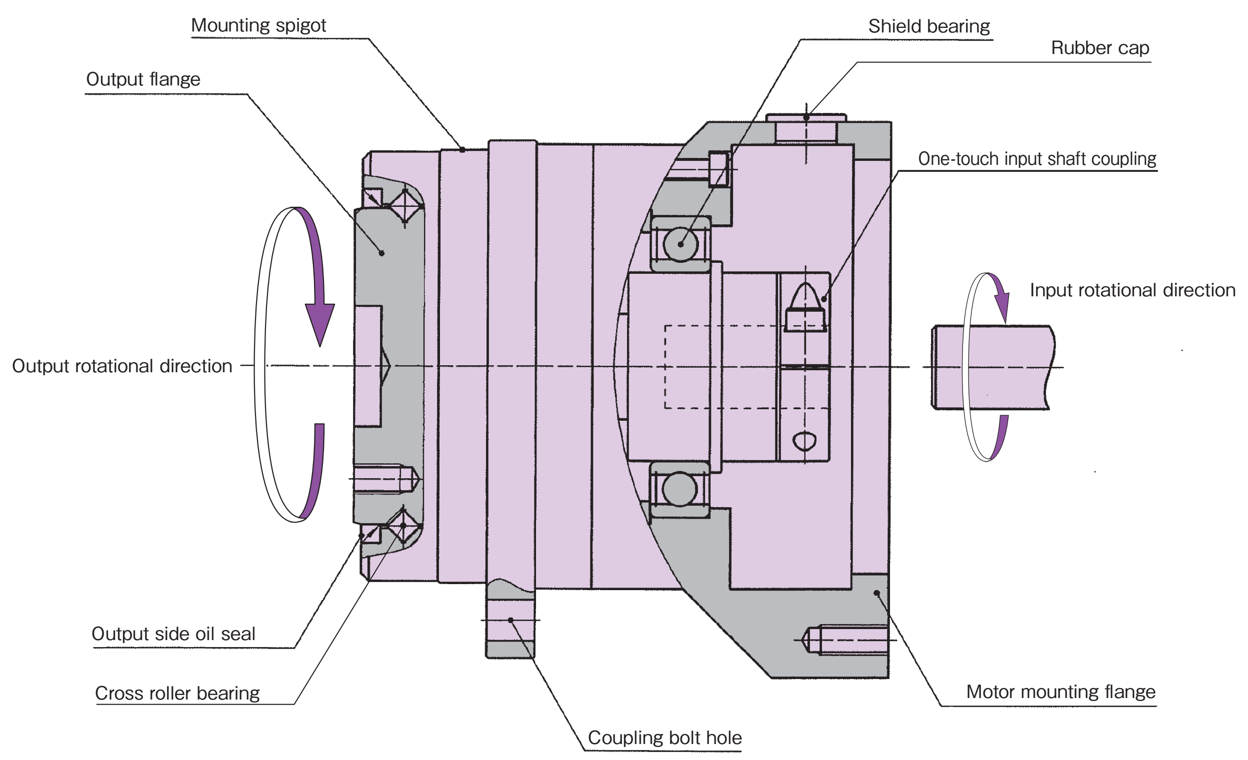
For other servo motors, please feel free to contact the nearest sales office.

* See the model selection tool on the web page to find matching model on each company's servo motors. (URL:https://hds-tech.jp/)



Structural drawing

Fig. 013-1



# Model Number Selection (HPGP/HPG Series)

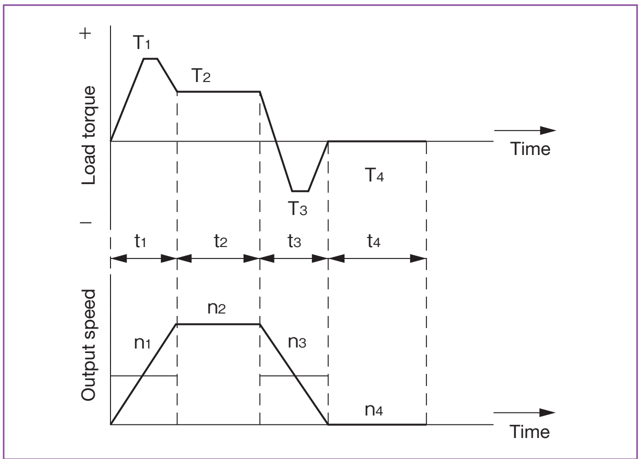
Check your operating conditions and select suitable model Nos. based on the flowchart to fully demonstrate the excellent performance of the Harmonic Planetary® HPGP/HPG series.

In general, the servo system is rarely in a continuous constant load state. The load torque changes according to the input rotational speed variation and comparatively large torque are applied at start and stop. Unexpected impact torque may be applied.
Check your operating conditions against the following load torque pattern and select suitable model Nos. 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). (See the specification of the input side main bearing and the output side main bearing on pages 114 to 119.)

## ■Checking the load torque pattern

First, you need to look at the picture of the load torque pattern. Check the specifications shown in the figure below.

Graph 014-1




**Obtain the value of each load torque pattern.**

| | |
|---|---|
| Load torque | $T_1$ to $T_n$ (N·m) |
| Time | $t_1$ to $t_n$ (sec) |
| Output speed | $n_1$ to $n_n$ (r/min) |

**<Normal operation pattern>**

| | |
|---|---|
| Starting time | $T_1$, $t_1$ $n_1$ |
| Steady operation time | $T_2$, $t_2$, $n_2$ |
| Stopping (slowing) time | $T_3$, $t_3$, $n_3$ |
| Break time | $T_4$, $t_4$ $n_4$ |

**<Maximum rotational speed>**

| | |
|---|---|
| Max. output rotational speed | $n_{o\,max} \geqq n_1$ to $n_n$ |
| Max. input rotational speed | $n_{i\,max} \geqq n_1 \times R$ to $n_n \times R$ |
| (Restricted by motors) | R: Reduction ratio |

**<Impact torque>**

When impact torque is applied $T_s$

**<Required lifespan>**

$L_{10} = L$ (hours)

## ■Flowchart of model number selection

Select a model number according to the following flowchart.
If you find a value exceeding that from the ratings, you should review it with the upper-level model number or consider reduction of conditions including the load torque.

Calculate the average load torque applied on the output side from the load torque pattern: *Tav* (N·m).

$$T_{av} = \sqrt[10/3]{\frac{|n_1|\cdot t_1\cdot|T_1|^{10/3}+|n_2|\cdot t_2\cdot|T_2|^{10/3}+\cdots+|n_n|\cdot t_n\cdot|T_n|^{10/3}}{n_1\cdot t_1+n_2\cdot t_2+\cdots+n_n\cdot t_n}}$$

Calculate the average output speed based on the load torque pattern: no av (r/min)

$$n_{o\,av}=\frac{|n_1|\cdot t_1+|n_2|\cdot t_2+\cdots+|n_n|\cdot t_n}{t_1+t_2+\cdots+t_n}$$

▼

Select a model number temporarily with the following condition: *Tav* ≦ Average load torque (See the rating table on page 016) — NG

OK ▼

Determine the reduction ratio (R) based on the maximum output rotational speed (no *max*) and maximum input rotational speed (ni *max*).

$$\frac{n_{i\,max}}{n_{o\,max}} \geqq R$$

(A limit is placed on ni *max* by motors.)
Calculate the maximum input rotational speed (ni *max*) from the maximum output rotational speed (no *max*) and the reduction ratio (R).

$$n_{i\,max}=n_{o\,max}\cdot R$$

▼

Calculate the average input rotational speed (ni *av*) from the average output rotational speed (no *av*) and the reduction ratio (R): ni *av* = no *av*·R ≦ Permissible average input rotational speed ($n_r$). — NG

Check the description in Caution below.

OK ▼

Check whether the maximum input rotational speed is equal to or less than the values in the rating table.
ni *max* ≦ maximum input rotational speed (r/min) — NG

OK ▼

Check whether $T_1$ and $T_3$ are equal to or less than the permissible peak torque (N·m) value at start and stop from the ratings. — NG

OK ▼

Check whether $T_s$ is equal to or less than the permissible maximum momentary torque (N·m) value from the ratings. — NG

OK ▼

Calculate the lifetime and check whether it meets the specification requirement.
Tr: Output torque
$n_r$: Permissible average input rotational speed

$$L_{10}=20000\cdot\left(\frac{T_r}{T_{av}}\right)^{10/3}\cdot\left(\frac{n_r}{n_{i\,av}}\right) \text{ (Hour)}$$

— NG

OK ▼

**The model number is determined.**

Review of the operation conditions, model No and reduction ratio.

**Caution**

Check impacts by speed reducer temperature rise, vibration during acceleration and deceleration and other factors if the operating conditions are as specified below. Study to "increase the speed reducer size", "review the operating conditions" and other means if it becomes necessary to study safety. Exercise reasonable caution especially when operating conditions are close to continuous operation.
Average load torque (*Tav*) > Permissible maximum value of average load torque (see page 016)
Calculate average input rotational speed (ni *av*) > Permissible average input rotational speed ($n_r$)

## Example of Model Number Selection

### Value of each load torque pattern.

| | | |
|---|---|---|
| Load torque | $T_n$ (N·m) | |
| Time | $t_n$ (sec) | |
| Output rotational speed | $n_n$ (r/min) | |

<Normal operation pattern>

| | | |
|---|---|---|
| Starting time | $T_1$ = 70 N·m, $t_1$ = 0.3 sec, | $n_1$ = 60 r/min |
| Steady operation time | $T_2$ = 18 N·m, $t_2$ = 3 sec, | $n_2$ = 120 r/min |
| Stopping (slowing) time | $T_3$ = 35 N·m, $t_3$ = 0.4 sec, | $n_3$ = 60 r/min |
| Break time | $T_4$ = 0 N·m, $t_4$ = 5 sec, | $n_4$ = 0 r/min |

<Maximum rotational speed>

| | |
|---|---|
| Max. output rotational speed | no *max* = 120 r/min |
| Max. input rotational speed | ni *max* = 5,000 r/min (Restricted by motors) |

<Impact torque>

When impact torque is applied $T_s$ = 180 N·m

<Required life>

$L_{10}$ = 30,000 (hours)

Calculate the average load torque applied on the output side based on the load torque pattern: T*av* (N·m).

$$T_{av}=\sqrt[10/3]{\frac{|60r/min|\cdot 0.3sec\cdot|70N\cdot m|^{10/3}+|120r/min|\cdot 3sec\cdot|18N\cdot m|^{10/3}+|60r/min|\cdot 0.4sec\cdot|35N\cdot m|^{10/3}}{|60r/min|\cdot 0.3sec+|120r/min|\cdot 3sec+|60r/min|\cdot 0.4sec}}$$

Calculate the average output rotational speed based on the load torque pattern: no *av* (r/min)

$$no\ av=\frac{|60r/min|\cdot 0.3sec+|120r/min|\cdot 3sec+|60r/min|\cdot 0.4sec+|0r/min|\cdot 5sec}{0.3sec+3sec+0.4sec+5sec}$$

▼

Select a model number temporarily with the following conditions. T*av* = 30.2 N·m ≦ 60 N·m. (**HPG-20A-33** is temporarily selected based on the average load torque (see the rating table on page 016) of model No. 20 and reduction ratio of 33.) — NG

OK

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

$$\frac{5{,}000\ r/min}{120\ r/min}=41.7\geqq 33$$

Calculate the maximum input rotational speed (ni *max*) from the maximum output rotational speed (no *max*) and reduction ratio (R): ni *max* = 120 r/min·33=3,960 r/min

▼

Calculate the average input rotational speed (ni *av*) from the average output speed (no *av*) and reduction ratio (R): ni *av* = 46.2 r/min·33 = 1,525 r/min≦ Permissible average input speed of model No. 20 3000 (r/min) — NG

OK

Check whether the maximum input rotational speed is equal to or less than the values specified in the rating table. ni *max* = 3960 r/min ≦ 6000 r/min (maximum input rotational speed of model No. 20) — NG

OK

Check whether $T_1$ and $T_3$ are equal to or less than the peak torques (N·m) on start and stop in the rating table.
$T_1$ = 70 N·m ≦ 100 N·m (Peak torques on start and stop of model No. 20)
$T_3$ = 35 N·m ≦ 100 N·m (Peak torques on start and stop of model No. 20) — NG

OK

Check whether Ts is equal to or less than the values of the momentary max. torque (N·m) in the rating table.
$T_s$ = 180 N·m ≦ 217 N·m (momentary max. torque of model No. 20) — NG

OK

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

$$L_{10}=20{,}000\cdot\left(\frac{29\ N\cdot m}{30.2\ N\cdot m}\right)^{10/3}\cdot\left(\frac{3{,}000\ r/min}{1{,}525\ r/min}\right)=34{,}543\ (hours)\geqq 30{,}000\ (hours)$$

— NG

OK

**As a result of the preceding steps, HPG-20A-33 is determined.**

Check the description in Caution at the bottom of page 014

Review of the operation conditions, model No and reduction ratio.

# Rating Table (HPGP Series)

HPGP series gear head type has a variety of 6 model numbers. For selecting the model number, refer to the rating table.

Table 016-1

| Model | Reduction ratio | Rated output torque *1 | | Permissible max. value of ave. load torque *2 | | Permissible peak torque at start/stop *3 | | Permissible max. momentary torque *4 | | Permissible ave. input rotational speed *5 | Permissible max. input rotational speed *6 | Inertia moment (equiv. value on input side) *7 | | Mass *8 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N·m | kgf·m | N·m | kgf·m | N·m | kgf·m | N·m | kgf·m | r/min | r/min | Shaft output $\times10^{-4}$kg·m² | Flange output $\times10^{-4}$kg·m² | Shaft output kg | Flange output kg |
| | 5 | 3.4 | 0.35 | 6.7 | 0.68 | 10 | 1.0 | | | | | 0.0040 | 0.0024 | 0.18 | 0.14 |
| 11 | 21 | | | | | | | 20 | 2.0 | 3000 | 10000 | 0.0019 | 0.0018 | | |
| | 37 | 4.6 | 0.47 | 8 | 0.82 | 13 | 1.3 | | | | | 0.00069 | 0.00066 | 0.24 | 0.20 |
| | 45 | | | | | | | | | | | 0.00050 | 0.00048 | | |
| | 5 | 7.8 | 0.80 | 17 | 1.7 | | | | | | | 0.023 | 0.017 | 0.54 | 0.42 |
| | 11 | 10 | 1.0 | | | | | | | | | 0.019 | 0.018 | | |
| 14 | 15 | 12 | 1.2 | | | 30 | 3.1 | 56 | 5.7 | 3000 | 6000 | 0.017 | 0.016 | | |
| | 21 | | | 20 | 2.0 | | | | | | | 0.0093 | 0.0090 | 0.63 | 0.51 |
| | 33 | 13 | 1.3 | | | | | | | | | 0.0030 | 0.0029 | | |
| | 45 | | | | | | | | | | | 0.0028 | 0.0027 | | |
| | 5 | 21 | 2.1 | 47 | 4.8 | | | | | | | 0.20 | 0.16 | 1.6 | 1.2 |
| | 11 | 26 | 2.7 | 60 | 6.1 | | | | | | | 0.17 | 0.17 | | |
| 20 | 15 | 32 | 3.3 | 70 | 7.1 | 133 | 14 | 217 | 22 | 3000 | 6000 | 0.16 | 0.15 | 1.9 | 1.5 |
| | 21 | 33 | 3.4 | 73 | 7.4 | | | | | | | 0.073 | 0.071 | | |
| | 33 | 39 | 4.0 | 80 | 8.2 | | | | | | | 0.030 | 0.029 | 2.0 | 1.6 |
| | 45 | | | | | | | | | | | 0.023 | 0.022 | 1.9 | 1.5 |
| | 5 | 87 | 8.9 | 200 | 20 | | | | | | | 1.1 | 0.8 | 4.4 | 3.0 |
| | 11 | 104 | 11 | | | | | | | | | | 1.0 | | |
| 32 | 15 | 122 | 12 | 226 | 23 | 400 | 41 | 650 | 66 | 3000 | 6000 | 0.77 | 0.74 | 5.1 | 3.7 |
| | 21 | 130 | 13 | | | | | | | | | 0.37 | 0.35 | | |
| | 33 | 143 | 15 | 266 | 27 | | | | | | | 0.17 | 0.17 | 5.4 | 4.0 |
| | 45 | | | | | | | | | | | 0.12 | 0.12 | 5.1 | 3.7 |
| | 5 | 226 | 23 | 452 | 46 | | | | | | | 6.2 | 4.9 | 13 | 10 |
| | 11 | 266 | 27 | 532 | 54 | | | | | | | 4.2 | 4.0 | | |
| 50 | 15 | 306 | 31 | 600 | 61 | 1130 | 115 | 1850 | 189 | 2000 | 4500 | 3.7 | 3.5 | | |
| | 21 | 346 | 35 | | | | | | | | | 1.7 | 1.6 | 15 | 12 |
| | 33 | 359 | 37 | 665 | 68 | | | | | | | 0.75 | 0.72 | | |
| | 45 | | | | | | | | | | | 0.52 | 0.50 | | |
| | 4 | 665 | 68 | 1200 | 122 | | | | | | 2500 | 46 *9 | 31 | 32 *9 | 22 |
| | 5 | 705 | 72 | 1330 | 136 | | | | | | | 30 *9 | 21 | | |
| 65 | 12 | 798 | 81 | 1460 | 149 | 2920 | 298 | 4500 | 459 | 2000 | | 22 *9 | 20 | | |
| | 15 | 971 | 99 | 1730 | 177 | | | | | | 3000 | 20 *9 | 19 | 47 *9 | 37 |
| | 20 | 1060 | 108 | 2000 | 204 | | | | | | | 7.8 *9 | 7.3 | | |
| | 25 | 1130 | 115 | | | | | | | | | 7.2 *9 | 6.8 | | |

(Note) 1. Output torque set based on the life of $L_{10}$ = 20000 hours when input rotational speed is 3000 r/min, which is the rated rotational speed of ordinary servo motors. Models 50 and 65 are set at 2000 r/min as the rated rotational speed and at $L_{10}$ = 20000 hours as the life for the servo motor to be combined.
2. Permissible maximum value of average load torque calculated based on a load torque pattern (page 014). A life of 2000 hours or more is a criterion when operated at an input speed of 2000 r/min.
3. Permissible maximum value of torque applied on start and stop in operation cycles.
4. Permissible maximum value for impact torque in an emergency stop and for external impact torque.Operation exceeding these ranges may cause damages to reducers.
5. Permissible maximum value of average input rotational speed during operations. Make it a point to operate below this value especially when the operation mode is near continuous operation.
6. Permissible maximum input rotational speed in operation modes other than continuous operation.
7. The value for a speed reducer itself. Values that include the input shaft coupling are shown in the model selection tool on the web page. (URL:https://hds-tech.jp/)
8. The weight of a speed reducer itself. See measurement tables for values that include an input shaft coupling, motor flange and other parts.
9. The standard specification is flange output. Shaft output is a customized specification.

# Performance Table (HPGP Series)

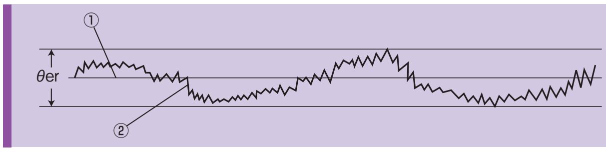
The values in the table are for the HPGP reducer alone.
The input side shape may vary depending on the size of the mounted motor. For the input shaft coupling and motor flange values, please contact us.

Table 017-1

| Model | Reduction ratio | Angle transmission precision [*1] | | Repeatability [*2] | Starting torque [*3] | | Overdrive starting torque [*4] | | No-load running torque [*5] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | arc-min | $\times 10^{-4}$rad | arc-sec | cN·m | kgf·cm | N·m | kgf·m | cN·m | kgf·cm |
| 11 | 5 | 5 | 14.5 | ±30 | 4.0 | 0.41 | 0.20 | 0.020 | 5.0 | 0.51 |
| | 21 | | | | 2.9 | 0.29 | 0.60 | 0.061 | 1.3 | 0.13 |
| | 37 | | | | 1.6 | 0.17 | | 0.062 | 0.90 | 0.092 |
| | 45 | | | | 1.4 | 0.15 | 0.64 | 0.066 | 0.80 | 0.082 |
| 14 | 5 | 4 | 11.6 | ±20 | 8.6 | 0.88 | 0.43 | 0.044 | 9.8 | 1.0 |
| | 11 | | | | 8.0 | 0.82 | 0.90 | 0.092 | 4.9 | 0.50 |
| | 15 | | | | 7.4 | 0.75 | 1.1 | 0.11 | 2.9 | 0.30 |
| | 21 | | | | 5.2 | 0.53 | | 0.12 | | |
| | 33 | | | | 3.3 | 0.34 | | | 2.0 | 0.20 |
| | 45 | | | | 2.4 | 0.25 | | | | |
| 20 | 5 | 4 | 11.6 | ±15 | 19 | 1.9 | 0.93 | 0.095 | 28 | 2.9 |
| | 11 | | | | 15 | 1.6 | 1.7 | 0.17 | 15 | 1.5 |
| | 15 | | | | 12 | 1.2 | 1.8 | 0.18 | 11 | 1.1 |
| | 21 | | | | 9.3 | 0.95 | 2.0 | 0.20 | 8.8 | 0.90 |
| | 33 | | | | 6.4 | 0.65 | 2.1 | 0.22 | 5.9 | 0.60 |
| | 45 | | | | 4.7 | 0.48 | | | 4.9 | 0.50 |
| 32 | 5 | 4 | 11.6 | ±15 | 33 | 3.4 | 1.7 | 0.17 | 73 | 7.4 |
| | 11 | | | | 27 | 2.7 | 2.9 | 0.30 | 38 | 3.9 |
| | 15 | | | | 25 | 2.5 | 3.7 | 0.38 | 29 | 3.0 |
| | 21 | | | | 22 | 2.3 | 4.7 | 0.48 | 24 | 2.4 |
| | 33 | | | | 15 | 1.5 | 4.8 | 0.49 | 14 | 1.4 |
| | 45 | | | | 11 | 1.2 | 5.1 | 0.52 | 13 | 1.3 |
| 50 | 5 | 3 | 8.7 | ±15 | 80 | 8.2 | 4.0 | 0.41 | 130 | 13 |
| | 11 | | | | 45 | 4.6 | 5.0 | 0.51 | 60 | 6.1 |
| | 15 | | | | 40 | 4.1 | 6.0 | 0.61 | 47 | 4.8 |
| | 21 | | | | 36 | 3.7 | 7.6 | 0.78 | 40 | 4.1 |
| | 33 | | | | 24 | 2.4 | 7.8 | 0.80 | 24 | 2.5 |
| | 45 | | | | 20 | 2.0 | 8.9 | 0.91 | 20 | 2.0 |
| 65 | 4 | 3 | 8.7 | ±15 | 288 | 29 | 12 | 1.2 | 420 | 43 |
| | 5 | | | | 240 | 24 | | | 360 | 37 |
| | 12 | | | | 125 | 13 | 15 | 1.5 | 190 | 19 |
| | 15 | | | | 110 | 11 | 17 | 1.7 | 160 | 16 |
| | 20 | | | | 95 | 10 | 19 | 1.9 | 130 | 13 |
| | 25 | | | | 84 | 8.6 | 21 | 2.1 | 110 | 11 |

(Note) 1. Angle transmission precision indicates the difference between (1) logical rotating angle and (2) actual rotating angle of output when any rotating angle is given as an input. The values in the table are maximum values.

Fig. 017-1

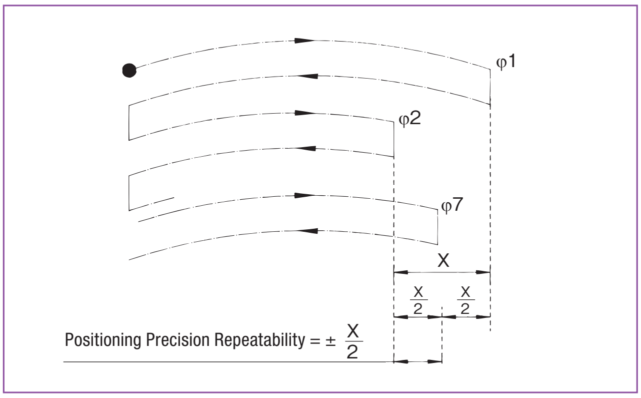



$\theta er$ : Angle transmission precision
$\theta_1$ : Input rotating angle
$\theta_2$ : Actual output rotating angle
R : Reduction ratio of HPG series

$$\theta er = \theta_2 - \frac{\theta_1}{R}$$

2. The repeatability is determined by repeating positioning in a given position from the same direction seven times, by measuring stop positions of the output shaft and by calculating the maximum difference. Measured values are indicated in angles (degrees) and are prefixed with "±" to 1/2 of the maximum differences. The values in the table are maximum values.

Fig. 017-2




3. Starting torque means the momentary "starting torque" with which the output side starts rotation when a torque is applied on the input side. The values in the table are maximum values.

Table 017-2

| Load | No load |
|---|---|
| HPGP speed reducer surface temperature | 25°C |

4. Overdrive starting torque means the momentary "starting torque" with which the input side starts rotation when a torque is applied on the output side. The values in the table are maximum values.

Table 017-3

| Load | No load |
|---|---|
| HPGP speed reducer surface temperature | 25°C |

5. No-load running torque means the torque on the input side required to put the speed reducer under a no-load condition. The values in the table are average values.

Table 017-4

| Input speed | 3000 r/min |
|---|---|
| Load | No load |
| HPGP speed reducer surface temperature | 25°C |

# Torque - Torsion Characteristic (HPGP Series)

## ■Gear Head Type Standard Item

Table 018-1

| Model | Reduction Ratio | Backlash | | Torsional quantity on one side at $T_R$ x 0.15 D | | Torsional rigidity A/B | |
|---|---|---|---|---|---|---|---|
| | | arc-min | $\times10^{-4}$rad | arc-min | $\times10^{-4}$rad | kgf·m/arc-min | ×100N·m/rad |
| 11 | 5 | 3.0 | 8.7 | 2.5 | 7.3 | 0.065 | 22 |
| | 21 | | | 3.0 | 8.7 | | |
| | 37 | | | | | | |
| | 45 | | | | | | |
| 14 | 5 | 3.0 | 8.7 | 2.2 | 6.4 | 0.14 | 47 |
| | 11 | | | 2.7 | 7.9 | | |
| | 15 | | | | | | |
| | 21 | | | | | | |
| | 33 | | | | | | |
| | 45 | | | | | | |
| 20 | 5 | 3.0 | 8.7 | 1.5 | 4.4 | 0.55 | 180 |
| | 11 | | | 2.0 | 5.8 | | |
| | 15 | | | | | | |
| | 21 | | | | | | |
| | 33 | | | | | | |
| | 45 | | | | | | |
| 32 | 5 | 3.0 | 8.7 | 1.3 | 3.8 | 2.2 | 740 |
| | 11 | | | 1.7 | 4.9 | | |
| | 15 | | | | | | |
| | 21 | | | | | | |
| | 33 | | | | | | |
| | 45 | | | | | | |
| 50 | 5 | 3.0 | 8.7 | 1.3 | 3.8 | 14 | 4700 |
| | 11 | | | 1.7 | 4.9 | | |
| | 15 | | | | | | |
| | 21 | | | | | | |
| | 33 | | | | | | |
| | 45 | | | | | | |
| 65 | 4 | 3.0 | 8.7 | 1.3 | 3.8 | 38 | 13000 |
| | 5 | | | | | | |
| | 12 | | | 1.7 | 4.9 | | |
| | 15 | | | | | | |
| | 20 | | | | | | |
| | 25 | | | | | | |

## ■Gear Head Type BL1 Specification (backlash of 1 min. or less)

Table 018-2

| Model | Reduction Ratio | Backlash | | Torsional quantity on one side at $T_R$ x 0.15 D | | Torsional rigidity A/B | |
|---|---|---|---|---|---|---|---|
| | | arc-min | $\times10^{-4}$rad | arc-min | $\times10^{-4}$rad | kgf·m/arc-min | ×100N·m/rad |
| 14 | 5 | 1.0 | 2.9 | 1.1 | 3.2 | 0.14 | 47 |
| | 11 | | | 1.7 | 4.9 | | |
| | 15 | | | | | | |
| | 21 | | | | | | |
| | 33 | | | | | | |
| | 45 | | | | | | |
| 20 | 5 | 1.0 | 2.9 | 0.6 | 1.7 | 0.55 | 180 |
| | 11 | | | 1.1 | 3.2 | | |
| | 15 | | | | | | |
| | 21 | | | | | | |
| | 33 | | | | | | |
| | 45 | | | | | | |
| 32 | 5 | 1.0 | 2.9 | 0.5 | 1.5 | 2.2 | 740 |
| | 11 | | | 1.0 | 2.9 | | |
| | 15 | | | | | | |
| | 21 | | | | | | |
| | 33 | | | | | | |
| | 45 | | | | | | |
| 50 | 5 | 1.0 | 2.9 | 0.5 | 1.5 | 14 | 4700 |
| | 11 | | | 1.0 | 2.9 | | |
| | 15 | | | | | | |
| | 21 | | | | | | |
| | 33 | | | | | | |
| | 45 | | | | | | |
| 65 | 4 | 1.0 | 2.9 | 0.5 | 1.5 | 38 | 13000 |
| | 5 | | | | | | |
| | 12 | | | 1.0 | 2.9 | | |
| | 15 | | | | | | |
| | 20 | | | | | | |
| | 25 | | | | | | |

## ■Torsional rigidity (windup curve)

Anchoring the speed reducer input and casing and applying a torque to the output part will generate torsion in the output part in accordance with the applied torque. Change the torque slowly in the order of: (1) Forward output torque, (2) Zero, (3) Reverse output torque, (4) Zero and (5) Forward output torque. A loop of (1) → (2) → (3) → (4) → (5) (return to (1)) will be drawn in Fig. 018-1.

The inclination in the region from "0.15 x output torque" to "Output torque" is small. The torsional rigidity of the HPGP series is an average value of this inclination.

The inclination in the region from "zero torque" to "0.15 x output torque" is large. This is caused by uneven distribution such as fine uneven contact of the engaging parts and load of the planet gears under a light load.

## ■Calculation of total torsional quantity (Windup)

The method to calculate the total torsional quantity (average value) on one side when the speed reducer applies a load in a no-load state.

Formula 018-1

● Calculation formula

$$\theta = D + \frac{T - T_L}{\frac{A}{B}}$$

Symbols in calculation formula

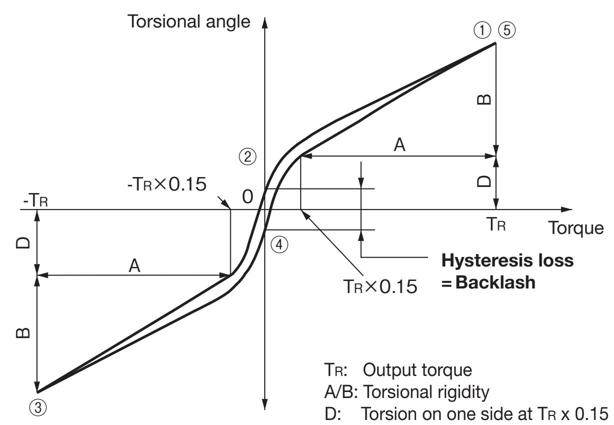
| | | |
|---|---|---|
| $\theta$ | Total torsional quantity | —— |
| D | Torsional quantity on one side at output torque x 0.15 torque | See Fig. 018-1, Table 018-1, Table 018-2 |
| T | Load torque | —— |
| $T_L$ | Output torque x 0.15 torque (= $T_R$ x 0.15) | See Fig. 018-1 Table 018-1 to 2 |
| A / B | Torsional rigidity | |

## ■Backlash (Hysteresis loss)

The zero-torque width (2) - (4) in Fig. 018-1 "Torque-torsional angle diagram" is called a hysteresis loss. The hysteresis loss between "Forward output torque" and "Reverse output torque" is defined as backlash of the HPGP series. At the time of pre-shipment factory inspection, the backlash of the HPGP series is less than 3 minutes (1 minute or less for customized products).

Fig. 018-1

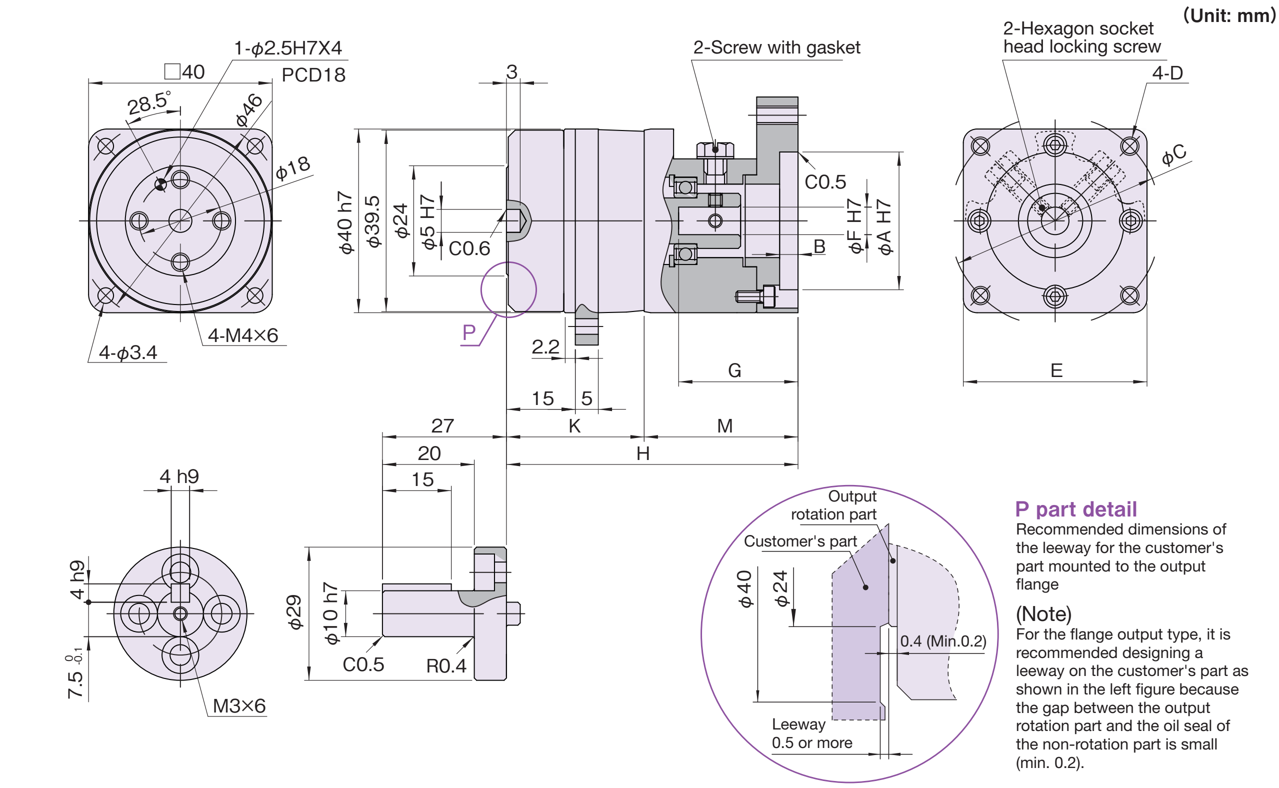
**Torque-torsional angle diagram**



# Dimensional Outline Drawing – Model No. 11 (HPGP Series)

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.

Fig. 019-1




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles). Contact us for the differential range of the size that is not described.

# Measurement Table

Table 019-1

Unit: mm

| | Shape symbol [*1] | A(H7) | B | C | D | E | F(H7) Min | F(H7) Max | G | H | K | M | Mass (kg) [*2] Shaft output | Mass (kg) [*2] Flange output |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Single-stage speed reduction type (Reduction ratio = 5) | AA□ | 28 | 3 | 33 | M2.5×5 | φ40 | 5 | 8 | 19.5 | 45.5 | 21 | 24.5 | 0.25 | 0.21 |
| | AB□ | 20 | | 28 | φ3.4 Through | □25 | | | 23.5 | 49.5 | | 28.5 | 0.26 | 0.22 |
| | AC□ | 22 | | 43.8 | | □40 | | | | | | | 0.27 | 0.23 |
| | AD□ | 30 | 4 | 46 | M4×9 | | | | 28 | 54.5 | | 33.5 | 0.29 | 0.25 |
| | AE□ | | | 45 | M3×9 | | | | | | | | | |
| | AN□ | 34 | | 48 | | | | | | | | | | |
| | AF□ | 50 | | 70 | M4×9 | □60 | | | | | | | 0.34 | 0.30 |
| | AG□ | | | | M5×9 | | | | | | | | | |
| | AH□ | | | 60 | M4×9 | | | | | | | | | |
| Dual-stage speed reduction type (Reduction ratio = 21, 37, 45) | AA□ | 28 | 3 | 33 | M2.5×5 | φ40 | 5 | 8 | 16.5 | 54.5 | 30 | 24.5 | 0.31 | 0.27 |
| | AB□ | 20 | | 28 | φ3.4 Through | □25 | | | 20.5 | 58.5 | | 28.5 | 0.32 | 0.28 |
| | AC□ | 22 | | 43.8 | | □40 | | | | | | | 0.33 | 0.29 |
| | AD□ | 30 | 4 | 46 | M4×9 | | | | 25.5 | 63.5 | | 33.5 | 0.35 | 0.31 |
| | AE□ | | | 45 | M3×9 | | | | | | | | | |
| | AN□ | 34 | | 48 | | | | | | | | | | |
| | AF□ | 50 | | 70 | M4×9 | □60 | | | | | | | 0.40 | 0.36 |
| | AG□ | | | | M5×9 | | | | | | | | | |
| | AH□ | | | 60 | M4×9 | | | | | | | | | |

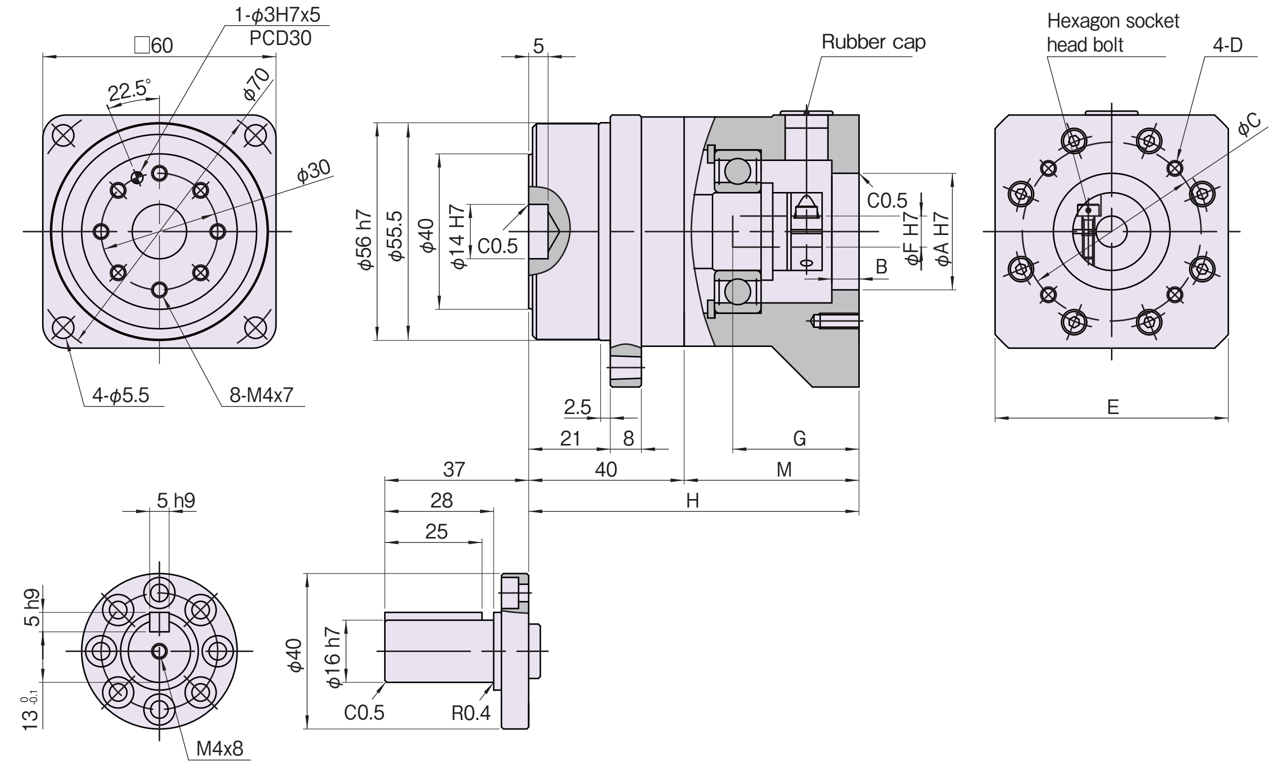
Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on speed reducers only and on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. The mass varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

# Dimensional Outline Drawing – Model No. 14 (HPGP Series)

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.

Fig. 020-1

(Unit: mm)




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# Measurement Table

Table 020-1
Unit: mm

| Shape symbol [*1] | A(H7) | B | C | D | E | F(H7) | | G | H | M | Mass (kg) [*2] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Reduction ratio=5 | | Reduction ratio=11,15,21,33,45 | |
| | | | | | | Min | Max | | | | Shaft output | Flange output | Shaft output | Flange output |
| AA□ | 30 | 7 | 45 | M3×8 | □60 | 6 | 8 | 32 | 85 | 45 | 1.01 | 0.89 | 1.07 | 0.95 |
| AB□ | | | 46 | M4×10 | | | | | | | | | | |
| AF□ | 34 | | 48 | M3×8 | | | | | | | | | | |
| AC□ | 50 | 6.5 | 70 | M5×12 | | | | | | | | | | |
| AD□ | | | | M4×10 | | | | | | | | | | |
| AE□ | | | 60 | | | | | | | | | | | |
| AX□ | | | 70 | | | 9 | 14 | | | | 1.06 | 0.94 | 1.12 | 1.00 |
| AY□ | | | 60 | | | | | | | | | | | |
| AZ□ | | | 70 | M5×12 | | | | | | | | | | |
| 9E□ | 70 | 7 | 90 | M6×12 | □80 | 11 | | 33 | 86 | 46 | | | | |
| 9F□ | | | | M5×12 | | | | | | | | | | |

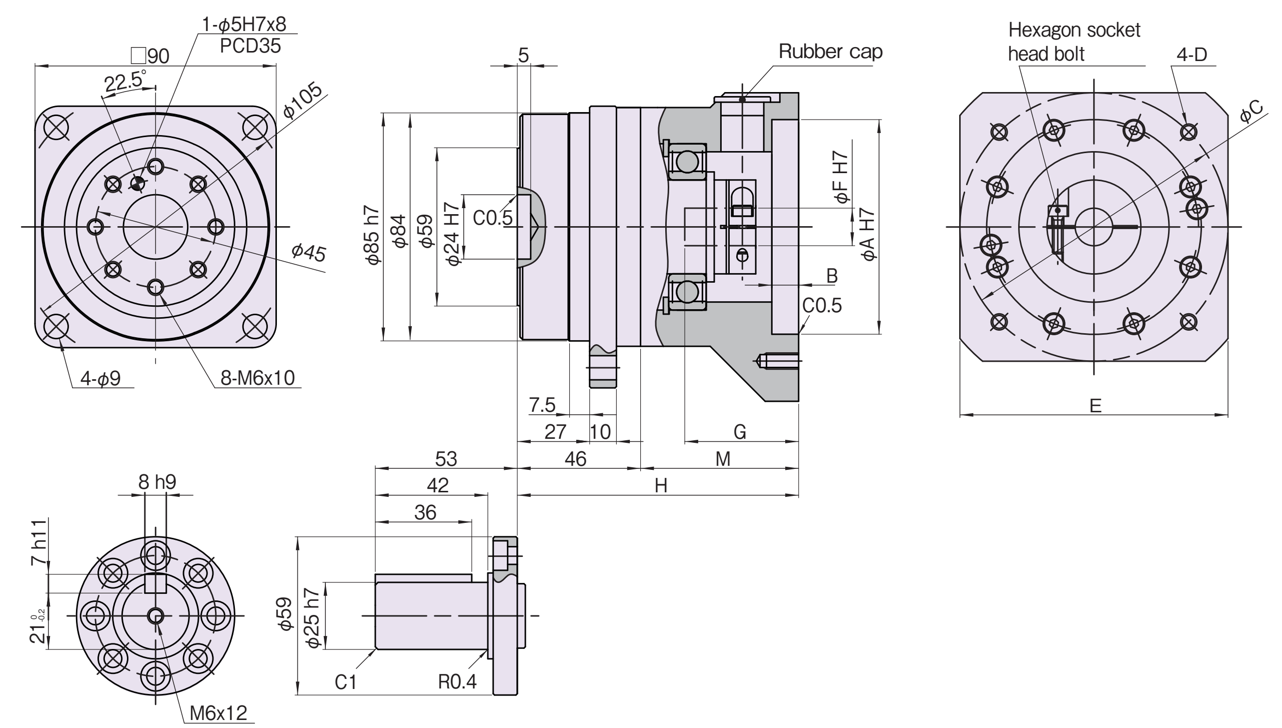
Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on speed reducers only and on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. The weight varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

# Dimensional Outline Drawing – Model No. 20 (HPGP Series)

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.

Fig. 021-1

(Unit: mm)




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

## Measurement Table

Table 021-1
Unit: mm

| Shape symbol[*1] | A(H7) | B | C | D | E | F(H7) | | G | H[*3] | M[*3] | Mass (kg)[*2] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Reduction ratio=5 | | Reduction ratio=11,15,21,45 | | Reduction ratio=33 | |
| | | | | | | Min | Max | | | | Shaft output | Flange output | Shaft output | Flange output | Shaft output | Flange output |
| PGC□ | 50 | 10 | 70 | M5×12 | φ89 | 7 | 19 | 35 | 98 (103) | 52 (57) | 2.7 | 2.3 | 3.0 | 2.6 | 3.1 | 2.7 |
| PGD□ | | | | M4×10 | | | | | | | | | | | | |
| PGE□ | | | 60 | M4×8 | | | | | | | | | | | | |
| PFF□ | 70 | 7 | 90 | M5×12 | □80 | | | 42 | 105 (110) | 59 (64) | 2.9 | 2.5 | 3.2 | 2.8 | 3.3 | 2.9 |
| PFE□□ | | | | M6×12 | | | | | | | | | | | | |
| PHC□□ | 80 | 10 | 100 | M6×12 | □100 | | | | | | | | | | | |
| PHD□ | 95 | 6 | 115 | M8×16 | | | | | | | | | | | | |
| PJA□□ | 30 | 5 | 45 | M3×8 | φ55 | 6 | 8 | 30.5 | 93.5 (98.5) | 47.5 (52.5) | – | – | 2.5 | 2.1 | 2.6 | 2.2 |
| PJB□□ | | | 46 | M4×10 | | | | | | | – | – | | | | |

Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on speed reducers only and on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. The weight varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.
3. The parenthesized value indicates the value for reduction ratio = 33.

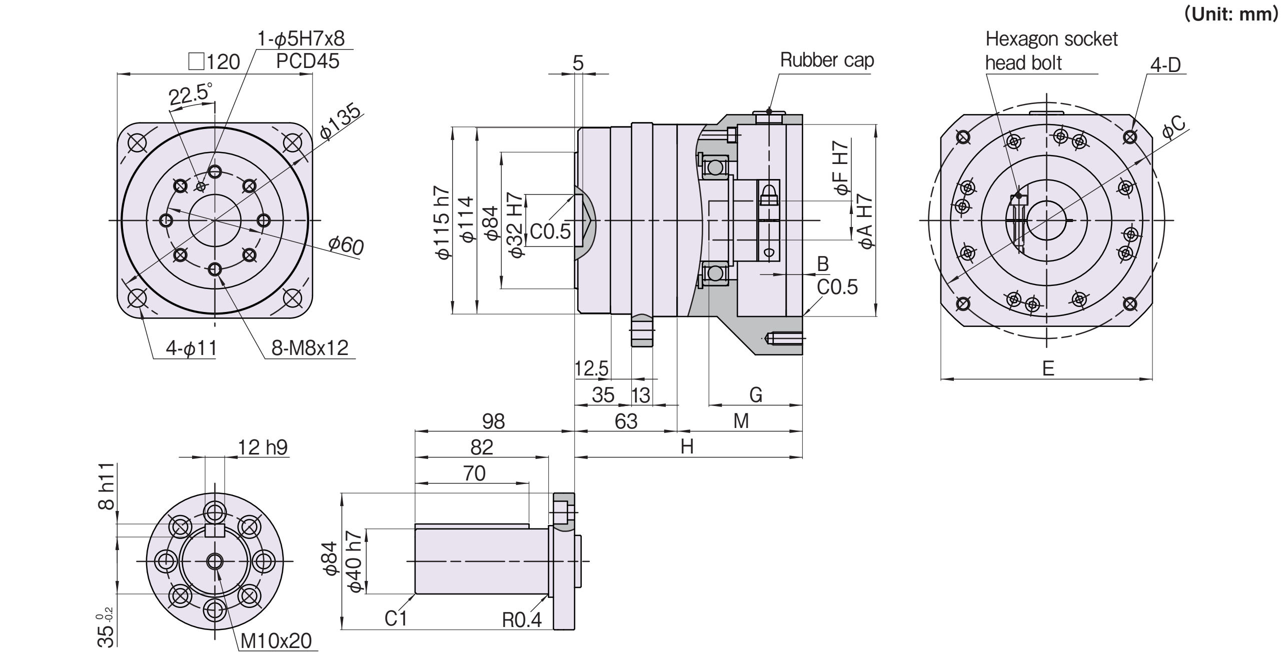
HPGP series HarmonicPlanetary® High-performance Gear Heads for Servo Motors series
HPG Series (Helical Gear Type) HarmonicPlanetary® High-performance Gear Heads for Servo Motors series
HPG Series (Standard Type) HarmonicPlanetary® High-performance Gear Heads for Servo Motors series
CSG-GH series HarmonicDrive® High-performance Gear Heads for Servo Motors series
CSF-GH series HarmonicDrive® High-performance Gear Heads for Servo Motors series
HPG series (Orthogonal Shaft Type) HarmonicPlanetary® High-performance Gear Heads for Servo Motors series

# Dimensional Outline Drawing – Model No. 32 (HPGP Series)

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.

Fig. 022-1

(Unit: mm)




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# Measurement Table

Table 022-1
Unit: mm

| Shape symbol[*1] | A(H7) | B | C | D | E | F(H7) | | G | H[*4] | M[*4] | Mass (kg)[*3] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Reduction ratio=5 | | Reduction ratio=11,15,21,45 | | Reduction ratio=33 | |
| | | | | | | Min | Max | | | | Shaft output | Flange output | Shaft output | Flange output | Shaft output | Flange output |
| PNA□ | 70 | 7 | 90 | M5×12 | φ122 | 10 | 24 | 56 | 139 (144) | 76 (81) | 7.4 | 6.0 | 8.0 | 6.6 | 8.3 | 6.9 |
| PNB□□ | 80 | | 100 | M6×12 | | | | | | | | | | | | |
| PNC□ | 70 | | 90 | | | | | | | | | | | | | |
| PND□□ | 50 | 10 | 70 | M5×12 | | | | 38 | | | – | – | 7.7 | 6.3 | 8.0 | 6.6 |
| PNE□□ | | | | M4×10 | | | | | | | – | – | | | | |
| PNF□ | 95 | 6 | 115 | M8×10 | φ135 | | | 62 | 145 (150) | 82 (87) | 7.5 | 6.1 | 8.1 | 6.7 | 8.4 | 7.0 |
| PNG□□ | 70 | 4 | 90 | M6×12 | φ122 | | | 38 | 139 (144) | 76 (81) | 7.4 | 6.0 | 8.0 | 6.6 | 8.3 | 6.9 |
| PNJ□ | 95 | 6 | 115 | M6×10 | φ135 | | | 62 | 145 (150) | 82 (87) | 7.5 | 6.1 | 8.1 | 6.7 | 8.4 | 7.0 |
| PMC□ | 110 | 10 | 145 | M8×18 | □130 | 16 | 35[*2] | 59 | 142 (147) | 79 (84) | 7.4 | 6.0 | 8.0 | 6.6 | 8.3 | 6.9 |
| PPA□ | | 6.5 | | M8×25 | | | | 81 | 164 (169) | 101 (106) | 8.0 | 6.6 | 8.6 | 7.2 | 9.1 | 7.5 |
| PPB□□ | 114.3 | | 200 | M12×25 | □180 | | | | | | 9.0 | 7.6 | 9.6 | 8.2 | 9.9 | 8.5 |
| PQP□□ | | | | | | | | | | | 14.6 | 13.2 | – | – | – | – |
| PPC□□ | 200 | | 235 | | □220 | | | | | | 9.1 | 7.7 | 9.7 | 8.3 | 10.0 | 8.6 |

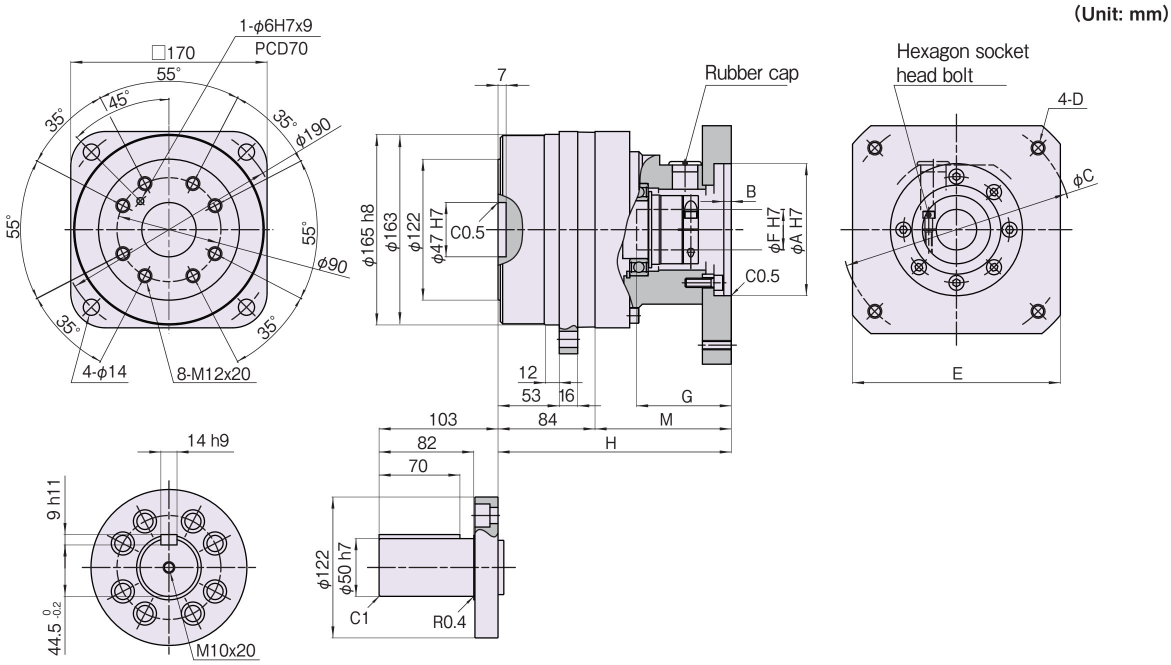
Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on speed reducers only and on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. Note that only diameter φ35 has H7 tolerance and plus tolerance.
3. The weight varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.
4. The parenthesized value indicates the value for reduction ratio = 33.

# Dimensional Outline Drawing – Model No. 50 (HPGP Series)

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.

Fig. 023-1

(Unit: mm)




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
  Contact us for the differential range of the size that is not described.

# Measurement Table

Table 023-1
Unit: mm

| Shape symbol[1] | A(H7) | B | C | D | E | F(H7) Min | F(H7) Max | G | H | M | Mass (kg)[3] Reduction ratio=5 Shaft output | Reduction ratio=5 Flange output | Reduction ratio=11,15,21,33,45 Shaft output | Reduction ratio=11,15,21,33,45 Flange output |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AA□□ | 110 | 10 | 145 | M8×16 | ϕ170 | 19 | 35[2] | 55.5 | 176 | 92 | 17.6 | 14.6 | 19.0 | 16.0 |
| AD□□ | 95 | | 115 | M8×10 | | | | | | | | | | |
| AE□□ | 80 | | 100 | M6×10 | | | | | | | | | | |
| AF□□ | 95 | | 115 | | | | | | | | | | | |
| BA□□ | 110 | 6.5 | 145 | M8×25 | □130 | | | 81 | 202 | 118 | 17.7 | 14.7 | 19.1 | 16.1 |
| BB□□ | 114.3 | | 200 | M12×25 | □180 | | 42 | | | | 18.6 | 15.6 | 20.1 | 17.1 |
| EP□□ | | | | | | | | | | | 25.9 | 22.9 | 27.4 | 24.4 |
| BC□□ | 200 | | 235 | | □220 | | 35[2] | | | | 18.7 | 15.7 | 20.2 | 17.2 |
| EQ□□ | | | | | | | | | | | 26.0 | 23.0 | 27.5 | 24.5 |
| BF□□ | 130 | | 165 | M10×25 | □180 | | | | | | 18.6 | 15.6 | 20.1 | 17.1 |
| CB□□ | 114.3 | | 200 | M12×25 | | | 42 | 114 | 243.5 | 159.5 | — | — | 20.4 | 17.4 |

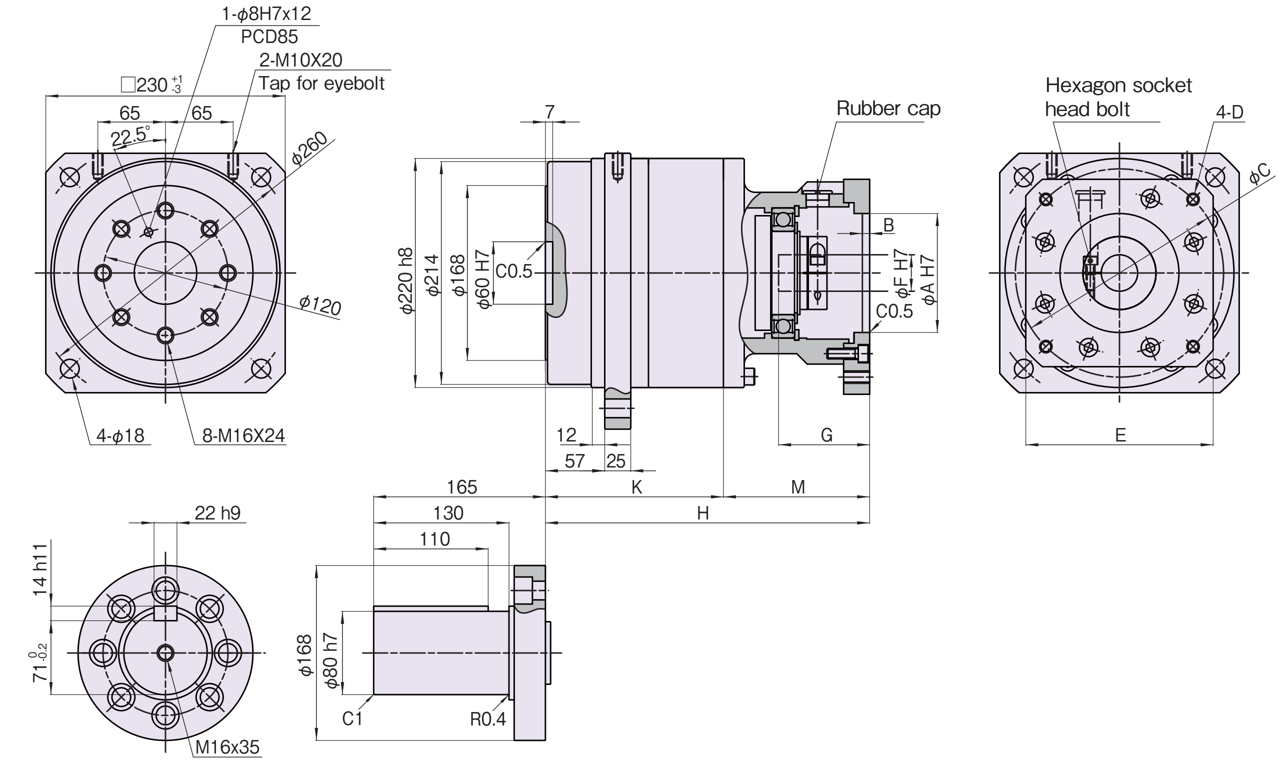
Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on speed reducers only and on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. Note that only diameter ϕ35 has H7 tolerance and plus tolerance.
3. The weight varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

# Dimensional Outline Drawing – Model No. 65 (HPGP Series)

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.

Fig. 024-1

(Unit: mm)




* While the flange output is for standard, the shaft output is for special specification.
* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles). Contact us for the differential range of the size that is not described.

# Measurement Table

Table 024-1
Unit: mm

| | Shape symbol*1 | A(H7) | B | C | D | E | F(H7) | | G | H | K | M | Mass (kg)*3 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Min | Max | | | | | Shaft output | Flange output |
| Single-stage speed reduction type (Reduction ratio = 4, 5) | CB□□ | 114.3 | 10 | 200 | M12×25 | □180 | 35*2 | 55 | 113 | 241.5 | 91 | 150.5 | 48 | 38 |
| | CG□□ | 180 | | 215 | | □220 | | | | | | | | |
| | CC□□ | 200 | | 235 | | | | | | | | | | |
| | CJ□□ | 230 | | 265 | | □250 | | | | | | | | |
| Dual-stage speed reduction type (Reduction ratio = 12, 15, 20, 25) | CB□□ | 114.3 | 10 | 200 | M12×25 | □180 | 35*2 | 55 | 113 | 311.5 | 161 | 150.5 | 52 | 42 |
| | CG□□ | 180 | | 215 | | □220 | | | | | | | | |
| | CC□□ | 200 | | 235 | | | | | | | | | | |
| | BB□□ | 114.3 | 6.5 | 200 | M12×25 | □180 | 19 | 35*2 | 84 | 288 | 170 | 118 | | |
| | BC□□ | 200 | | 235 | | □220 | | | | | | | | |
| | BF□□ | 130 | | 165 | M10×25 | □180 | | | | | | | | |
| | BA□□ | 110 | | 145 | M8×25 | □130 | | | | | | | | |

Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on speed reducers only and on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. Note that only diameter ϕ35 has H7 tolerance and plus tolerance.
3. The weight varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

■MEMO

# Rating Table (HPG Series Helical Gear Type)

For selecting the model number, refer to the rating table.

Table 026-1

| Model | Reduction ratio | Rated output torque *1 | | Permissible max. value of ave. load torque *2 | | Permissible peak torque at start/stop *3 | | Permissible max. momentary torque *4 | | Permissible ave. input rotational speed *5 | Permissible max. input rotational speed *6 | Inertia moment (equiv. value on input side) *7 | | Mass *8 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Shaft output | Flange output | Shaft output | Flange output |
| | | N·m | kgf·m | N·m | kgf·m | N·m | kgf·m | N·m | kgf·m | r/min | r/min | $\times10^{-4}$kg·m$^2$ | $\times10^{-4}$kg·m$^2$ | kg | kg |
| 11 | 4 | 2.8 | 0.3 | 6.3 | 0.64 | 10 | 1.0 | 20 | 2.0 | 3000 | 10000 | 0.011 | 0.0084 | 0.24 | 0.19 |
| | 5 | 2.9 | 0.3 | 6.5 | 0.67 | 10 | 1.0 | | | | | 0.0069 | 0.0053 | | |
| | 6 | 2.9 | 0.3 | 6.5 | 0.67 | 10 | 1.0 | | | | | 0.0047 | 0.0036 | | |
| | 7 | 3.1 | 0.3 | 7.0 | 0.71 | 9.0 | 0.9 | | | | | 0.0035 | 0.0027 | | |
| | 8 | 3.1 | 0.3 | 7.0 | 0.71 | 7.0 | 0.7 | | | | | 0.0026 | 0.002 | | |
| | 9 | 3.1 | 0.3 | 6.0 | 0.61 | 6.0 | 0.6 | | | | | 0.0021 | 0.0016 | | |
| | 10 | 3.4 | 0.3 | 5.0 | 0.51 | 5.0 | 0.5 | | | | | 0.0017 | 0.0013 | | |
| 14 | 3 | 4.0 | 0.4 | 9.0 | 0.92 | 20 | 2.0 | 37 | 3.8 | 3000 | 5000 | 0.089 | 0.072 | 0.55 | 0.45 |
| | 4 | 7.0 | 0.7 | 16 | 1.6 | 30 | 3.1 | 56 | 5.7 | | 6000 | 0.047 | 0.037 | | |
| | 5 | 7.2 | 0.7 | 16 | 1.6 | 30 | 3.1 | | | | | 0.03 | 0.023 | | |
| | 6 | 7.3 | 0.7 | 16 | 1.6 | 30 | 3.1 | | | | | 0.028 | 0.024 | | |
| | 7 | 7.8 | 0.8 | 18 | 1.8 | 26 | 2.7 | | | | | 0.021 | 0.018 | | |
| | 8 | 7.8 | 0.8 | 18 | 1.8 | 20 | 2.0 | | | | | 0.016 | 0.014 | | |
| | 9 | 7.9 | 0.8 | 17 | 1.7 | 17 | 1.7 | | | | | 0.013 | 0.011 | | |
| | 10 | 8.5 | 0.9 | 15 | 1.5 | 15 | 1.5 | | | | | 0.01 | 0.0087 | | |
| 20 | 3 | 11 | 1.1 | 25 | 2.6 | 90 | 9.2 | 124 | 13 | 3000 | 4000 | 0.64 | 0.53 | 1.7 | 1.3 |
| | 4 | 23 | 2.3 | 51 | 5.2 | 133 | 14 | 217 | 22 | | 6000 | 0.36 | 0.3 | | |
| | 5 | 23 | 2.4 | 53 | 5.4 | 133 | 14 | | | | | 0.23 | 0.19 | | |
| | 6 | 23 | 2.4 | 53 | 5.4 | 126 | 13 | | | | | 0.15 | 0.13 | | |
| | 7 | 25 | 2.5 | 56 | 5.7 | 108 | 11 | | | | | 0.11 | 0.093 | | |
| | 8 | 25 | 2.5 | 56 | 5.7 | 84 | 8.6 | | | | | 0.085 | 0.07 | | |
| | 9 | 25 | 2.6 | 57 | 5.8 | 73 | 7.4 | | | | | 0.067 | 0.055 | | |
| | 10 | 27 | 2.8 | 61 | 6.2 | 65 | 6.6 | | | | | 0.055 | 0.046 | | |
| 32 | 3 | 50 | 5.1 | 110 | 11 | 290 | 30 | 507 | 52 | 3000 | 3600 | 3.5 | 2.8 | 4.5 | 3.1 |
| | 4 | 77 | 7.9 | 170 | 17 | 400 | 41 | 650 | 66 | | 6000 | 1.7 | 1.3 | | |
| | 5 | 80 | 8.2 | 180 | 18 | 400 | 41 | | | | | 1.1 | 0.79 | | |
| | 6 | 80 | 8.2 | 180 | 18 | 390 | 40 | | | | | 0.73 | 0.55 | | |
| | 7 | 85 | 8.7 | 190 | 19 | 330 | 34 | | | | | 0.55 | 0.41 | | |
| | 8 | 85 | 8.7 | 190 | 19 | 260 | 27 | | | | | 0.43 | 0.33 | | |
| | 9 | 86 | 8.8 | 190 | 19 | 220 | 22 | | | | | 0.34 | 0.26 | | |
| | 10 | 92 | 9.4 | 200 | 20 | 200 | 20 | | | | | 0.28 | 0.22 | | |

(Note)
1. Output torque set based on the life of $L_{10}$ = 20000 hours when input rotational speed is 3000 r/min, which is the rated rotational speed of ordinary servo motors. Models 50 and 65 are set at 2000 r/min as the rated rotational speed and at $L_{10}$ = 20000 hours as the life for the servo motor to be combined.
2. Permissible maximum value of average load torque calculated based on a load torque pattern (page 014). A life of 2000 hours or more is a criterion when operated at an input speed of 2000 r/min.
3. Permissible maximum value of torque applied on start and stop in operation cycles.
4. Permissible maximum value for impact torque in an emergency stop and for external impact torque. Operation exceeding these ranges may cause damages to reducers.
5. Permissible maximum value of average input rotational speed during operations. Make it a point to operate below this value especially when the operation mode is near continuous operation.
6. Permissible maximum input rotational speed in operation modes other than continuous operation.
7. The value for a speed reducer itself. Values that include the input shaft coupling are shown in the model selection tool on the web page. (URL:https://hds-tech.jp/)
8. The weight of a speed reducer itself. See measurement tables for values that include an input shaft coupling, motor flange and other parts.

# Performance Table (HPG Series Helical Gear Type)

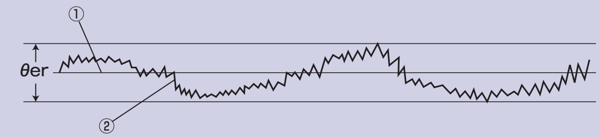
The values in the table are for the HPG reducer alone.
The input side shape may vary depending on the size of the mounted motor. For the input shaft coupling and motor flange values, please contact us.

Table 027-1

| Model | Reduction ratio | Angle transmission precision *1 | | Repeatability *2 | Starting torque *3 | | Overdrive starting torque *4 | | No-load running torque *5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | arc-min | $\times10^{-4}$rad | arc-sec | cN·m | kgf·cm | N·m | kgf·m | cN·m | kgf·cm |
| 11 | 4 | 5 | 14.5 | ±20 | 4.7 | 0.48 | 0.19 | 0.019 | 6.8 | 0.69 |
| | 5 | | | | 4.1 | 0.42 | 0.21 | 0.021 | 5.4 | 0.55 |
| | 6 | | | | 3.6 | 0.37 | 0.22 | 0.022 | 4.5 | 0.46 |
| | 7 | | | | 3.3 | 0.34 | 0.23 | 0.024 | 3.9 | 0.4 |
| | 8 | | | | 3 | 0.31 | 0.24 | 0.024 | 3.4 | 0.35 |
| | 9 | | | | 2.8 | 0.29 | 0.25 | 0.026 | 3 | 0.31 |
| | 10 | | | | 2.6 | 0.27 | 0.26 | 0.027 | 2.7 | 0.28 |
| 14 | 3 | 4 | 11.6 | ±15 | 13 | 1.3 | 0.38 | 0.039 | 22 | 2.2 |
| | 4 | | | | 11 | 1.1 | 0.45 | 0.046 | 17 | 1.7 |
| | 5 | | | | 10 | 1 | 0.51 | 0.052 | 13 | 1.3 |
| | 6 | | | | 9.5 | 1 | 0.57 | 0.058 | 11 | 1.1 |
| | 7 | | | | 9 | 0.92 | 0.63 | 0.064 | 9.4 | 1 |
| | 8 | | | | 8.5 | 0.87 | 0.68 | 0.069 | 8.3 | 0.85 |
| | 9 | | | | 8.1 | 0.83 | 0.73 | 0.074 | 7.3 | 0.74 |
| | 10 | | | | 7.8 | 0.8 | 0.78 | 0.08 | 6.6 | 0.67 |
| 20 | 3 | 4 | 11.6 | ±10 | 31 | 3.2 | 0.93 | 0.095 | 50 | 5.1 |
| | 4 | | | | 25 | 2.6 | 1 | 0.1 | 38 | 3.9 |
| | 5 | | | | 22 | 2.2 | 1.1 | 0.11 | 30 | 3.1 |
| | 6 | | | | 20 | 2 | 1.2 | 0.12 | 25 | 2.6 |
| | 7 | | | | 18 | 1.8 | 1.3 | 0.13 | 21 | 2.1 |
| | 8 | | | | 17 | 1.7 | 1.4 | 0.14 | 19 | 1.9 |
| | 9 | | | | 17 | 1.8 | 1.5 | 0.15 | 17 | 1.7 |
| | 10 | | | | 16 | 1.6 | 1.6 | 0.16 | 15 | 1.5 |
| 32 | 3 | 4 | 11.6 | ±10 | 56 | 5.7 | 1.7 | 0.17 | 135 | 14 |
| | 4 | | | | 52 | 5.3 | 2.1 | 0.21 | 101 | 10 |
| | 5 | | | | 49 | 5 | 2.5 | 0.26 | 81 | 8.3 |
| | 6 | | | | 47 | 4.8 | 2.8 | 0.29 | 68 | 6.9 |
| | 7 | | | | 45 | 4.6 | 3.2 | 0.33 | 58 | 5.9 |
| | 8 | | | | 44 | 4.5 | 3.5 | 0.36 | 51 | 5.2 |
| | 9 | | | | 43 | 4.4 | 3.9 | 0.4 | 45 | 4.6 |
| | 10 | | | | 42 | 4.3 | 4.2 | 0.43 | 41 | 4.2 |

(Note) 1. Angle transmission precision indicates the difference between (1) logical rotating angle and (2) actual rotating angle of output when any rotating angle is given as an input. The values in the table are maximum values.

Fig. 027-1

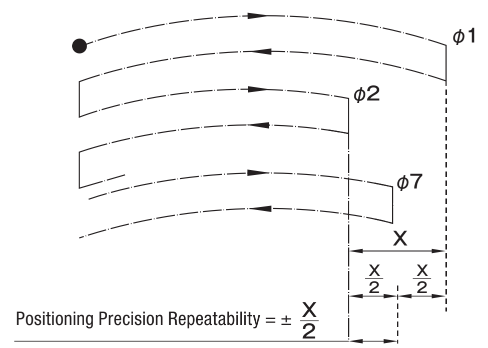



$\theta er$ : Angle transmission precision
$\theta_1$ : Input rotation angle
$\theta_2$ : Actual output rotation angle
R : Reduction ratio of HPG series

$$\theta er = \theta_2 - \frac{\theta_1}{R}$$

(Note) 2. The repeatability is determined by repeating positioning in a given position from the same direction seven times, by measuring stop positions of the output shaft and by calculating the maximum difference. Measured values are indicated in angles (degrees) and are prefixed with "±" to 1/2 of the maximum differences.The values in the table are maximum values.

Fig. 027-2




(Note) 3. Starting torque means the momentary "starting torque" with which the output side starts rotation when a torque is applied on the input side.The values in the table are maximum values.

Table 027-2

| Load | No load |
|---|---|
| HPG speed reducer surface temperature | 25°C |

(Note) 4. Overdrive starting torque means the momentary "starting torque" with which the input side starts rotation when a torque is applied on the output side.The values in the table are maximum values.

Table 027-3

| Load | No load |
|---|---|
| HPG speed reducer surface temperature | 25°C |

(Note) 5. No-load running torque means the torque on the input side required to put the speed reducer under a no-load condition.The values in the table are average values.

Table 027-4

| Input speed | 3000r/min |
|---|---|
| Load | No load |
| HPG speed reducer surface temperature | 25°C |

HPGP series HarmonicPlanetary High-performance Gear Heads for Servo Motors series
HPG Series (Helical Gear Type) HarmonicPlanetary High-performance Gear Heads for Servo Motors series
HPG Series (Standard Type) HarmonicPlanetary High-performance Gear Heads for Servo Motors series
CSG-GH series HarmonicDrive High-performance Gear Heads for Servo Motors series
CSF-GH series HarmonicDrive High-performance Gear Heads for Servo Motors series
HPG series (Orthogonal Shaft Type) HarmonicPlanetary High-performance Gear Heads for Servo Motors series

# Torque – Torsion Characteristic (HPG Series)

## ■Gear head type standard item

Table 028-1

| Model | Reduction ratio | Backlash arc-min | Backlash $\times10^{-4}$rad | Torsional quantity on one side at $T_R$ x 0.15 D arc-min | Torsional quantity on one side at $T_R$ x 0.15 D $\times10^{-4}$rad | Torsional rigidity A/B kgf·m/arc-min | Torsional rigidity A/B x100N·m/rad |
|---|---|---|---|---|---|---|---|
| 11 | 4 | 3.0 | 8.7 | 2.5 | 7.3 | 0.065 | 22.0 |
| | 5 | | | | | | |
| | 6 | | | | | | |
| | 7 | | | | | | |
| | 8 | | | | | | |
| | 9 | | | | | | |
| | 10 | | | | | | |
| 14 | 3 | 3.0 | 8.7 | 2.2 | 6.4 | 0.14 | 47.0 |
| | 4 | | | | | | |
| | 5 | | | | | | |
| | 6 | | | | | | |
| | 7 | | | | | | |
| | 8 | | | | | | |
| | 9 | | | | | | |
| | 10 | | | | | | |
| 20 | 3 | 3.0 | 8.7 | 1.5 | 4.4 | 0.55 | 180.0 |
| | 4 | | | | | | |
| | 5 | | | | | | |
| | 6 | | | | | | |
| | 7 | | | | | | |
| | 8 | | | | | | |
| | 9 | | | | | | |
| | 10 | | | | | | |
| 32 | 3 | 3.0 | 8.7 | 1.3 | 3.8 | 2.2 | 740.0 |
| | 4 | | | | | | |
| | 5 | | | | | | |
| | 6 | | | | | | |
| | 7 | | | | | | |
| | 8 | | | | | | |
| | 9 | | | | | | |
| | 10 | | | | | | |

## ■Gear head type BL1 specification (backlash of 1 min. or less)

Table 028-2

| Model | Reduction ratio | Backlash arc-min | Backlash $\times10^{-4}$rad | Torsional quantity on one side at $T_R$ x 0.15 D arc-min | Torsional quantity on one side at $T_R$ x 0.15 D $\times10^{-4}$rad | Torsional rigidity A/B kgf·m/arc-min | Torsional rigidity A/B x100N·m/rad |
|---|---|---|---|---|---|---|---|
| 14 | 3 | 1.0 | 2.9 | 1.1 | 3.2 | 0.14 | 47.0 |
| | 4 | | | | | | |
| | 5 | | | | | | |
| | 6 | | | | | | |
| | 7 | | | | | | |
| | 8 | | | | | | |
| | 9 | | | | | | |
| | 10 | | | | | | |
| 20 | 3 | 1.0 | 2.9 | 0.6 | 1.7 | 0.55 | 180.0 |
| | 4 | | | | | | |
| | 5 | | | | | | |
| | 6 | | | | | | |
| | 7 | | | | | | |
| | 8 | | | | | | |
| | 9 | | | | | | |
| | 10 | | | | | | |
| 32 | 3 | 1.0 | 2.9 | 0.5 | 1.5 | 2.2 | 740.0 |
| | 4 | | | | | | |
| | 5 | | | | | | |
| | 6 | | | | | | |
| | 7 | | | | | | |
| | 8 | | | | | | |
| | 9 | | | | | | |
| | 10 | | | | | | |

## ■Torsional rigidity (windup curve)

Anchoring the speed reducer input and casing and applying a torque to the output part will generate torsion in the output part in accordance with the applied torque. Change the torque slowly in the order of: (1) Forward output torque, (2) Zero, (3) Reverse output torque, (4) Zero and (5) Forward output torque. A loop of (1) → (2) → (3) → (4) → (5) (return to (1)) will be drawn in Fig. 028-1. The inclination in the region from "0.15 x output torque" to "Output torque" is small. The torsional rigidity of the HPG series is an average value of this inclination.
The inclination in the region from "zero torque" to "0.15 x output torque" is large. This is caused by uneven distribution such as fine uneven contact of the engaging parts and load of the planet gears under a light load.

## ■Calculation of total torsional quantity (Windup)

The method to calculate the total torsional quantity (average value) on one side when the speed reducer applies a load in a no-load state.

Formula 028-1

● Calculation formula

$$\theta = D + \frac{T - T_L}{\frac{A}{B}}$$

Symbols in calculation formula

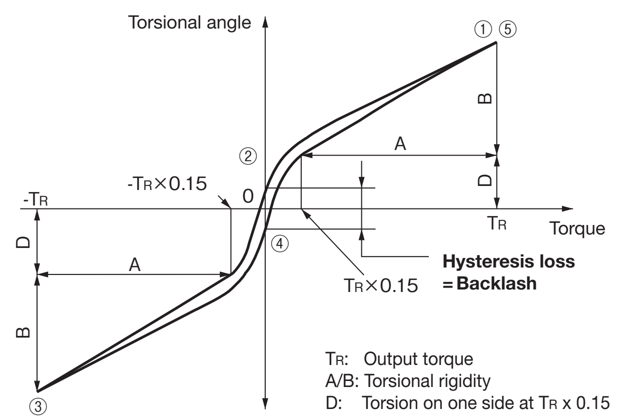
| | | |
|---|---|---|
| $\theta$ | Total torsional quantity | —— |
| D | Torsional quantity on one side at output torque x 0.15 torque | See Fig. 028-1, Table 028-1, Table 028-2 |
| T | Load torque | —— |
| $T_L$ | Output torque x 0.15 torque (=$T_R$ x 0.15) | See Fig. 028-1 |
| A / B | Torsional rigidity | See Fig. 028-1, Table 028-1, Table 028-2 |

## ■Backlash (Hysteresis loss)

The zero-torque width (2) - (4) in Fig. 028-1 "Torque-torsional angle diagram" is called a hysteresis loss. The hysteresis loss between "Forward output torque" and "Reverse output torque" is defined as backlash of the HPG series. At the time of pre-shipment factory inspection, the backlash of the HPG series is less than 3 minutes (1 minute or less for customized products).

Fig. 028-1

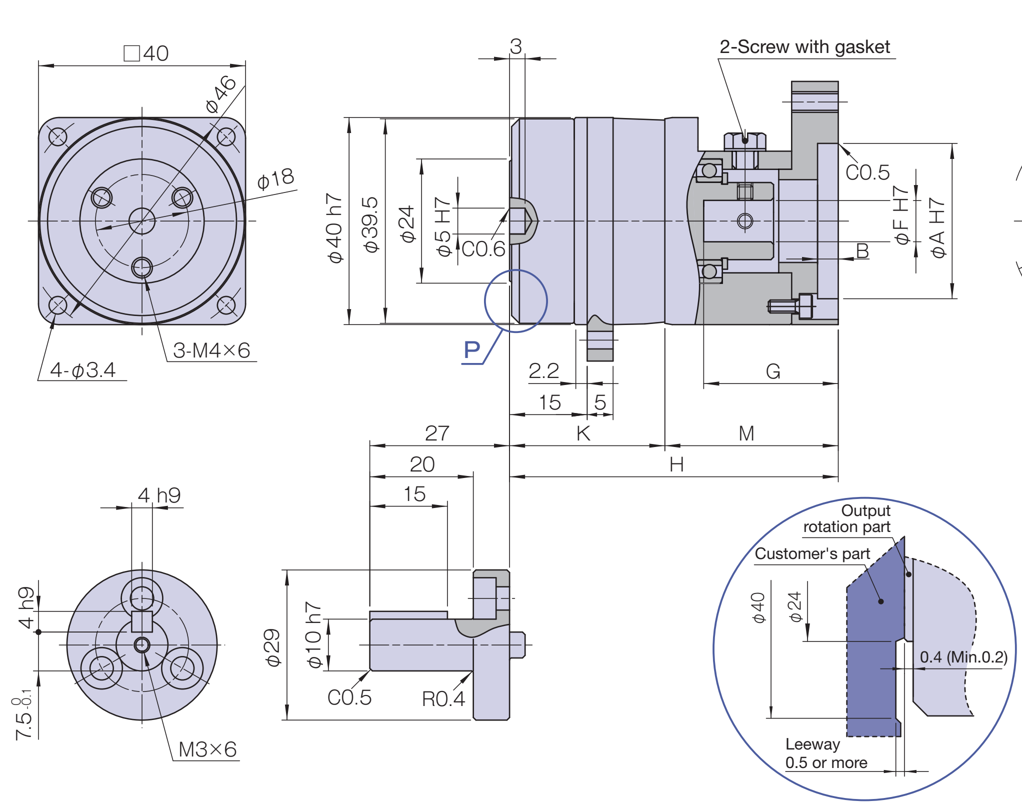
**Torque-torsional angle diagram**



# Dimensional Outline Drawing – Model No. 11 (HPG Series Helical Gear Type)

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.
You can download the CAD data of this product from the following homepage. URL: https://www.hds.co.jp/

Fig. 029-1




**P part detail**
Recommended dimensions of the leeway for the customer's part mounted to the output flange

(Note)
For the flange output type, it is recommended designing a leeway on the customer's part as shown in the left figure because the gap between the output rotation part and the oil seal of the non-rotation part is small (min. 0.2).

* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# Measurement Table

Table 029-1
Unit: mm

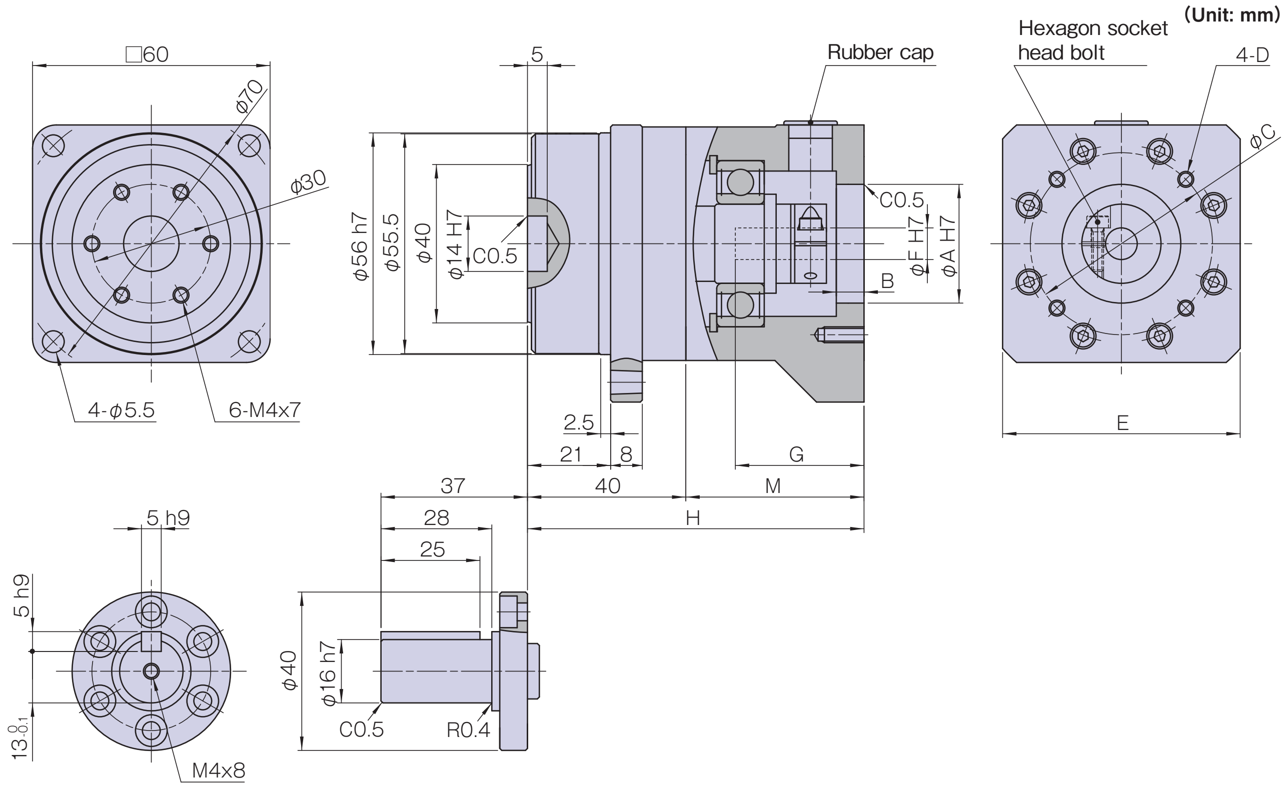
| Shape symbol[*1] | A(H7) | B | C | D | E | F(H7) Min | F(H7) Max | G | H | M | Mass (kg)[*2] Reduction ratio=4,5,6,7,8,9,10 Shaft output | Mass (kg)[*2] Reduction ratio=4,5,6,7,8,9,10 Flange output |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RAA□ | 28 | 3 | 33 | M2.5×5 | φ40 | 5 | 8 | 16.5 | 45.5 | 24.5 | 0.31 | 0.26 |
| RAB□ | 20 | | 28 | φ3.4 through | □25 | | | 20.5 | 49.5 | 28.5 | 0.32 | 0.27 |
| RAC□ | 22 | | 43.8 | φ3.4 through | □40 | | | | | | 0.33 | 0.28 |
| RAD□ | 30 | 4 | 46 | M4×9 | | | | 25.5 | 54.5 | 33.5 | 0.35 | 0.30 |
| RAE□ | | | 45 | M3×9 | | | | | | | | |
| RAN□ | 34 | | 48 | M3×9 | | | | | | | | |
| RAF□ | 50 | | 70 | M4×9 | □60 | | | | | | 0.40 | 0.35 |
| RAG□ | | | 70 | M5×9 | | | | | | | | |
| RAH□ | | | 60 | M4×9 | | | | | | | | |

Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on speed reducers only and on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. The mass varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

# Dimensional Outline Drawing – Model No. 14 (HPG Series Helical Gear Type)

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.
You can download the CAD data of this product from the following homepage. URL: https://www.hds.co.jp/

Fig. 030-1




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

## Measurement Table

Table 030-1
Unit: mm

| Shape symbol[1] | A(H7) | B | C | D | E | F(H7) Min | F(H7) Max | G | H | M | Mass (kg)[2] Reduction ratio=3,4,5,6,7,8,9,10 Shaft output | Mass (kg)[2] Flange output |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AA□ | 30 | 7 | 45 | M3×8 | □60 | 8 | 8 | 32 | 85 | 45 | 1.02 | 0.92 |
| AB□ | 30 | 7 | 46 | M4×10 | □60 | 8 | 8 | 32 | 85 | 45 | 1.02 | 0.92 |
| AF□ | 34 | 7 | 48 | M3×8 | □60 | 8 | 8 | 32 | 85 | 45 | 1.02 | 0.92 |
| AC□ | 50 | 6.5 | 70 | M5×12 | □60 | 8 | 8 | 32 | 85 | 45 | 1.02 | 0.92 |
| AD□ | 50 | 6.5 | 70 | M4×10 | □60 | 8 | 8 | 32 | 85 | 45 | 1.02 | 0.92 |
| AE□ | 50 | 6.5 | 60 | M4×10 | □60 | 8 | 8 | 32 | 85 | 45 | 1.02 | 0.92 |
| RAX□ | 50 | 6.5 | 70 | M4×10 | □60 | 9 | 14 | 32 | 85 | 45 | 1.07 | 0.97 |
| RAY□ | 50 | 6.5 | 60 | M4×10 | □60 | 9 | 14 | 32 | 85 | 45 | 1.07 | 0.97 |
| RAZ□ | 50 | 6.5 | 70 | M5×12 | □60 | 9 | 14 | 32 | 85 | 45 | 1.07 | 0.97 |
| RDA□ | 70 | 7 | 90 | M6×12 | □80 | 11 | 14 | 33 | 86 | 46 | 1.07 | 0.97 |
| RDB□ | 70 | 7 | 90 | M5×12 | □80 | 11 | 14 | 33 | 86 | 46 | 1.07 | 0.97 |

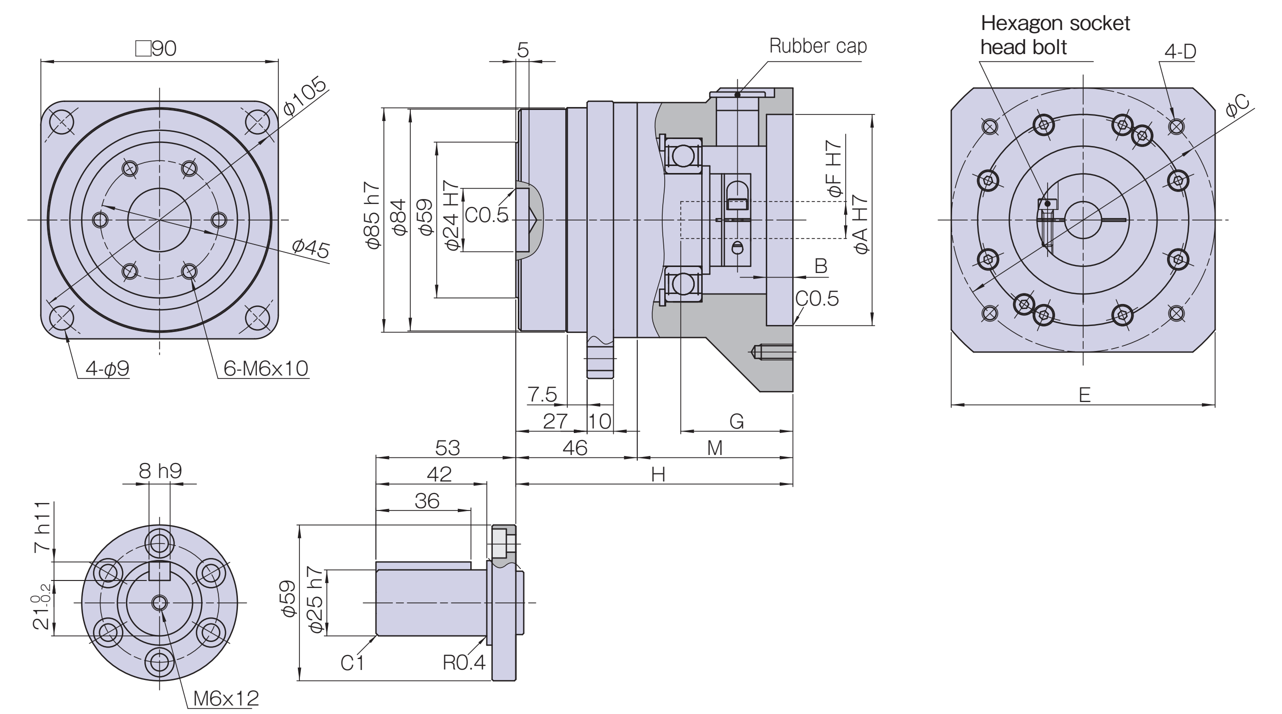
Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on speed reducers only and on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. The weight varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

# Dimensional Outline Drawing – Model No. 20 (HPG Series Helical Gear Type)

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.
You can download the CAD data of this product from the following homepage. URL: https://www.hds.co.jp/

Fig. 031-1

(Unit: mm)




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# Measurement Table

Table 031-1
Unit: mm

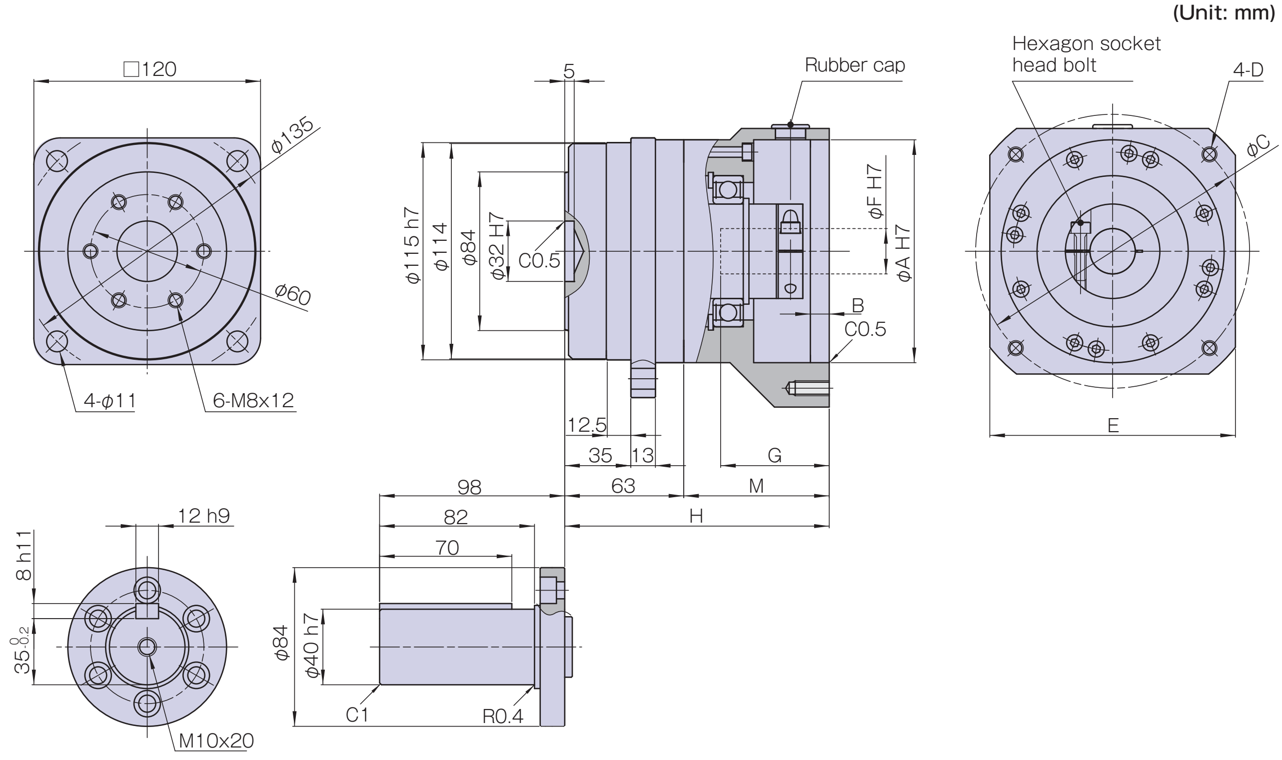
| Shape symbol[*1] | A(H7) | B | C | D | E | F(H7) | | G | H | M | Mass (kg)[*2] Reduction ratio=3,4,5,6,7,8,9,10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Min | Max | | | | Shaft output | Flange output |
| PGC□ | 50 | 10 | 70 | M5×12 | φ89 | 7 | 19 | 38 | 98 | 52 | 2.8 | 2.4 |
| PGD□ | | | | M4×10 | | | | | | | | |
| PGE□ | | | 60 | M4×8 | | | | | | | | |
| PFF□ | 70 | 7 | 90 | M5×12 | □80 | | | 45 | 105 | 59 | 3.0 | 2.6 |
| PFE□□ | | | | M6×12 | | | | | | | | |
| PHC□□ | 80 | 20 | 100 | | □100 | | | | | | | |
| PHD□ | | 6 | 115 | M8×16 | | | | | | | | |

Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on speed reducers only and on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. The weight varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

# Dimensional Outline Drawing – Model No. 32 (HPG Series Helical Gear Type)

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.
You can download the CAD data of this product from the following homepage.  URL: https://www.hds.co.jp/

Fig. 032-1




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# Measurement Table

Table 032-1
Unit: mm

| Shape symbol[1] | A(H7) | B | C | D | E | F(H7) | | G | H | M | Mass (kg)[3] Reduction ratio=3,4,5,6,7,8,9,10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Min | Max | | | | Shaft output | Flange output |
| PNA□ | 70 | 7 | 90 | M5×12 | ϕ122 | 10 | 24 | 56 | 139 | 76 | 7.5 | 6.1 |
| PNB□□ | 80 | | 100 | M6×12 | | | | | | | | |
| PNC□ | 70 | | 90 | M6×12 | | | | | | | | |
| PNF□ | 95 | 6 | 115 | M8×10 | ϕ135 | | | 62 | 145 | 82 | 7.6 | 6.2 |
| PNG□□ | 70 | 4 | 90 | M6×12 | ϕ122 | | | 38 | 139 | 76 | 7.5 | 6.1 |
| PNJ□ | 95 | 6 | 115 | M6×10 | ϕ135 | | | 62 | 145 | 82 | 7.6 | 6.2 |
| PMC□ | 110 | 10 | 145 | M8×18 | □135 | 16 | 35[2] | 59 | 142 | 79 | 7.5 | 6.1 |
| PPA□ | | 6.5 | | M8×25 | | | | 81 | 164 | 101 | 8.1 | 6.7 |
| PPB□□ | 114.3 | | 200 | M12×25 | □180 | | | | | | 9.1 | 7.7 |
| PQP□□ | | | | | | | | | | | 14.7 | 13.3 |
| PPC□□ | 200 | | 235 | | □220 | | | | | | 9.2 | 7.8 |

Dimensions of only typical products are shown.  Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on speed reducers only and on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols.  See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. Note that only diameter ϕ35 has H7 tolerance and plus tolerance.
3. The weight varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

## MEMO

# Rating Table (HPG Series)

HPG series gear head type has a variety of 6 model numbers. For selecting the model number, refer to the rating table.

Table 034-1

| Model | Reduction ratio | Rated output torque *1 | | Permissible max. value of ave. load torque *2 | | Permissible peak torque at start/stop *3 | | Permissible max. momentary torque *4 | | Permissible ave. input rotational speed *5 | Permissible max. input rotational speed *6 | Inertia moment (equiv. value on input side) *7 | | Mass *8 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Shaft output | Flange output | Shaft output | Flange output |
| | | N·m | kgf·m | N·m | kgf·m | N·m | kgf·m | N·m | kgf·m | r/min | r/min | ×10⁻⁴kg·m² | ×10⁻⁴kg·m² | kg | kg |
| 11 | 5 | 2.5 | 0.26 | 5.0 | 0.51 | 7.8 | 0.80 | 20 | 2.0 | 3000 | 10000 | 0.0036 | 0.0021 | 0.18 | 0.14 |
| | 9 | 2.5 | 0.26 | 3.9 | 0.40 | 3.9 | 0.40 | | | | | 0.0012 | 0.00070 | | |
| | 21 | 3.4 | 0.35 | 6.0 | 0.61 | 9.8 | 1.0 | | | | | 0.0019 | 0.0018 | 0.24 | 0.20 |
| | 37 | 3.4 | 0.35 | | | | | | | | | 0.00068 | 0.00066 | | |
| | 45 | 3.4 | 0.35 | | | | | | | | | 0.00049 | 0.00048 | | |
| 14 | 3 | 2.9 | 0.30 | 6.4 | 0.65 | 15 | 1.5 | 37 | 3.8 | 3000 | 5000 | 0.077 | 0.059 | 0.50 | 0.40 |
| | 5 | 5.9 | 0.60 | 13 | 1.3 | 23 | 2.3 | 56 | 5.7 | | 6000 | 0.026 | 0.020 | | |
| | 11 | 7.8 | 0.80 | 15 | 1.5 | | | | | | | 0.019 | 0.018 | 0.60 | 0.50 |
| | 15 | 9.0 | 0.90 | | | | | | | | | 0.017 | 0.016 | | |
| | 21 | 8.8 | 0.90 | | | | | | | | | 0.0092 | 0.0089 | | |
| | 33 | 10 | 1.0 | | | | | | | | | 0.0030 | 0.0029 | | |
| | 45 | 10 | 1.0 | | | | | | | | | 0.0028 | 0.0027 | | |
| 20 | 3 | 8.8 | 0.90 | 19 | 2.0 | 64 | 6.5 | 124 | 13 | 3000 | 4000 | 0.57 | 0.46 | 1.6 | 1.2 |
| | 5 | 16 | 1.6 | 35 | 3.6 | 100 | 10 | 217 | 22 | | 6000 | 0.21 | 0.17 | | |
| | 11 | 20 | 2.0 | 45 | 4.6 | | | | | | | 0.16 | 0.15 | 1.8 | 1.4 |
| | 15 | 24 | 2.4 | 53 | 5.4 | | | | | | | 0.14 | 0.14 | | |
| | 21 | 25 | 2.5 | 55 | 5.6 | | | | | | | 0.071 | 0.069 | | |
| | 33 | 29 | 3.0 | 60 | 6.1 | | | | | | | 0.024 | 0.023 | | |
| | 45 | 29 | 3.0 | | | | | | | | | 0.022 | 0.022 | | |
| 32 | 3 | 31 | 3.2 | 71 | 7.2 | 225 | 23 | 507 | 52 | 3000 | 3600 | 2.8 | 2.0 | 4.3 | 2.9 |
| | 5 | 66 | 6.7 | 150 | 15 | 300 | 31 | 650 | 66 | | 6000 | 1.0 | 0.73 | | |
| | 11 | 88 | 9.0 | 170 | 17 | | | | | | | 0.84 | 0.78 | 4.9 | 3.5 |
| | 15 | 92 | 9.4 | | | | | | | | | 0.65 | 0.62 | | |
| | 21 | 98 | 10 | | | | | | | | | 0.36 | 0.34 | | |
| | 33 | 108 | 11 | 200 | 20 | | | | | | | 0.13 | 0.12 | | |
| | 45 | 108 | 11 | | | | | | | | | 0.12 | 0.11 | | |
| 50 | 3 | 97 | 9.9 | 195 | 20 | 657 | 67 | 1200 | 122 | 2000 | 3000 | 17 | 13 | 13 | 10 |
| | 5 | 170 | 17 | 340 | 35 | 850 | 87 | 1850 | 189 | | 4500 | 6.1 | 4.8 | | |
| | 11 | 200 | 20 | 400 | 41 | | | | | | | 3.6 | 3.3 | 15 | 12 |
| | 15 | 230 | 24 | 450 | 46 | | | | | | | 3.1 | 2.9 | | |
| | 21 | 260 | 27 | 500 | 51 | | | | | | | 1.7 | 1.6 | | |
| | 33 | 270 | 28 | | | | | | | | | 0.63 | 0.60 | | |
| | 45 | 270 | 28 | | | | | | | | | 0.59 | 0.60 | | |
| 65 | 4 | 500 | 51 | 900 | 92 | 2200 | 225 | 4500 | 460 | 2000 | 2500 | 42 *9 | 28 | 32 *9 | 22 |
| | 5 | 530 | 54 | 1000 | 102 | | | | | | 3000 | 27 *9 | 18 | | |
| | 12 | 600 | 61 | 1100 | 112 | | | | | | | 18 *9 | 17 | 47 *9 | 37 |
| | 15 | 730 | 75 | 1300 | 133 | | | | | | | 17 *9 | 16 | | |
| | 20 | 800 | 81 | 1500 | 153 | | | | | | | 7.1 *9 | 6.5 | | |
| | 25 | 850 | 87 | | | | | | | | | 6.5 *9 | 6.1 | | |
| | 40 | 640 | 66 | 1300 | 133 | 1900 | 194 | | | | | 1.5 *9 | 1.3 | | |
| | 50 | 750 | 77 | 1500 | 153 | 2200 | 225 | | | | | 1.3 *9 | 1.2 | | |

(Note)
1. Output torque set based on the life of $L_{10}$ = 20000 hours when input rotational speed is 3000 r/min, which is the rated rotational speed of ordinary servo motors. Models 50 and 65 are set at 2000 r/min as the rated rotational speed and at $L_{10}$ = 20000 hours as the life for the servo motor to be combined.
2. Permissible maximum value of average load torque calculated based on a load torque pattern (page 014). A life of 2000 hours or more is a criterion when operated at an input speed of 2000 r/min.
3. Permissible maximum value of torque applied on start and stop in operation cycles.
4. Permissible maximum value for impact torque in an emergency stop and for external impact torque. Operation exceeding these ranges may cause damages to reducers.
5. Permissible maximum value of average input rotational speed during operations. Make it a point to operate below this value especially when the operation mode is near continuous operation.
6. Permissible maximum input rotational speed in operation modes other than continuous operation.
7. The value for a speed reducer itself. Values that include the input shaft coupling are shown in the model selection tool on the web page. (URL:https://hds-tech.jp/)
8. The weight of a speed reducer itself. See measurement tables for values that include an input shaft coupling, motor flange and other parts.
9. The standard specification is flange output. Shaft output is a customized specification.

# Performance Table (HPG Series)

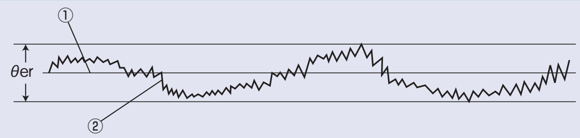
The values in the table are for the HPG reducer alone.
The input side shape may vary depending on the size of the mounted motor. For the input shaft coupling and motor flange values, please contact us.

Table 035-1

| Model | Reduction ratio | Angle transmission precision *1 | | Repeatability *2 | Starting torque *3 | | Overdrive starting torque *4 | | No-load running torque *5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | arc-min | ×10⁻⁴rad | arc-sec | cN·m | kgf·cm | N·m | kgf·m | cN·m | kgf·cm |
| 11 | 5 | 5 | 14.5 | ±30 | 4.0 | 0.41 | 0.20 | 0.020 | 5.0 | 0.51 |
| | 9 | | | | 3.7 | 0.37 | 0.33 | 0.034 | 2.5 | 0.26 |
| | 21 | | | | 2.9 | 0.29 | 0.60 | 0.061 | 1.3 | 0.13 |
| | 37 | | | | 1.6 | 0.17 | | 0.062 | 0.90 | 0.092 |
| | 45 | | | | 1.4 | 0.15 | 0.64 | 0.066 | 0.80 | 0.082 |
| 14 | 3 | 4 | 11.6 | ±20 | 14 | 1.5 | 0.43 | 0.044 | 21 | 2.1 |
| | 5 | | | | 8.6 | 0.88 | | | 9.8 | 1.0 |
| | 11 | | | | 8.0 | 0.82 | 0.90 | 0.092 | 4.9 | 0.50 |
| | 15 | | | | 7.4 | 0.75 | 1.1 | 0.11 | 2.9 | 0.30 |
| | 21 | | | | 5.2 | 0.53 | | 0.12 | | |
| | 33 | | | | 3.3 | 0.34 | | | 2.0 | 0.20 |
| | 45 | | | | 2.4 | 0.25 | | | | |
| 20 | 3 | 4 | 11.6 | ±15 | 31 | 3.2 | 0.93 | 0.095 | 50 | 5.1 |
| | 5 | | | | 19 | 1.9 | | | 28 | 2.9 |
| | 11 | | | | 15 | 1.6 | 1.7 | 0.17 | 15 | 1.5 |
| | 15 | | | | 12 | 1.2 | 1.8 | 0.18 | 11 | 1.1 |
| | 21 | | | | 9.3 | 0.95 | 2.0 | 0.20 | 8.8 | 0.90 |
| | 33 | | | | 6.4 | 0.65 | 2.1 | 0.22 | 5.9 | 0.60 |
| | 45 | | | | 4.7 | 0.48 | | | 4.9 | 0.50 |
| 32 | 3 | 4 | 11.6 | ±15 | 56 | 5.7 | 1.7 | 0.17 | 135 | 14 |
| | 5 | | | | 33 | 3.4 | | | 73 | 7.4 |
| | 11 | | | | 27 | 2.7 | 2.9 | 0.30 | 38 | 3.9 |
| | 15 | | | | 25 | 2.5 | 3.7 | 0.38 | 29 | 3.0 |
| | 21 | | | | 22 | 2.3 | 4.7 | 0.48 | 24 | 2.4 |
| | 33 | | | | 15 | 1.5 | 4.8 | 0.49 | 14 | 1.4 |
| | 45 | | | | 11 | 1.2 | 5.1 | 0.52 | 13 | 1.3 |
| 50 | 3 | 3 | 8.7 | ±15 | 134 | 14 | 4.0 | 0.41 | 250 | 26 |
| | 5 | | | | 80 | 8.2 | | | 130 | 13 |
| | 11 | | | | 45 | 4.6 | 5.0 | 0.51 | 60 | 6.1 |
| | 15 | | | | 40 | 4.1 | 6.0 | 0.61 | 47 | 4.8 |
| | 21 | | | | 36 | 3.7 | 7.6 | 0.78 | 40 | 4.1 |
| | 33 | | | | 24 | 2.4 | 7.8 | 0.80 | 24 | 2.5 |
| | 45 | | | | 20 | 2.0 | 8.9 | 0.91 | 20 | 2.0 |
| 65 | 4 | 3 | 8.7 | ±15 | 288 | 29 | 12 | 1.2 | 420 | 43 |
| | 5 | | | | 240 | 24 | | | 360 | 37 |
| | 12 | | | | 125 | 13 | 15 | 1.5 | 190 | 19 |
| | 15 | | | | 110 | 11 | 17 | 1.7 | 160 | 16 |
| | 20 | | | | 95 | 10 | 19 | 1.9 | 130 | 13 |
| | 25 | | | | 84 | 8.6 | 21 | 2.1 | 110 | 11 |
| | 40 | | | | 75 | 7.7 | 30 | 3.1 | 76 | 7.7 |
| | 50 | | | | 70 | 7.1 | 35 | 3.6 | 64 | 6.6 |

(Note) 1. Angle transmission precision indicates the difference between (1) logical rotating angle and (2) actual rotating angle of output when any rotating angle is given as an input. The values in the table are maximum values.

Fig. 035-1

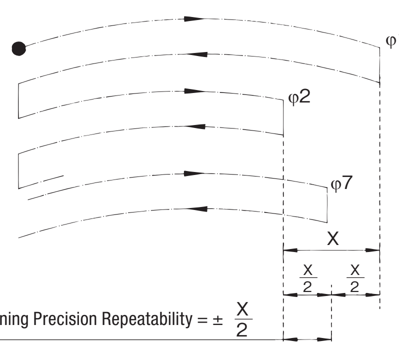



$\theta er$ : Angle transmission precision
$\theta_1$ : Input rotation angle
$\theta_2$ : Actual output rotation angle
R : Reduction ratio of HPG series

$$\theta er = \theta_2 - \frac{\theta_1}{R}$$

2. The repeatability is determined by repeating positioning in a given position from the same direction seven times, by measuring stop positions of the output shaft and by calculating the maximum difference. Measured values are indicated in angles (degrees) and are prefixed with "±" to 1/2 of the maximum differences. The values in the table are maximum values.

Fig. 035-2




Positioning Precision Repeatability $= \pm \frac{X}{2}$

3. Starting torque means the momentary "starting torque" with which the output side starts rotation when a torque is applied on the input side. The values in the table are maximum values.

Table 035-2

| Load | No load |
|---|---|
| HPG speed reducer surface temperature | 25°C |

4. Overdrive starting torque means the momentary "starting torque" with which the input side starts rotation when a torque is applied on the output side. The values in the table are maximum values.

Table 035-3

| Load | No load |
|---|---|
| HPG speed reducer surface temperature | 25°C |

5. No-load running torque means the torque on the input side required to put the speed reducer under a no-load condition. The values in the table are average values.

Table 035-4

| Input speed | 3000r/min |
|---|---|
| Load | No load |
| HPG speed reducer surface temperature | 25°C |

# Torque – Torsion Characteristic (HPG Series)

## ■Gear head type standard item

Table 036-1

| Model | Reduction ratio | Backlash arc-min | Backlash $\times10^{-4}$rad | Torsional quantity on one side at $T_R$ x 0.15 D arc-min | D $\times10^{-4}$rad | Torsional rigidity A/B kgf·m/arc-min | A/B $\times$100N·m/rad |
|---|---|---|---|---|---|---|---|
| 11 | 5, 9 | 3.0 | 8.7 | 2.5 | 7.3 | 0.065 | 22 |
| | 21, 37, 45 | | | 3.0 | 8.7 | | |
| 14 | 3, 5 | 3.0 | 8.7 | 2.2 | 6.4 | 0.14 | 47 |
| | 11, 15, 21, 33, 45 | | | 2.7 | 7.9 | | |
| 20 | 3, 5 | 3.0 | 8.7 | 1.5 | 4.4 | 0.55 | 180 |
| | 11, 15, 21, 33, 45 | | | 2.0 | 5.8 | | |
| 32 | 3, 5 | 3.0 | 8.7 | 1.3 | 3.8 | 2.2 | 740 |
| | 11, 15, 21, 33, 45 | | | 1.7 | 4.9 | | |
| 50 | 3, 5 | 3.0 | 8.7 | 1.3 | 3.8 | 14 | 4700 |
| | 11, 15, 21, 33, 45 | | | 1.7 | 4.9 | | |
| 65 | 4, 5 | 3.0 | 8.7 | 1.3 | 3.8 | 38 | 13000 |
| | 12, 15, 20, 25, 40, 50 | | | 1.7 | 4.9 | | |

## ■Gear head type BL1 specification (backlash of 1 min. or less)

Table 036-2

| Model | Reduction ratio | Backlash arc-min | Backlash $\times10^{-4}$rad | Torsional quantity on one side at $T_R$ x 0.15 D arc-min | D $\times10^{-4}$rad | Torsional rigidity A/B kgf·m/arc-min | A/B $\times$100N·m/rad |
|---|---|---|---|---|---|---|---|
| 14 | 3, 5 | 1.0 | 2.9 | 1.1 | 3.2 | 0.14 | 47 |
| | 11, 15, 21, 33, 45 | | | 1.7 | 4.9 | | |
| 20 | 3, 5 | 1.0 | 2.9 | 0.6 | 1.7 | 0.55 | 180 |
| | 11, 15, 21, 33, 45 | | | 1.1 | 3.2 | | |
| 32 | 3, 5 | 1.0 | 2.9 | 0.5 | 1.5 | 2.2 | 740 |
| | 11, 15, 21, 33, 45 | | | 1.0 | 2.9 | | |
| 50 | 3, 5 | 1.0 | 2.9 | 0.5 | 1.5 | 14 | 4700 |
| | 11, 15, 21, 33, 45 | | | 1.0 | 2.9 | | |
| 65 | 4, 5 | 1.0 | 2.9 | 0.5 | 1.5 | 38 | 13000 |
| | 12, 15, 20, 25, 40, 50 | | | 1.0 | 2.9 | | |

## ■Torsional rigidity (windup curve)

Anchoring the speed reducer input and casing and applying a torque to the output part will generate torsion in the output part in accordance with the applied torque. Change the torque slowly in the order of: (1) Forward output torque, (2) Zero, (3) Reverse output torque, (4) Zero and (5) Forward output torque. A loop of (1) → (2) → (3) → (4) → (5) (return to (1)) will be drawn in Fig. 036-1.
The inclination in the region from "0.15 x output torque" to "Output torque" is small. The torsional rigidity of the HPG series is an average value of this inclination.
The inclination in the region from "zero torque" to "0.15 x output torque" is large. This is caused by uneven distribution such as fine uneven contact of the engaging parts and load of the planet gears under a light load.

## ■Calculation of total torsional quantity (Windup)

The method to calculate the total torsional quantity (average value) on one side when the speed reducer applies a load in a no-load state.

Formula 036-1

● Calculation formula

$$\theta = D + \frac{T - T_L}{\frac{A}{B}}$$

Symbols in calculation formula

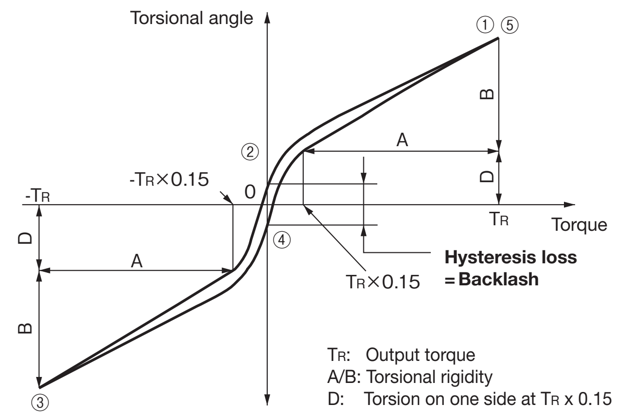
| | | | |
|---|---|---|---|
| $\theta$ | Total torsional quantity | —— |
| D | Torsional quantity on one side at output torque x 0.15 torque | See Fig. 036-1, Table 036-1, Table 036-2 |
| T | Load torque | —— |
| $T_L$ | Output torque x 0.15 torque (=$T_R$ x 0.15) | See Fig. 036-1 |
| A / B | Torsional rigidity | See Fig. 036-1, Table 036-1, Table 036-2 |

## ■Backlash (Hysteresis loss)

The zero-torque width (2) - (4) in Fig. 036-1 "Torque-torsional angle diagram" is called a hysteresis loss. The hysteresis loss between "Forward output torque" and "Reverse output torque" is defined as backlash of the HPG series. At the time of pre-shipment factory inspection, the backlash of the HPG series is less than 3 minutes (1 minute or less for customized products).

Fig. 036-1

**Torque-torsional angle diagram**

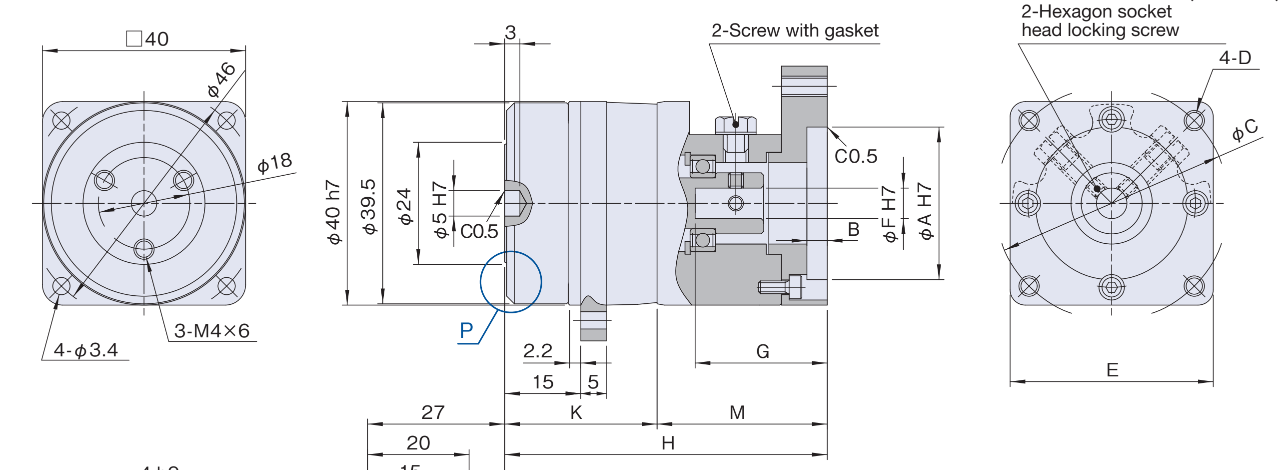


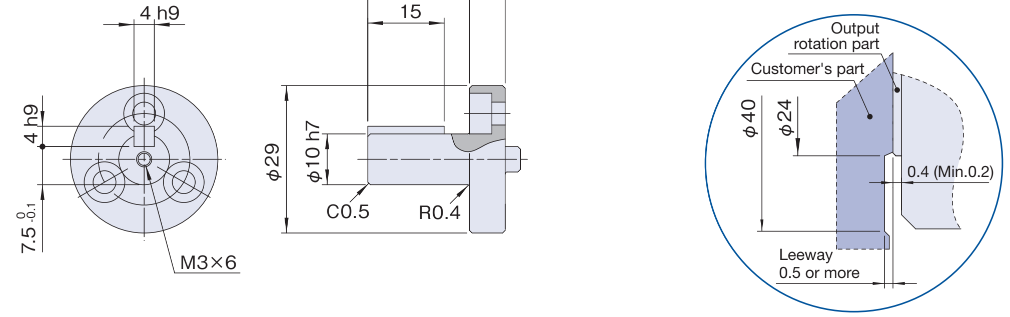
# Dimensional Outline Drawing – Model No. 11 (HPG Series)

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.
You can download the CAD data of this product from the following homepage. URL: https://www.hds.co.jp/

Fig. 037-1

(Unit: mm)




**P part detail**
Recommended dimensions of the leeway for the customer's part mounted to the output flange

(Note)
For the flange output type, it is recommended designing a leeway on the customer's part as shown in the left figure because the gap between the output rotation part and the oil seal of the non-rotation part is small (min. 0.2).

* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# Measurement Table

Table 037-1
Unit: mm

<table>
<tr><th rowspan="2"></th><th rowspan="2">Shape symbol[1]</th><th rowspan="2">A(H7)</th><th rowspan="2">B</th><th rowspan="2">C</th><th rowspan="2">D</th><th rowspan="2">E</th><th colspan="2">F(H7)</th><th rowspan="2">G</th><th rowspan="2">H</th><th rowspan="2">K</th><th rowspan="2">M</th><th colspan="2">Mass (kg)[2]</th></tr>
<tr><th>Min</th><th>Max</th><th>Shaft output</th><th>Flange output</th></tr>
<tr><td rowspan="9">Single-stage speed reduction type (Reduction ratio = 5, 9)</td><td>AA□</td><td>28</td><td rowspan="3">3</td><td>33</td><td>M2.5×5</td><td>φ40</td><td rowspan="9">5</td><td rowspan="9">8</td><td>19.5</td><td>45.5</td><td rowspan="9">21</td><td>24.5</td><td>0.25</td><td>0.21</td></tr>
<tr><td>AB□</td><td>20</td><td>28</td><td rowspan="2">φ3.4 through</td><td>□25</td><td rowspan="2">23.5</td><td rowspan="2">49.5</td><td rowspan="2">28.5</td><td>0.26</td><td>0.22</td></tr>
<tr><td>AC□</td><td>22</td><td>43.8</td><td rowspan="3">□40</td><td>0.27</td><td>0.23</td></tr>
<tr><td>AD□</td><td rowspan="2">30</td><td rowspan="6">4</td><td>46</td><td>M4×9</td><td rowspan="6">28</td><td rowspan="6">54.5</td><td rowspan="6">33.5</td><td rowspan="3">0.29</td><td rowspan="3">0.25</td></tr>
<tr><td>AE□</td><td>45</td><td rowspan="2">M3×9</td></tr>
<tr><td>AN□</td><td>34</td><td>48</td></tr>
<tr><td>AF□</td><td rowspan="3">50</td><td rowspan="2">70</td><td>M4×9</td><td rowspan="3">□60</td><td rowspan="3">0.34</td><td rowspan="3">0.30</td></tr>
<tr><td>AG□</td><td>M5×9</td></tr>
<tr><td>AH□</td><td>60</td><td>M4×9</td></tr>
<tr><td rowspan="9">Dual-stage speed reduction type (Reduction ratio = 21, 37, 45)</td><td>AA□</td><td>28</td><td rowspan="3">3</td><td>33</td><td>M2.5×5</td><td>φ40</td><td rowspan="9">5</td><td rowspan="9">8</td><td>16.5</td><td>54.5</td><td rowspan="9">30</td><td>24.5</td><td>0.31</td><td>0.27</td></tr>
<tr><td>AB□</td><td>20</td><td>28</td><td rowspan="2">φ3.4 through</td><td>□25</td><td rowspan="2">20.5</td><td rowspan="2">58.5</td><td rowspan="2">28.5</td><td>0.32</td><td>0.28</td></tr>
<tr><td>AC□</td><td>22</td><td>43.8</td><td rowspan="3">□40</td><td>0.33</td><td>0.29</td></tr>
<tr><td>AD□</td><td rowspan="2">30</td><td rowspan="6">4</td><td>46</td><td>M4×9</td><td rowspan="6">25.5</td><td rowspan="6">63.5</td><td rowspan="6">33.5</td><td rowspan="3">0.35</td><td rowspan="3">0.31</td></tr>
<tr><td>AE□</td><td>45</td><td rowspan="2">M3×9</td></tr>
<tr><td>AN□</td><td>34</td><td>48</td></tr>
<tr><td>AF□</td><td rowspan="3">50</td><td rowspan="2">70</td><td>M4×9</td><td rowspan="3">□60</td><td rowspan="3">0.40</td><td rowspan="3">0.36</td></tr>
<tr><td>AG□</td><td>M5×9</td></tr>
<tr><td>AH□</td><td>60</td><td>M4×9</td></tr>
</table>

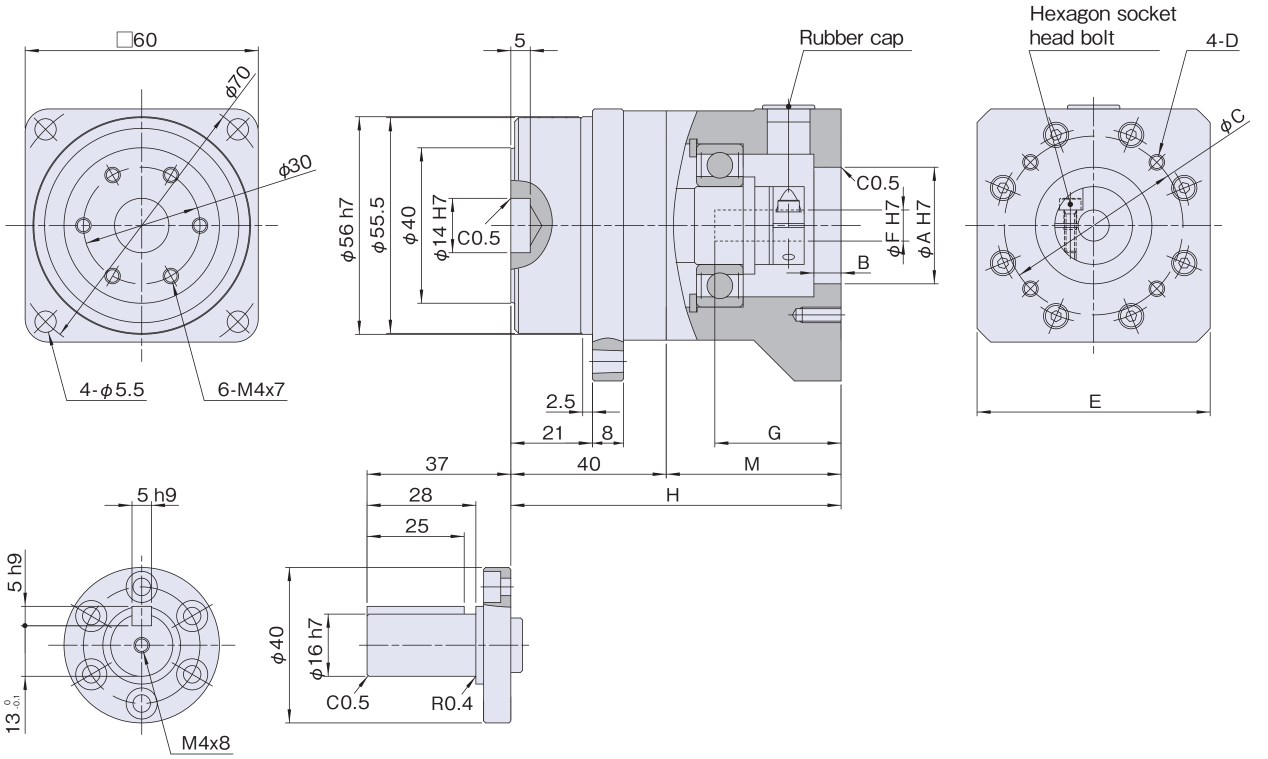
Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on speed reducers only and on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. The mass varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

# Dimensional Outline Drawing – Model No. 14 (HPG Series)

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.
You can download the CAD data of this product from the following homepage. URL: https://www.hds.co.jp/

Fig. 038-1

(Unit: mm)




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# Measurement Table

Table 038-1
Unit: mm

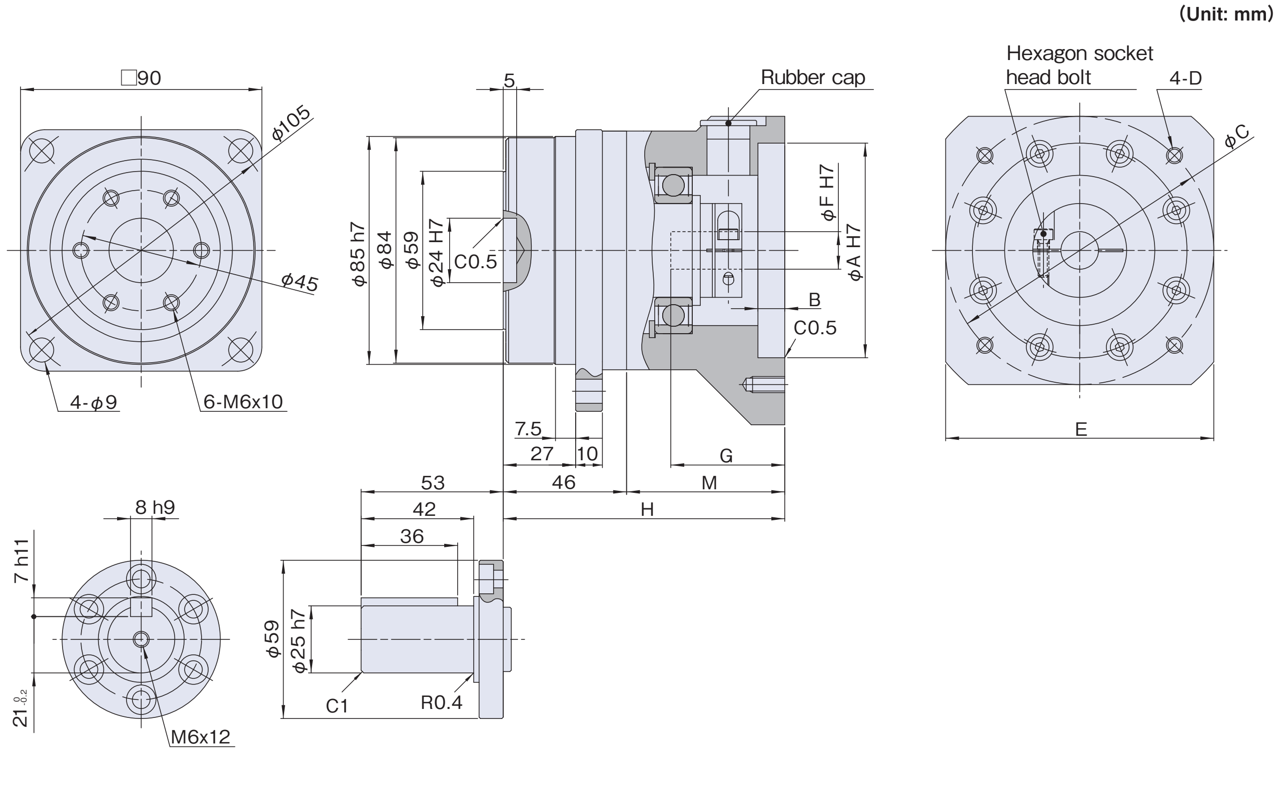
| Shape symbol[*1] | A(H7) | B | C | D | E | F(H7) | | G | H | M | Mass (kg)[*2] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Reduction ratio=3,5 | | Reduction ratio=11,15,21,33,45 | |
| | | | | | | Min | Max | | | | Shaft output | Flange output | Shaft output | Flange output |
| AA□ | 30 | 7 | 45 | M3×8 | □60 | 6 | 8 | 32 | 85 | 45 | 0.97 | 0.85 | 1.04 | 0.92 |
| AB□ | | | 46 | M4×10 | | | | | | | | | | |
| AF□ | 34 | | 48 | M3×8 | | | | | | | | | | |
| AC□ | 50 | 6.5 | 70 | M5×12 | | | | | | | | | | |
| AD□ | | | | M4×10 | | | | | | | | | | |
| AE□ | | | 60 | | | | | | | | | | | |
| AX□ | | | 70 | | | 9 | 14 | | | | 1.02 | 0.90 | 1.09 | 0.97 |
| AY□ | | | 60 | | | | | | | | | | | |
| AZ□ | | | 70 | M5×12 | | | | | | | | | | |

Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on speed reducers only and on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. The weight varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

# Dimensional Outline Drawing – Model No. 20 (HPG Series)

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.
You can download the CAD data of this product from the following homepage. URL: https://www.hds.co.jp/

Fig. 039-1




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# Measurement Table

Table 039-1
Unit: mm

| Shape symbol*1 | A(H7) | B | C | D | E | F(H7) | | G | H | M | Mass (kg)*2 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Reduction ratio=3,5 | | Reduction ratio=11,15,21,33,45 | |
| | | | | | | Min | Max | | | | Shaft output | Flange output | Shaft output | Flange output |
| GC□ | 50 | 10 | 70 | M5×12 | φ89 | 7 | 19 | 35 | 98 | 52 | 2.7 | 2.3 | 2.9 | 2.5 |
| GD□ | | | | M4×10 | | | | | | | | | | |
| GE□ | | | 60 | M4×8 | | | | | | | | | | |
| FF□ | 70 | 7 | 90 | M5×12 | □80 | | | 42 | 105 | 59 | 2.9 | 2.5 | 3.1 | 2.7 |
| FE□□ | | | | M6×12 | | | | | | | | | | |
| HC□□ | 80 | 10 | 100 | M6×12 | □100 | | | | | | | | | |
| HD□ | 95 | 6 | 115 | M8×16 | | | | | | | | | | |
| JA□□ | 30 | 5 | 45 | M3×8 | φ55 | 6 | 8 | 30.5 | 93.5 | 47.5 | – | – | 2.4 | 2.0 |
| JB□□ | | | 46 | M4×10 | | | | | | | – | – | | |

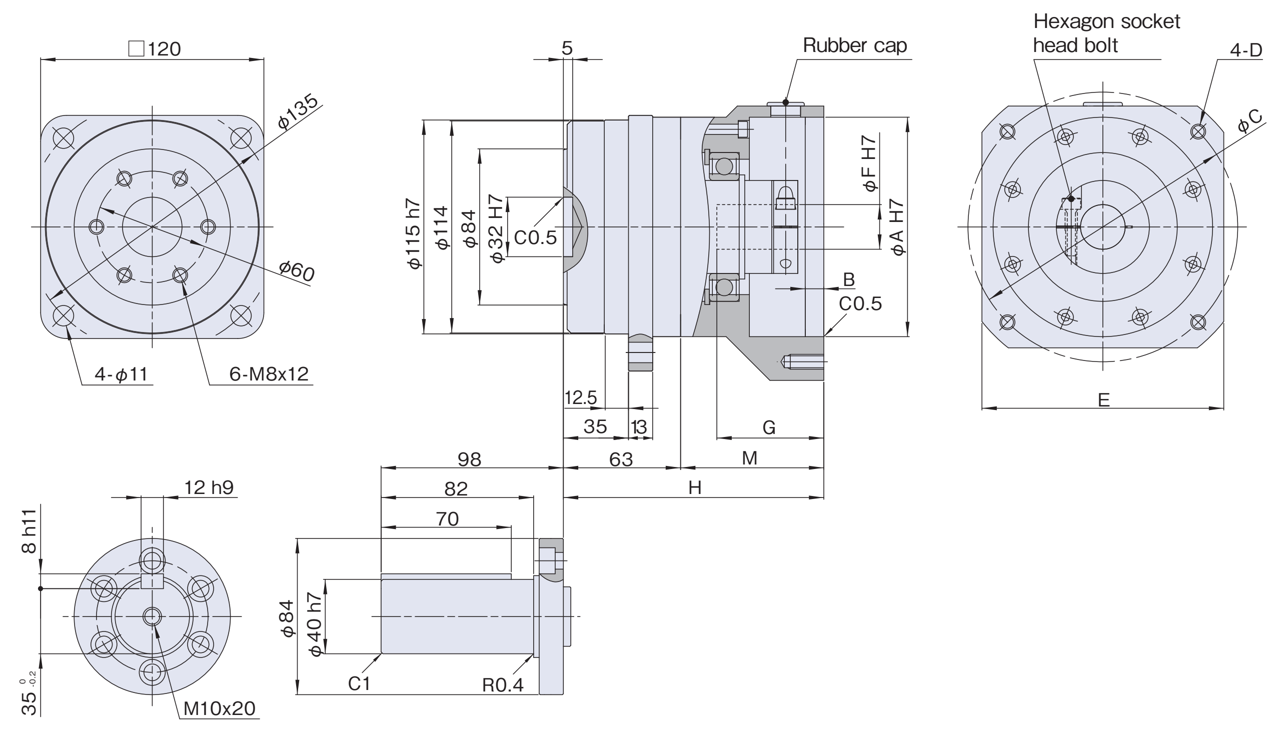
Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on speed reducers only and on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. The weight varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

# Dimensional Outline Drawing – Model No. 32 (HPG Series)

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.
You can download the CAD data of this product from the following homepage. URL: https://www.hds.co.jp/

Fig. 040-1

(Unit: mm)




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# Measurement Table

Table 040-1
Unit: mm

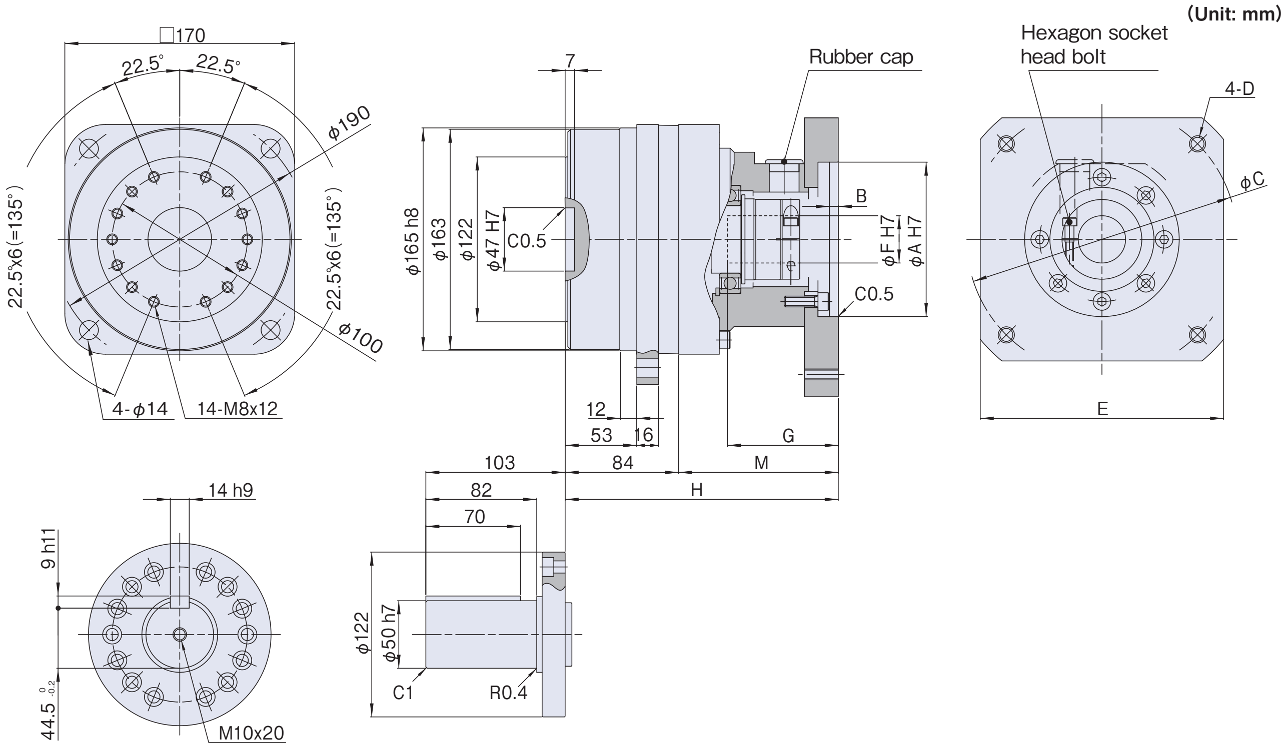
| Shape symbol[*1] | A(H7) | B | C | D | E | F(H7) | | G | H | M | Mass (kg)[*3] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Reduction ratio=3,5 | | Reduction ratio=11,15,21,33,45 | |
| | | | | | | Min | Max | | | | Shaft output | Flange output | Shaft output | Flange output |
| NA□ | 70 | 7 | 90 | M5×12 | φ122 | 10 | 24 | 56 | 139 | 76 | 7.3 | 5.9 | 7.8 | 6.4 |
| NB□□ | 80 | | 100 | M6×12 | | | | | | | | | | |
| NC□ | 70 | | 90 | | | | | | | | | | | |
| ND□□ | 50 | 10 | 70 | M5×12 | | | | 38 | | | – | – | 7.5 | 6.1 |
| NE□□ | | | | M4×10 | | | | | | | – | – | | |
| NF□ | 95 | 6 | 115 | M8×10 | φ135 | | | 62 | 145 | 82 | 7.4 | 6.0 | 7.9 | 6.5 |
| NG□□ | 70 | 4 | 90 | M6×12 | φ122 | | | 38 | 139 | 76 | 7.3 | 5.9 | 7.8 | 6.4 |
| NJ□ | 95 | 6 | 115 | M6×10 | φ135 | | | 62 | 145 | 82 | 7.4 | 6.0 | 7.9 | 6.5 |
| MC□ | 110 | 10 | 145 | M8×18 | □130 | 16 | 35[*2] | 59 | 142 | 79 | 7.3 | 5.9 | 7.8 | 6.4 |
| PA□ | | 6.5 | | M8×25 | | | | 81 | 164 | 101 | 7.9 | 6.5 | 8.4 | 7.0 |
| PB□□ | 114.3 | | 200 | M12×25 | □180 | | | | | | 8.9 | 7.5 | 9.4 | 8.0 |
| PC□□ | 200 | | 235 | | □220 | | | | | | 9.0 | 7.6 | 9.5 | 8.1 |

Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on speed reducers only and on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. Note that only diameter φ35 has H7 tolerance and plus tolerance.
3. The weight varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

# Dimensional Outline Drawing – Model No. 50 (HPG Series)

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.
You can download the CAD data of this product from the following homepage. URL: https://www.hds.co.jp/

Fig. 041-1




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# Measurement Table

Table 041-1
Unit: mm

| Shape symbol[1] | A(H7) | B | C | D | E | F(H7) | | G | H | M | Mass (kg)[3] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Reduction ratio=3,5 | | Reduction ratio=11,15,21,33,45 | |
| | | | | | | Min | Max | | | | Shaft output | Flange output | Shaft output | Flange output |
| AA□□ | 110 | 10 | 145 | M8×16 | φ170 | 19 | 35[2] | 55.5 | 176 | 92 | 17.6 | 14.6 | 19.0 | 16.0 |
| AD□□ | 95 | | 115 | M8×10 | | | | | | | | | | |
| AE□□ | 80 | | 100 | M6×10 | | | | | | | | | | |
| AF□□ | 95 | | 115 | | | | | | | | | | | |
| BA□□ | 110 | 6.5 | 145 | M8×25 | □130 | | | 81 | 202 | 118 | 17.7 | 14.7 | 19.1 | 16.1 |
| BB□□ | 114.3 | | 200 | M12×25 | □180 | | 42 | | | | 18.6 | 15.6 | 20.1 | 17.1 |
| EP□□ | | | | | | | | | | | 25.9 | 22.9 | 27.4 | 24.4 |
| BC□□ | 200 | | 235 | | □220 | | 35[2] | | | | 18.7 | 15.7 | 20.2 | 17.2 |
| EQ□□ | | | | | | | | | | | 26.0 | 23.0 | 27.5 | 24.5 |
| BF□□ | 130 | | 165 | M10×25 | □180 | | | | | | 18.6 | 15.6 | 20.1 | 17.1 |
| CB□□ | 114.3 | | 200 | M12×25 | | | 42 | 114 | 243.5 | 159.5 | – | – | 20.4 | 17.4 |

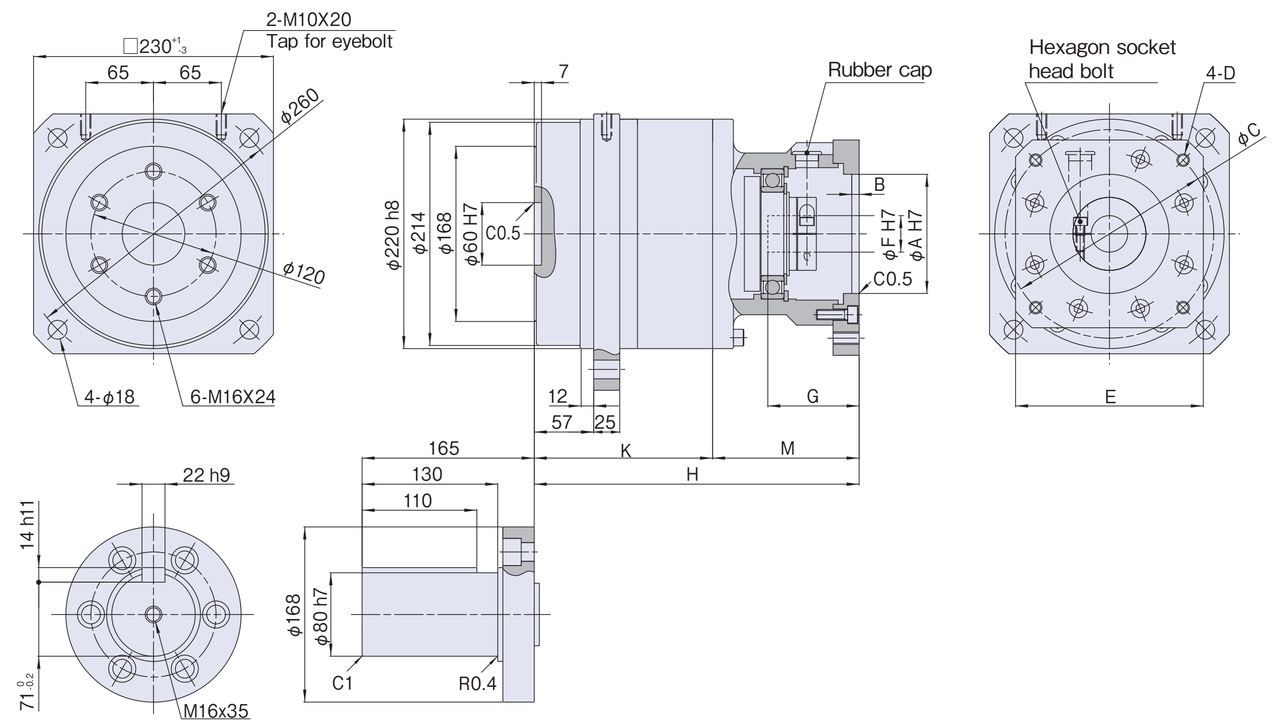
Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on speed reducers only and on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. Note that only diameter φ35 has H7 tolerance and plus tolerance.
3. The weight varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

# Dimensional Outline Drawing – Model No. 65 (HPG Serires)

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.
You can download the CAD data of this product from the following homepage. URL: https://www.hds.co.jp/

Fig. 042-1

(Unit: mm)




* While the flange output is for standard, the shaft output is for special specification.
* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
  Contact us for the differential range of the size that is not described.

# Measurement Table

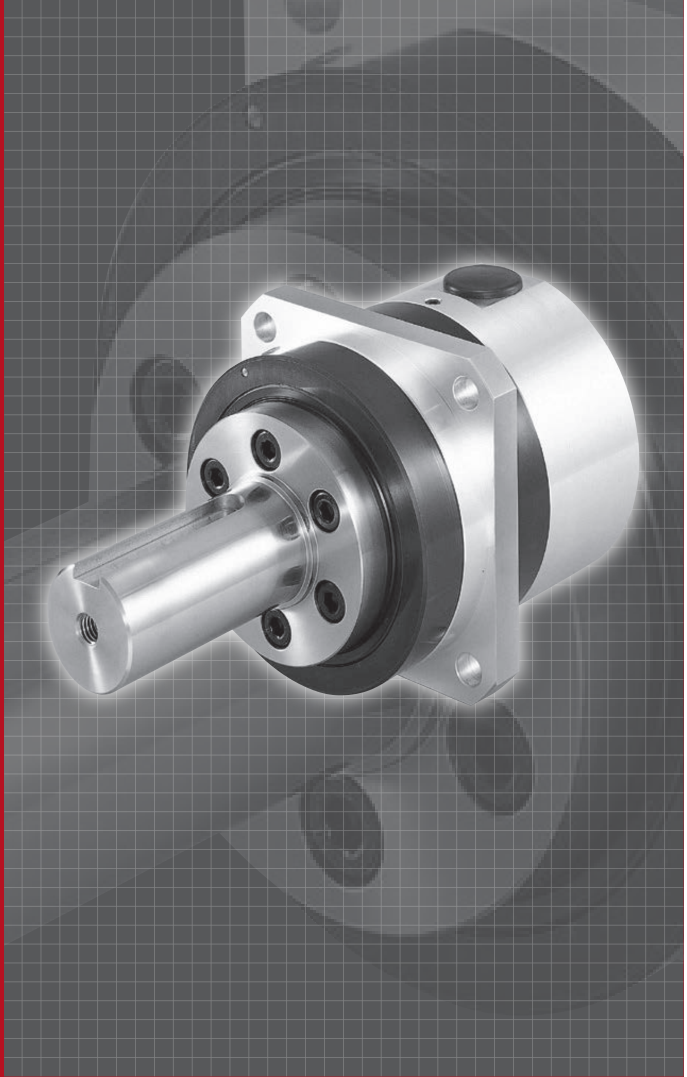
Table 042-1
Unit: mm

| | Shape symbol*1 | A(H7) | B | C | D | E | F(H7) Min | F(H7) Max | G | H | K | M | Mass (kg)*3 Shaft output | Mass (kg)*3 Flange output |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Single-stage speed reduction type (Reduction ratio = 4, 5) | CB□□ | 114.3 | 10 | 200 | M12×25 | □180 | 35*2 | 55 | 113 | 241.5 | 91 | 150.5 | 48 | 38 |
| | CG□□ | 180 | | 215 | | □220 | | | | | | | | |
| | CC□□ | 200 | | 235 | | | | | | | | | | |
| | CJ□□ | 230 | | 265 | | □250 | | | | | | | | |
| Dual-stage speed reduction type (Reduction ratio = 12, 15, 20, 25, 40, 50) | CB□□*4 | 114.3 | 10 | 200 | M12×25 | □180 | 35*2 | 55 | 113 | 311.5 | 161 | 150.5 | 52 | 42 |
| | CG□□*4 | 180 | | 215 | | □220 | | | | | | | | |
| | CC□□*4 | 200 | | 235 | | | | | | | | | | |
| | BB□□ | 114.3 | 6.5 | 200 | M12×25 | □180 | 19 | 35*2 | 84 | 288 | 170 | 118 | | |
| | BC□□ | 200 | | 235 | | □220 | | | | | | | | |
| | BF□□ | 130 | | 165 | M10×25 | □180 | | | | | | | | |
| | BA□□ | 110 | | 145 | M8×25 | □130 | | | | | | | | |

Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on speed reducers only and on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. Note that only diameter φ35 has H7 tolerance and plus tolerance.
3. The mass varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.
4. Reduction ratio 40 and 50 not supported.

# HarmonicDrive®

# CSG-GH Series
## High-torque Type
# CSF-GH Series
## Standard Type



**Size** — 5 Types
Model: 14, 20, 32, 45, 65

**Peak torque**
CSG-GH: = 23 N·m to 3419 N·m
CSF-GH: = 18 N·m to 2630 N·m

**Reduction ratio**
CSG-GH: = 50 to 160
CSF-GH: = 50 to 160

**High positioning precision**
Repetitive positioning ±4 to ±10arc-sec

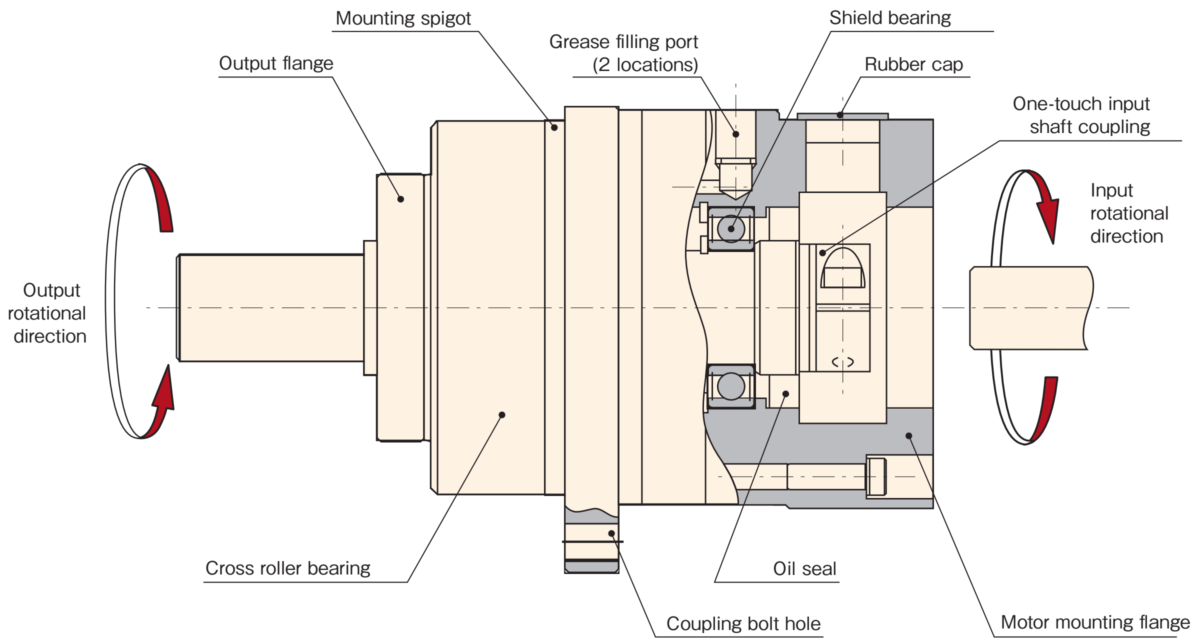
**No backlash**

**Can be mounted to servo motors of many manufacturers**
Yasukawa Electric, Mitsubishi Electric, Fanuc, Panasonic, Sanyo Denki, Tamagawa Seiki, Fuji Electric, Omron, Toshiba Machine, Keyence
For other servo motors, please feel free to contact the nearest sales office.

* See the model selection tool on the web page to find matching model on each company's servo motors. (URL:https://hds-tech.jp/)

Structural drawing

Fig. 043-1




(The figure indicates output shaft type.)

# Terms on the Rating Table

See the corresponding pages of each series for values from the ratings.

### ■Rated torque

This indicates the permissible continuous load torque when the input rotational speed is 2000 r/min.

### ■Permissible peak torque for start and stop (see Graph 044-1)

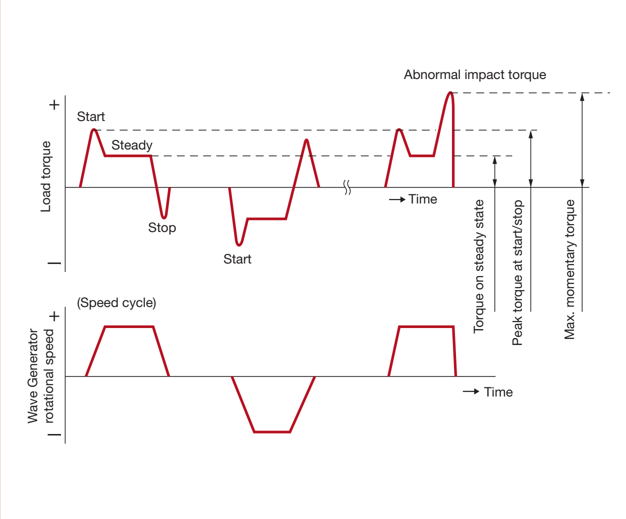
Load larger than the steady torque is applied to HarmonicDrive® by the load inertia moment for start and stop. Values from the ratings show the acceptable value at peak torque.

### ■Permissible maximum value at average load torque

When the load torque and input rotational speed change, the average value of the load torque needs to be obtained. Values from the ratings show the acceptable value at average load torque. When the average load torque (calculation formula: Page 049) exceeds the value from the ratings, generation of heat degrades the lubricant earlier and accelerates the abrasion of the teeth. Due care should be taken.

Example of load torque pattern

Graph 044-1




### ■Permissible maximum momentary torque (see Graph 044-1)

Unexpected impact torque may be applied from the exterior except regular-load torque and load torque for start and stop. Values from the ratings show the acceptable value at the time. The frequency of applying this torque is limited. See "On intensity" and "On life" section.

### ■Permissible maximum input rotational speed, permissible average input rotational speed

Use the input rotational speed within the limit of acceptable values shown from the ratings (calculation formula of the average input rotational speed: Page 049).

### ■Inertia moment

The inertia moment on the axles of the wave generators of each model is indicated.

# On Life

### ■Life of the wave generator

The life of HarmonicDrive® is determined by the life of the wave generator bearing, and you can calculate this by the rotational speed and the load torque just as with a general ball bearing.

Table 044-1

| | Life | |
|---|---|---|
| Series name | CSF-GH | CSG-GH |
| $L_{10}$ (10% damage probability) | 7,000 hours | 10,000 hours |
| $L_{50}$ (average life) | 35,000 hours | 50,000 hours |

* Life is based on the rated rotational speed and rated torque from the ratings.

Caluculation formula for Life (Lh) by actual operation condition

Formula 044-1

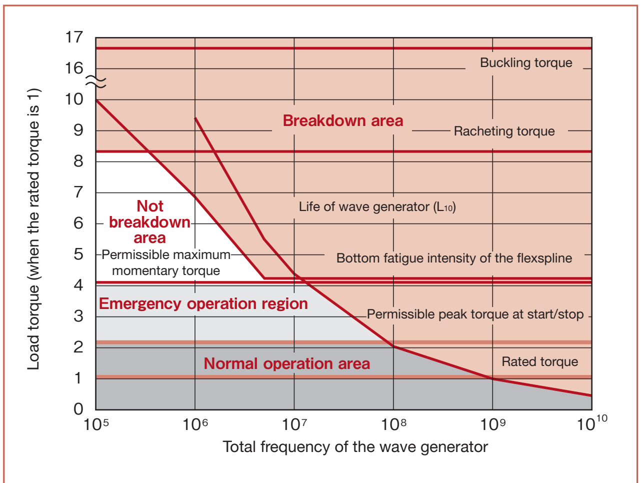
$$Lh = Ln \cdot \left(\frac{Tr}{Tav}\right)^3 \cdot \left(\frac{Nr}{Nav}\right)$$

Table 044-2

| | |
|---|---|
| Ln | Life of $L_{10}$ or $L_{50}$ |
| Tr | Rated torque |
| Nr | Rated rotational speed |
| *Tav* | Average load torque on the output side (calculation formula: Page 049) |
| *Nav* | Average input rotational speed (calculation formula: Page 049) |

Relational diagram of intensity and life of HarmonicDrive®

Graph 044-2




(Note)
Use HarmonicDrive® within the range of "Normal operation area." Using it beyond "Emergency operation area" may result in damaging HarmonicDrive® earlier than usual.
* Lubricant life such as for abrasion on the tooth surface is not taken into consideration in the graph described above.
* Use the graph above as reference values.

# On Intensity

## ■Intensity of flexspline

As flexspline repeats elastic deformation, the transmission torque of HarmonicDrive® is calculated based on the fatigue strength of the bottom of the flexspline. Values of the rated torque and permissible peak torque for start and stop are those within the fatigue limit of the bottom of the flexspline.
Although the value of the permissible maximum momentary torque (impact torque) fully endures the fatigue limit of the bottom of the flexspline, it could generate fatigue fracture if it frequently exceeds the permissible maximum momentary torque. Therefore, the number of applications of impact torque is limited to prevent possible fatigue fracture.

Restriction on the bending frequency of the flexspline by the rotation of the wave generator while the impact torque is applied: 1.0 x $10^4$ (frequency)

You can calculate the permissible frequency of impact torques from this restriction on the bending frequency.

Calculation formula

Formula 045-1

$$N=\frac{1.0\times10^4}{2\times\frac{n}{60}\times t}$$

Table 045-1

| | |
|---|---|
| Permissible frequency | N frequency |
| Time that impact torque is applied | t sec |
| Rotational speed of the wave generator | n r/min |
| The flexspline bends two times by one cycle of the wave generator. | |

| | |
|---|---|
| Caution | Exceeding the permissible frequency may cause fatigue damage to the flexspline. |

## ■Buckling torque

When excess torque is applied to the flexspline (output) with the wave generator fixed, the flexspline causes elastic deformation, buckles on the body before long and will be destroyed. The torque at the time is called buckling torque.

* See the corresponding pages of each series for buckling torque values.

| | |
|---|---|
| Warning | When the flexspline buckles, HarmonicDrive® will be put out of commission. Therefore, adequate care should be exercised. |

## ■Ratcheting torque

When excess impact torque is applied during operation, the engagement of the teeth between the circular spline and the flexspline may be put momentarily out of alignment instead of damaging the flexspline. This phenomenon is called "ratcheting," and the torque is called "ratcheting torque" (see values on the corresponding page of each series). Operating the drive without fixing ratcheting will result in earlier abrasion of the teeth and shorter life of the wave generator bearing due to the effect of the grinding powder generated by ratcheting.

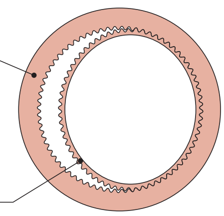
* See the corresponding pages of each series for ratcheting torque values.
* Ratcheting torque is affected by the rigidity of the housing to be used when installing the circular spline. Contact us for details of the ratcheting torque.

| | |
|---|---|
| Caution | When ratcheting is caused, the teeth may not be correctly engaged and become out of alignment as shown in Fig. 045-1. As operating the drive in this condition will generate vibration and damage the flexspline, adequate care should be exercised. |

| | |
|---|---|
| Caution | Once ratcheting is caused, the tips of the teeth are worn and the torque value generated by ratcheting will be lowered. Pay due attention to this point as well. |

When the engagement of the teeth is out of alignment

Fig. 045-1




This condition is called "dedoi-dal".

HPGP series HarmonicPlanetary® High-performance Gear Heads for Servo Motors series
HPG Series (Helical Gear Type) HarmonicPlanetary® High-performance Gear Heads for Servo Motors series
HPG Series (Standard Type) HarmonicPlanetary® High-performance Gear Heads for Servo Motors series
CSG-GH series HarmonicDrive® High-performance Gear Heads for Servo Motors series
CSF-GH series HarmonicDrive® High-performance Gear Heads for Servo Motors series
HPG series (Orthogonal Shaft Type) HarmonicPlanetary® High-performance Gear Heads for Servo Motors series

# On Rigidity

Rigidity and backlash of the drive system greatly affects the performance of the servo system. A detailed review of these items is required before designing the equipment and selecting a model number.

## ■Rigidity

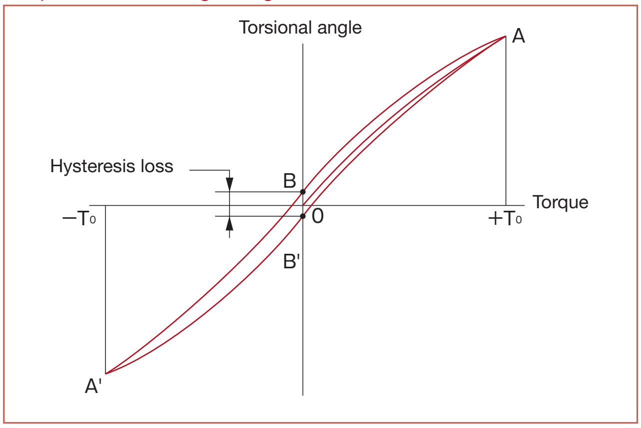
Fixing the input side (wave generator) and applying torque to the output side (flexspline) generates torsion almost proportional to the torque on the output side. Fig. 046-1 shows the torsional angle quantity on the output side when the torque applied on the output side starts from zero, increases up to $+T_0$ and decreases down to $-T_0$. This is called the "Torque – torsional angle diagram," which normally draws a loop of 0 – A – B – A' – B' – A. The slope described in the "Torque – torsional angle diagram" is represented as the spring constant for the rigidity of HarmonicDrive® (unit: N·m/rad).
As shown in Fig. 046-2, this "Torque – torsional angle diagram" is divided into 3 partitions, and the spring constants in the area are represented as $K_1$, $K_2$ and $K_3$.

$K_1$……The spring constant when the torque changes from [zero] to [$T_1$]
$K_2$……The spring constant when the torque changes from [$T_1$] to [$T_2$]
$K_3$……The spring constant when the torque changes [$T_2$] or more.

■See the corresponding pages of each series for values of the spring constants ($K_1$, $K_2$, $K_3$) and the torque-torsional angles ($T_1$, $T_2$- $\theta_1$, $\theta_2$).

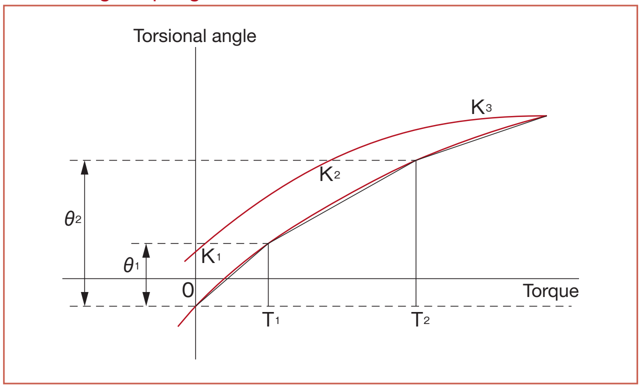
Torque - torsional angle diagram

Fig. 046-1




Partitioning of spring constant

Fig. 046-2




## ■Example of calculating torsional quantity

The torsional quantity ($\theta$) is obtained from the example of CSF-25-100-2A-GR.

**When the load torque is extremely small ($T_{L1}$=2.9 N·m)**

As the torque is $T_1$ or less, torsional quantity $\theta_{L1}$ is represented as follows.

$$\theta_{L1} = T_{L1}/K_1 = 2.9/3.1\times10^4 = 9.4\times10^{-5}\,\text{rad (0.33 arc-min)}$$

**When the load torque is $T_{L2}$=39 N·m)**

As the torque between $T_1$ and $T_2$, torsional quantity $\theta_{L2}$ is represented as follows.

$$\theta_{L2} = \theta_1 + (T_{L2}-T_1)/K_2 = 4.4\times10^{-4} + (39-14)/5.0\times10^4 = 9.4\times10^{-4}\,\text{rad (3.2 arc-min)}$$

The total torsional quantity when the load is applied the other way round will be double the quantity obtained above plus the backlash quantity.

* The torsional quantity indicates the value of the stand-alone component.
Note that the torsional quantity of the output shaft is not included.

## ■Hysteresis loss

As shown in Fig. 046-1, when the torque is applied up to the rated value and is brought back to [zero], the torsional angle does not become absolutely [zero] and a small amount remains (B – B').
This is called hysteresis loss.

■See the corresponding pages of each series for hysteresis loss quantity.

## ■Backlash

As hysteresis loss is mainly generated by internal abrasion, it is hardly generated, and only a small allowance is represented in the diagram when the torque is extremely small.
As the allowance of the tooth engagement is suppressed to [zero] for HarmonicDrive®, the backlash quantity is caused by the clearance of Oldham's coupling (self-aligning mechanism) of the wave generator. The rigid type has no clearance. The value measured on the output side by fixing the input side is very small as shown on the corresponding page of each series.

* See the corresponding pages of each series for the backlash quantity.

## On Vibration

The angle transmission error elements of HarmonicDrive® may appear as rotating vibration of the load side inertia.
Especially when the characteristic frequency of the vibration system including HarmonicDrive® overlaps that of the chassis or load inertia, it generates a resonant condition that amplifies angle transmission error elements of HarmonicDrive®. Observe the design guide of each series.

Two angle transmission error elements of HarmonicDrive® correspond to a cycle of the input shaft from the mechanical viewpoint of HarmonicDrive®. Therefore, the frequency is double the input frequency as it is the main element of the error.

If the characteristic frequency of the vibration system including HarmonicDrive® is f=15 Hz, the input rotational speed (N) is expressed as shown below.

Formula 047-1

$$N = \frac{15}{2} \cdot 60 = 450\text{r/min}$$

The resonant condition is generated in the rotating speed area (450 r/min).

How to obtain the characteristic frequency of the vibration system including HarmonicDrive®

Formula 047-2

$$f = \frac{1}{2\pi}\sqrt{\frac{K}{J}}$$

Symbol of the calculation formula

Table 047-1

| | | | |
|---|---|---|---|
| f | The characteristic frequency of the vibration system including HarmonicDrive® | Hz | |
| K | Spring constant of HarmonicDrive® | N·m/rad | See pages of each series. |
| J | Load inertia | $kg\cdot m^2$ | |

## Efficiency Characteristics

The efficiency varies depending on the following conditions.

■Reduction ratio
■Input rotational speed
■Load torque
■Temperature
■Lubrication condition (Type of lubricant and the quantity)

The efficiency characteristics of each series shown in this catalog depends depend on the measuring condition shown in Table 047-2.

■See the corresponding pages of on each series for efficiency values.

Measuring condition

Table 047-2

| | | | |
|---|---|---|---|
| Built-in | Measurement by building the recommended built-in precision into the product | | |
| Load torque | The rated torque shown in the ratings (see the corresponding pages on each series) | | |
| Lubricating condition | Grease lubrication | Name | Harmonic grease® SK-1A |
| | | | Harmonic grease® SK-2 |

# Model Number Selection

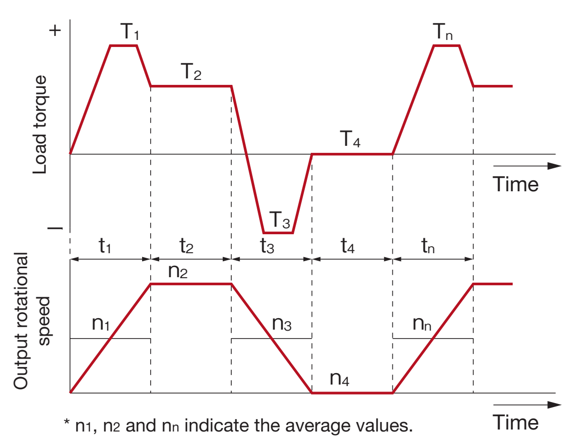
In general, the servo system is rarely in a continuous constant load state. The input rotational speed, load torque change and comparatively large torque are applied at start and stop. Unexpected impact torque may be applied.
These fluctuating load torques should be converted to the average load torque in selecting a model number.
As an accurate cross roller bearing is built in the direct external load support (output flange) of the unit type, the maximum moment load, life of the cross roller bearing and the static safety coefficient should also be checked (see "Checking the main roller bearing" on Page 114 to 119).

(Note) If HarmonicDrive® CSG/CSF-GH series is installed with the output shaft facing downward (motor faces upward) and continuously operated in one direction under the constant load state, lubrication failure may occur. In this case, please contact the sales office of Harmonic Drive Systems Inc.

## ■Checking the load torque pattern

First, you need to look at the picture of the load torque pattern. Check the specifications shown in the figure below.

Graph 048-1




* $n_1$, $n_2$ and $n_n$ indicate the average values.

**Obtain the value of each load torque pattern.**

| | |
|---|---|
| Load torque | $T_n$ (N·m) |
| Time | $t_n$ (sec) |
| Output rotational speed | $n_n$ (r/min) |

**<Normal operation pattern>**

| | |
|---|---|
| Starting time | $T_1$, $t_1$, $n_1$ |
| Steady operation time | $T_2$, $t_2$, $n_2$ |
| Stopping (slowing) time | $T_3$, $t_3$, $n_3$ |
| Break time | $T_4$, $t_4$, $n_4$ |

**<Maximum rotational speed>**

| | |
|---|---|
| Max. output rotational speed | $n_{o\,max}$ |
| Max. input rotational speed (Restricted by motors) | $n_{i\,max}$ |

**<Impact torque>**

| | |
|---|---|
| When impact torque is applied | $T_s$, $t_s$, $n_s$ |

**<Required life>**

$L_{10} = L$ (hours)

## ■Flowchart of model number selection

Select a model number according to the following flowchart.
If you find a value exceeding that from the ratings, you should review it with the upper-level model number or consider reduction of conditions including the load torque.

Calculate the average load torque applied on the output side of Harmonic Drive from the load torque pattern: $T_{av}$ (N·m).

$$T_{av} = \sqrt[3]{\frac{n_1 \cdot t_1 \cdot |T_1|^3 + n_2 \cdot t_2 \cdot |T_2|^3 + \cdots n_n \cdot t_n \cdot |T_n|^3}{n_1 \cdot t_1 + n_2 \cdot t_2 + \cdots n_n \cdot t_n}}$$

↓

Select a model number temporarily with the following conditions.
$T_{av} \leqq$ Permissible maximum value of the average load torque
(See the ratings of each series).

↓

Calculate the average output rotational speed: $n_{o\,av}$ (r/min)

$$n_{o\,av} = \frac{n_1 \cdot t_1 + n_2 \cdot t_2 + \cdots n_n \cdot t_n}{t_1 + t_2 + \cdots t_n}$$

Obtain the reduction ratio (R). A limit is placed on "$n_{i\,max}$" by motors.

$$\frac{n_{i\,max}}{n_{o\,max}} \geqq R$$

Calculate the average input rotational speed from the average output rotational speed ($n_{o\,av}$) and the reduction ratio (R): $n_{i\,av}$ (r/min)

$$n_{i\,av} = n_{o\,av} \cdot R$$

Calculate the maximum input rotational speed from the max. output rotational speed ($n_{o\,max}$) and the reduction ratio (R): $n_{i\,max}$ (r/min)

$$n_{i\,max} = n_{o\,max} \cdot R$$

↓

Check whether the temporarily selected model number satisfies the following condition from the ratings.
$N_{i\,av} \leqq$ Permissible average input rotational speed (r/min)
$N_{i\,max} \leqq$ Permissible max. input rotational speed (r/min)
→ NG / ↓ OK

Check whether $T_1$ and $T_3$ are equal to or less than the permissible peak torque (N·m) value at start and stop from the ratings.
→ NG / ↓ OK

Check whether $T_s$ is equal to or less than the permissible maximum momentary torque (N·m) value from the ratings.
→ NG / ↓ OK

Calculate ($N_s$) the permissible number of times from output rotational speed $n_s$ and time $t_s$ when the impact torque is applied, and check whether it satisfies the usage conditions.

$$N_S = \frac{10^4}{2 \cdot \frac{n_S \cdot R}{60} \cdot t} \text{ (times)} \cdot N_S \leqq 1.0 \times 10^4 \text{ (times)}$$

→ NG / ↓ OK

Calculate the lifetime.

$$L_{10} = 7000 \cdot \left(\frac{T_r}{T_{av}}\right)^3 \cdot \left(\frac{n_r}{n_{i\,av}}\right) \text{(hours)}$$

↓

Check whether the calculated lifetime is equal to or more than the life of the wave generator (see Page 044).
→ NG / ↓ OK

The model number is determined.

NG → Review of the operation conditions and model number

# Example of model number selection

**Value of each load torque pattern.**

Load torque $T_n$ (N·m)
Time $t_n$ (sec)
Output rotational speed $n_n$ (r/min)

**<Normal operation pattern>**

Starting time $T_1$ = 400 N·m, $t_1$ = 0.3 sec, $n_1$ = 7 r/min
Steady operation time $T_2$ = 320 N·m, $t_2$ = 3 sec, $n_2$ = 14 r/min
Stopping (slowing) time $T_3$ = 200 N·m, $t_3$ = 0.4 sec, $n_3$ = 7 r/min
Break time $T_4$ = 0 N·m, $t_4$ = 0.2 sec, $n_4$ = 0 r/min

**<Maximum rotational speed>**

Max. output rotational speed no *max* = 14 r/min
Max. input rotational speed ni *max* = 1800 r/min
(Restricted by motors)

**<Impact torque>**

When impact torque is applied $T_s$ = 500 N·m, $t_s$ = 0.15 sec, $n_s$ = 14 r/min

**<Required life>**

$L_{10}$ = 7000 (hours)

Calculate the average load torque applied on the output side of Harmonic Drive from the load torque pattern: T*av* (N·m).

$$T_{av} = \sqrt[3]{\frac{7\text{r/min}\cdot 0.3\text{sec}\cdot|400\text{N·m}|^3+14\text{r/min}\cdot 3\text{sec}\cdot|320\text{N·m}|^3+7\text{r/min}\cdot 0.4\text{sec}\cdot|200\text{N·m}|^3}{7\text{r/min}\cdot 0.3\text{sec}+14\text{r/min}\cdot 3\text{sec}+7\text{r/min}\cdot 0.4\text{sec}}}$$

Select a model number temporarily with the following conditions. T*av* = 319 N·m ≦ 620 N·m
(Permissible maximum value of the average load torque for model number CSF-45-120-GH: See the ratings on Page 050.)
Thus, **CSF-45-120-GH** is temporarily selected.

Calculate the average output rotational speed: no *av* (r/min)

$$n_{o\,av} = \frac{7\text{ r/min}\cdot 0.3\text{ sec}+14\text{ r/min}\cdot 3\text{ sec}+7\text{ r/min}\cdot 0.4\text{ sec}}{0.3\text{ sec} + 3\text{ sec} + 0.4\text{ sec} + 0.2\text{ sec}} = 12\text{ r/min}$$

Obtain the reduction ratio (R).

$$\frac{1800\text{ r/min}}{14\text{ r/min}} = 128.6 \geqq 120$$

Calculate the average input rotational speed from the average output rotational speed (no *av*) and the reduction ratio (R): ni *av* (r/min)

ni *av* = 12 r/min·120 = 144 0r/min

Calculate the maximum input rotational speed from the maximum output rotational speed (no *max*) and the reduction ratio (R): ni *max* (r/min)

ni *max* = 14 r/min·120 = 1680 r/min

Check whether the temporarily selected model number satisfies the following condition from the ratings.

Ni *av* = 1440 r/min ≦ 3000 r/min (Permissible average input rotational speed of model No. 45)
Ni *max* = 1680 r/min ≦ 3800 r/min (Permissible max. input rotational speed of model No. 45)

NG / OK

Check whether $T_1$ and $T_3$ are equal to or less than the permissible peak torque (N·m) value at start and stop from the ratings.

$T_1$ = 400 N·m ≦ 823 N·m (Permissible peak torque at start and stop of model number 45)
$T_3$ = 200 N·m ≦ 823 N·m (Permissible peak torque at start and stop of model number 45)

NG / OK

Check whether Ts is equal to or less than the permissible maximum momentary torque (N·m) value from the ratings.

$T_s$ = 500 N·m ≦ 1760 N·m (Permissible maximum momentary torque of model number 45)

NG / OK

Calculate the permissible number of times ($N_s$) from output rotational speed $n_s$ and time $t_s$ when the impact torque is applied, and check whether it satisfies the usage conditions.

$$N_S = \frac{10^4}{2\cdot\dfrac{14\text{ r/min}\cdot 120}{60}\cdot 0.15\text{ sec}} = 1190 \leqq 1.0\times10^4 \text{ (times)}$$

NG / OK

Calculate the lifetime.

$$L_{10} = 7000\cdot\left(\frac{402\text{ N·m}}{319\text{ N·m}}\right)^3\cdot\left(\frac{2000\text{ r/min}}{1440\text{ r/min}}\right)\text{(hours)}$$

Check whether the calculated life is equal to or more than the life of the wave generator (see Page 026).
$L_{10}$ =19,457 hours ≧ 7000 (life of the wave generator: $L_{10}$)

NG / OK

Model number **CSF-45-120-GH** is determined from the result described above.

Review of the operation conditions and model number

# Rating Table CSG-GH

CSG-GH series is high-torque type HarmonicDrive® gear head.
The HarmonicDrive® CSG-GH series is especially suitable for a wide range of high technology fields requiring precision motion control such as the semiconductor or LCD production equipment, robot and machine tool industries.

Table 050-1

| Model | Reduction ratio | Rated output torque at 2000 r/min. [*1] | | Rated output torque at 3000 r/min. [*2 *8] | | Permissible max. value of ave. load torque [*3] | | Permissible peak torque on start/stop [*4] | | Permissible max. momentary torque [*5] | | Permissible ave. input speed | Permissible max. input speed [*6] | Mass of reducer itself [*7] Shaft output | Mass of reducer itself [*7] Flange output |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N·m | kgf·m | N·m | kgf·m | N·m | kgf·m | N·m | kgf·m | N·m | kgf·m | r/min | r/min | kg | kg |
| 14 | 50 | 7.0 | 0.7 | 6.1 | 0.6 | 9.0 | 0.9 | 23 | 2.3 | 46 | 4.7 | 3500 | 8500 | 0.62 | 0.50 |
| | 80 | 10 | 1.0 | 8.7 | 0.9 | 14 | 1.4 | 30 | 3.1 | 61 | 6.2 | | | | |
| | 100 | 10 | 1.0 | 8.7 | 0.9 | 14 | 1.4 | 36 | 3.7 | 70 | 7.2 | | | | |
| 20 | 50 | 33 | 3.3 | 29 | 2.9 | 44 | 4.5 | 73 | 7.4 | 127 | 13 | 3500 | 6500 | 1.8 | 1.4 |
| | 80 | 44 | 4.5 | 38 | 3.9 | 61 | 6.2 | 96 | 9.8 | 165 | 17 | | | | |
| | 100 | 52 | 5.3 | 45 | 4.6 | 64 | 6.5 | 107 | 10.9 | 191 | 20 | | | | |
| | 120 | 52 | 5.3 | 45 | 4.6 | 64 | 6.5 | 113 | 11.5 | 191 | 20 | | | | |
| | 160 | 52 | 5.3 | 45 | 4.6 | 64 | 6.5 | 120 | 12.2 | 191 | 20 | | | | |
| 32 | 50 | 99 | 10 | 86 | 8.8 | 140 | 14 | 281 | 29 | 497 | 51 | 3500 | 4800 | 4.6 | 3.2 |
| | 80 | 153 | 16 | 134 | 14 | 217 | 22 | 395 | 40 | 738 | 75 | | | | |
| | 100 | 178 | 18 | 155 | 16 | 281 | 29 | 433 | 44 | 812 | 83 | | | | |
| | 120 | 178 | 18 | 155 | 16 | 281 | 29 | 459 | 47 | 812 | 83 | | | | |
| | 160 | 178 | 18 | 155 | 16 | 281 | 29 | 484 | 49 | 812 | 83 | | | | |
| 45 | 50 | 229 | 23 | 200 | 20 | 345 | 35 | 650 | 66 | 1235 | 126 | 3000 | 3800 | 13 | 10 |
| | 80 | 407 | 41 | 356 | 36 | 507 | 52 | 918 | 94 | 1651 | 168 | | | | |
| | 100 | 459 | 47 | 401 | 41 | 650 | 66 | 982 | 100 | 2033 | 207 | | | | |
| | 120 | 523 | 53 | 457 | 47 | 806 | 82 | 1070 | 109 | 2033 | 207 | | | | |
| | 160 | 523 | 53 | 457 | 47 | 819 | 84 | 1147 | 117 | 2033 | 207 | | | | |
| 65 | 80 | 969 | 99 | 846 | 86 | 1352 | 138 | 2743 | 280 | 4836 | 493 | 1900 | 2800 | 32 | 24 |
| | 100 | 1236 | 126 | 1080 | 110 | 1976 | 202 | 2990 | 305 | 5174 | 528 | | | | |
| | 120 | 1236 | 126 | 1080 | 110 | 2041 | 208 | 3263 | 333 | 5174 | 528 | | | | |
| | 160 | 1236 | 126 | 1080 | 110 | 2041 | 208 | 3419 | 349 | 5174 | 528 | | | | |

(Note)
1. Output torque set based on the life of $L_{10}$ = 10,000 hours when input rotational speed is 2000 r/min, which is the rated rotational speed of ordinary servo motors.
2. Output torque set based on the life of $L_{10}$ = 10,000 hours when input speed is 3000 r/min, which is the rated rotational speed of ordinary servo motors.
3. Permissible maximum value of average load torque calculated based on a load torque pattern (page 048).
   Note that exceeding this value may deteriorate the life or durability of the product.
4. Permissible maximum value of torque applied on start and stop in operation cycles.
5. Permissible maximum value for impact torque in an emergency stop and for external impact torque.Calculate the permissible frequency when selecting the model and check whether it meets the operating conditions.
6. Permissible maximum value of average load torque on non-continuous operation condition. The input rotational speed varies depending on operating environment or operating conditions. It is appropriate to regard the reference input speed during continuous operation as 3000 r/min.
   (Note) If HarmonicDrive® CSG-GH series is installed with the output shaft facing downward (motor faces upward) and continuously operated in one direction under the constant load state, lubrication failure may occur. * In this case, please contact the sales office of Harmonic Drive Systems Inc.
7. The weight of a speed reducer itself. See dimension (pages 053 to 057) tables for values that include an input shaft coupling, motor flange and other parts.
8. The rated torque of the model number 65 is for input 2800 r/min.

# Ratcheting Torque CSG-GH

Table 050-2
Unit: N·m

| Reduction ratio \ Model | 14 | 20 | 32 | 45 | 65 |
|---|---|---|---|---|---|
| 50 | 110 | 280 | 1200 | 3500 | — |
| 80 | 140 | 450 | 1800 | 5000 | 14000 |
| 100 | 100 | 330 | 1300 | 4000 | 12000 |
| 120 | — | 310 | 1200 | 3600 | 10000 |
| 160 | — | 280 | 1200 | 3300 | 10000 |

# Buckling Torque CSG-GH

Table 050-3
Unit: N·m

| Model | 14 | 20 | 32 | 45 | 65 |
|---|---|---|---|---|---|
| Total reduction ratio | 260 | 800 | 3500 | 8900 | 26600 |

# Performance Table CSG-GH

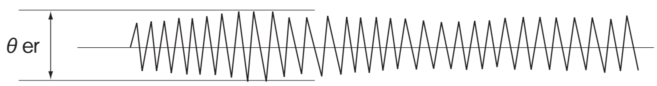
CSG-GH series is high-torque type HarmonicDrive® gear head.
The HarmonicDrive® CSG-GH series is especially suitable for a wide range of high technology fields requiring precision motion control such as the semiconductor or LCD production equipment, robot and machine tool industries.

Table 051-1

| Model | Shape symbol on input side*1 | Reduction ratio | Angle transmission precision*2 | | Positioning Precision Repeatability*3 | Starting torque*4 | | Overdrive starting torque*5 | | No-load running torque*6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | arc-min | $\times10^{-4}$rad | arc-sec | cN·m | kgf·cm | N·m | kgf·m | cN·m | kgf·cm |
| 14 | All products | 50 | 1.5 | 4.4 | ±10 | 8.5 | 0.9 | 3.0 | 0.3 | 5.6 | 0.6 |
| | | 80 | | | | 7.1 | 0.7 | 4.0 | 0.4 | 5.1 | 0.5 |
| | | 100 | | | | 6.8 | 0.7 | 4.9 | 0.5 | 4.6 | 0.5 |
| 20 | E□□ | 50 | 1.0 | 2.9 | ±8 | 14 | 1.4 | 8 | 0.8 | 11 | 1.2 |
| | | 80 | | | | 10 | 1.1 | 10 | 1.0 | 10 | 1.0 |
| | | 100 | | | | 10 | 1.0 | 13 | 1.3 | 10 | 1.0 |
| | | 120 | | | | 9.4 | 1.0 | 14 | 1.4 | 9.8 | 1.0 |
| | | 160 | | | | 8.9 | 0.9 | 18 | 1.8 | 9.6 | 1.0 |
| | F□□<br>G□□ | 50 | | | | 21 | 2.1 | 12 | 1.3 | 11 | 1.2 |
| | | 80 | | | | 17 | 1.8 | 16 | 1.7 | 10 | 1.0 |
| | | 100 | | | | 16 | 1.7 | 20 | 2.0 | 10 | 1.0 |
| | | 120 | | | | 16 | 1.7 | 24 | 2.4 | 9.8 | 1.0 |
| | | 160 | | | | 15 | 1.6 | 30 | 3.0 | 9.6 | 1.0 |
| 32 | KP□<br>KQ□<br>KR□<br>KS□ | 50 | 1.0 | 2.9 | ±6 | 61 | 6.2 | 37 | 3.8 | 47 | 4.8 |
| | | 80 | | | | 48 | 4.9 | 46 | 4.7 | 42 | 4.3 |
| | | 100 | | | | 47 | 4.8 | 56 | 5.7 | 41 | 4.2 |
| | | 120 | | | | 43 | 4.4 | 63 | 6.4 | 40 | 4.1 |
| | | 160 | | | | 42 | 4.3 | 81 | 8.3 | 40 | 4.1 |
| | Products other than above | 50 | | | | 53 | 5.4 | 32 | 3.3 | 47 | 4.8 |
| | | 80 | | | | 40 | 4.1 | 39 | 4.0 | 42 | 4.3 |
| | | 100 | | | | 39 | 4.0 | 47 | 4.8 | 41 | 4.2 |
| | | 120 | | | | 35 | 3.6 | 51 | 5.2 | 40 | 4.1 |
| | | 160 | | | | 34 | 3.5 | 66 | 6.7 | 40 | 4.1 |
| 45 | All products | 50 | 1.0 | 2.9 | ±5 | 129 | 13 | 78 | 8.0 | 120 | 12 |
| | | 80 | | | | 99 | 10 | 96 | 9.8 | 109 | 11 |
| | | 100 | | | | 93 | 9.5 | 111 | 11 | 107 | 11 |
| | | 120 | | | | 88 | 9.0 | 128 | 13 | 105 | 11 |
| | | 160 | | | | 82 | 8.4 | 158 | 16 | 103 | 11 |
| 65 | All products | 80 | 1.0 | 2.9 | ±4 | 197 | 20 | 191 | 19 | 297 | 30 |
| | | 100 | | | | 176 | 18 | 213 | 22 | 289 | 30 |
| | | 120 | | | | 165 | 17 | 240 | 24 | 285 | 29 |
| | | 160 | | | | 147 | 15 | 285 | 29 | 278 | 28 |

(Note) 1. The shape symbols indicate the motor flange shape and input shaft joint shape of the model (refer to P007). (Upper 2 digits indicate the motor flange shape, and lower 1 digit indicates the input shaft joint shape.)
2. Angle transmission precision indicates the difference between the logical rotating angle and the actual rotating angle of output when any rotating angle is given as an input. The values in the table are maximum values.

Fig. 051-1

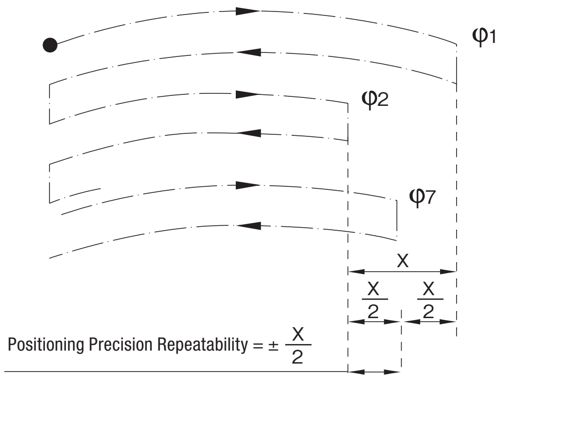



$\theta er$ : Angle transmission precision
$\theta_1$ : Input rotating angle
$\theta_2$ : Actual output rotating angle
R : Reduction ratio of HPG series (i =1: R)

$$\theta er = \theta_2 - \frac{\theta_1}{R}$$

3. The positioning precision repeatability is determined by repeating positioning in a given position from the same direction seven times, by measuring stop positions of the output shaft and by calculating the maximum difference. Measured values are indicated in angles (degrees) and are prefixed with "±" to 1/2 of the maximum differences. The values in the table are maximum values.

Fig. 051-2




4. Starting torque means the momentary "starting torque" with which the output side starts rotation when a torque is applied on the input side. The values in the table are maximum values.

## Measuring condition

Table 051-2

| | |
|---|---|
| Load | No load |
| Speed reducer surface temperature | 25°C |

5. Overdrive starting torque means the momentary "starting torque" with which the input side starts rotation when a torque is applied on the output side. The values in the table are maximum values.

## Measuring condition

Table 051-3

| | |
|---|---|
| Load | No load |
| Speed reducer surface temperature | 25°C |

6. No-load running torque means the torque on the input side required to put the speed reducer under a no-load condition. The values in the table are average values.

## Measuring condition

Table 051-4

| | |
|---|---|
| Input speed | 2000 r/min |
| Load | No load |
| Speed reducer surface temperature | 25°C |

# Rigidity (Spring constant) CSG-GH

Table 052-1

| Symbol | | Model | 14 | 20 | 32 | 45 | 65 |
|---|---|---|---|---|---|---|---|
| $T_1$ | | N·m | 2.0 | 7.0 | 29 | 76 | 235 |
| | | kgf·m | 0.2 | 0.7 | 3.0 | 7.8 | 24 |
| $T_2$ | | N·m | 6.9 | 25 | 108 | 275 | 843 |
| | | kgf·m | 0.7 | 2.5 | 11 | 28 | 86 |
| Reduction ratio 50 | $K_1$ | $\times 10^4$ N·m/rad | 0.34 | 1.3 | 5.4 | 15 | — |
| | | kgf·m/arc-min | 0.1 | 0.38 | 1.6 | 4.3 | — |
| | $K_2$ | $\times 10^4$ N·m/rad | 0.47 | 1.8 | 7.8 | 2.0 | — |
| | | kgf·m/arc-min | 0.14 | 0.52 | 2.3 | 6.0 | — |
| | $K_3$ | $\times 10^4$ N·m/rad | 0.57 | 2.3 | 9.8 | 26 | — |
| | | kgf·m/arc-min | 0.17 | 0.67 | 2.9 | 7.6 | — |
| | $\theta_1$ | $\times 10^{-4}$ rad | 5.8 | 5.2 | 5.5 | 5.2 | — |
| | | arc-min | 2.0 | 1.8 | 1.9 | 1.8 | — |
| | $\theta_2$ | $\times 10^{-4}$ rad | 16 | 15.4 | 15.7 | 15.1 | — |
| | | arc-min | 5.6 | 5.3 | 5.4 | 5.2 | — |
| Reduction ratio 80 or more | $K_1$ | $\times 10^4$ N·m/rad | 0.47 | 1.6 | 6.7 | 18 | 54 |
| | | kgf·m/arc-min | 0.14 | 0.47 | 2.0 | 5.4 | 16 |
| | $K_2$ | $\times 10^4$ N·m/rad | 0.61 | 2.5 | 11 | 29 | 88 |
| | | kgf·m/arc-min | 0.18 | 0.75 | 3.2 | 8.5 | 26 |
| | $K_3$ | $\times 10^4$ N·m/rad | 0.71 | 2.9 | 12 | 33 | 98 |
| | | kgf·m/arc-min | 0.21 | 0.85 | 3.7 | 9.7 | 29 |
| | $\theta_1$ | $\times 10^{-4}$ rad | 4.1 | 4.4 | 4.4 | 4.1 | 4.4 |
| | | arc-min | 1.4 | 1.5 | 1.5 | 1.4 | 1.5 |
| | $\theta_2$ | $\times 10^{-4}$ rad | 12 | 11.3 | 11.6 | 11.1 | 11.3 |
| | | arc-min | 4.2 | 3.9 | 4.0 | 3.8 | 3.9 |

See page 046 for a description of terms. * The values in this table are average values.

# Hysteresis Loss CSG-GH

Reduction ratio 50: Approx. 5.8 x $10^{-4}$ rad (2arc-min)
Reduction ratio 80 or more: Approx. 2.9 x $10^{-4}$ rad (1arc-min)

See page 046 for a description of terms.

# Max. Backlash Quantity CSG-GH

Table 052-2

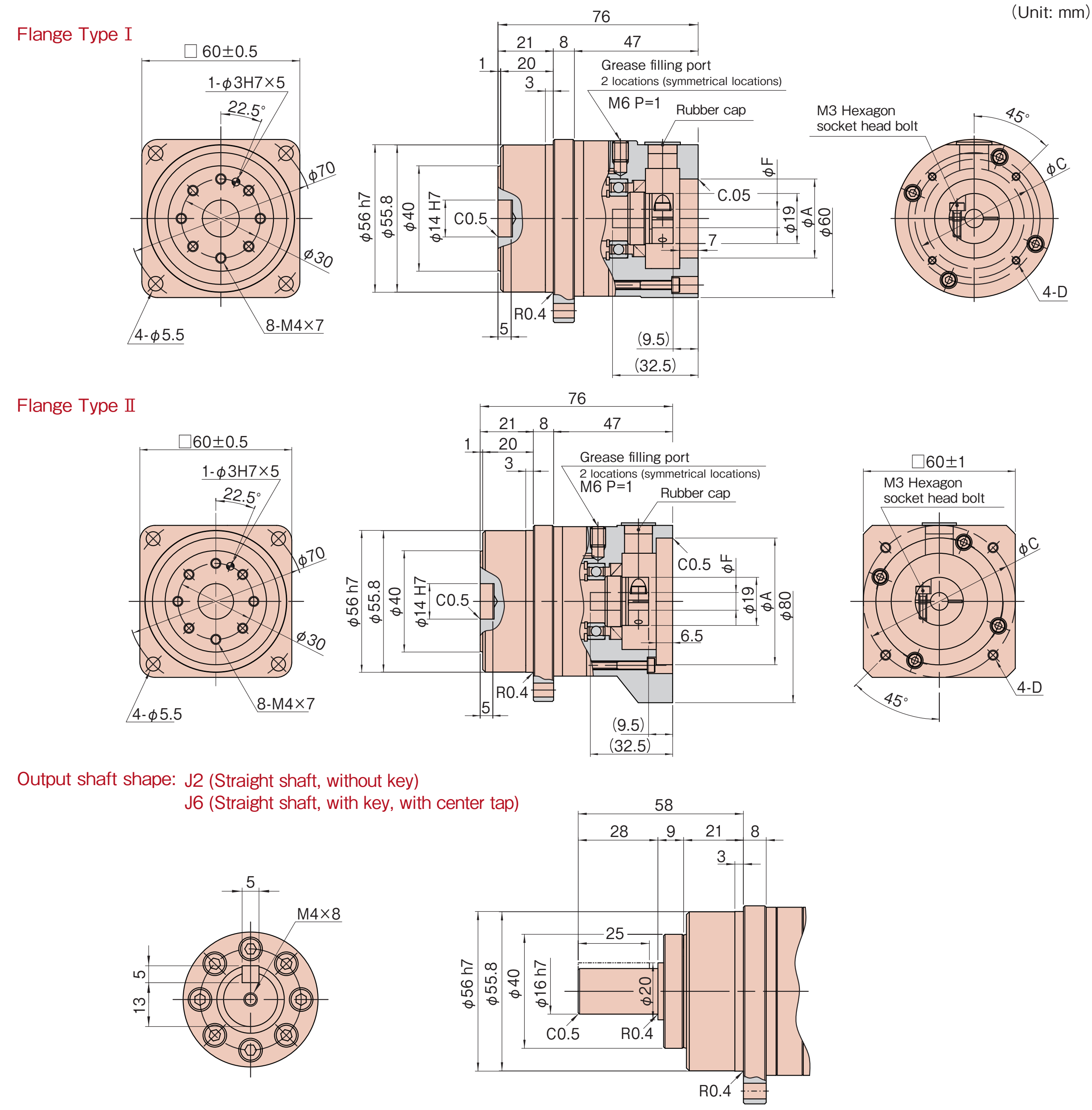
| Reduction ratio | Model | 14 | 20 | 32 | 45 | 65 |
|---|---|---|---|---|---|---|
| 50 | $\times 10^{-5}$ rad | 17.5 | 8.2 | 6.8 | 5.8 | — |
| | arc-sec | 36 | 17 | 14 | 12 | — |
| 80 | $\times 10^{-5}$ rad | 11.2 | 5.3 | 4.4 | 3.9 | 2.9 |
| | arc-sec | 23 | 11 | 9 | 8 | 6 |
| 100 | $\times 10^{-5}$ rad | 8.7 | 4.4 | 3.4 | 2.9 | 2.4 |
| | arc-sec | 18 | 9 | 7 | 6 | 5 |
| 120 | $\times 10^{-5}$ rad | — | 3.9 | 2.9 | 2.4 | 1.9 |
| | arc-sec | — | 8 | 6 | 5 | 4 |
| 160 | $\times 10^{-5}$ rad | — | 2.9 | 2.4 | 1.9 | 1.5 |
| | arc-sec | — | 6 | 5 | 4 | 3 |

See page 046 for a description of terms.

# Dimensional Outline Drawing – Model No. 14 CSG-GH

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.

Fig. 053-1




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# Measurement Table

Table 053-1
Unit: mm

| | Shape symbol [*1] | A(H7) | C | D | F(H7) Min | F(H7) Max | Mass (kg)[*2] Shaft output | Mass (kg)[*2] Flange output |
|---|---|---|---|---|---|---|---|---|
| Flange Type Ⅰ | AB□ | 30 | 45 | M3×8 | 6 | 8 | 0.88 | 0.76 |
| | AC□ | | 46 | M4×10 | | | | |
| | AD□ | 34 | 48 | M3×8 | | | | |
| Flange Type Ⅱ | BA□ | 50 | 60 | M4×10 | 6 | 8 | 0.9 | 0.78 |
| | BB□ | | 70 | | | | | |
| | BC□ | | | M5×12 | | | | |

Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on special installation method.

(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. The mass varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

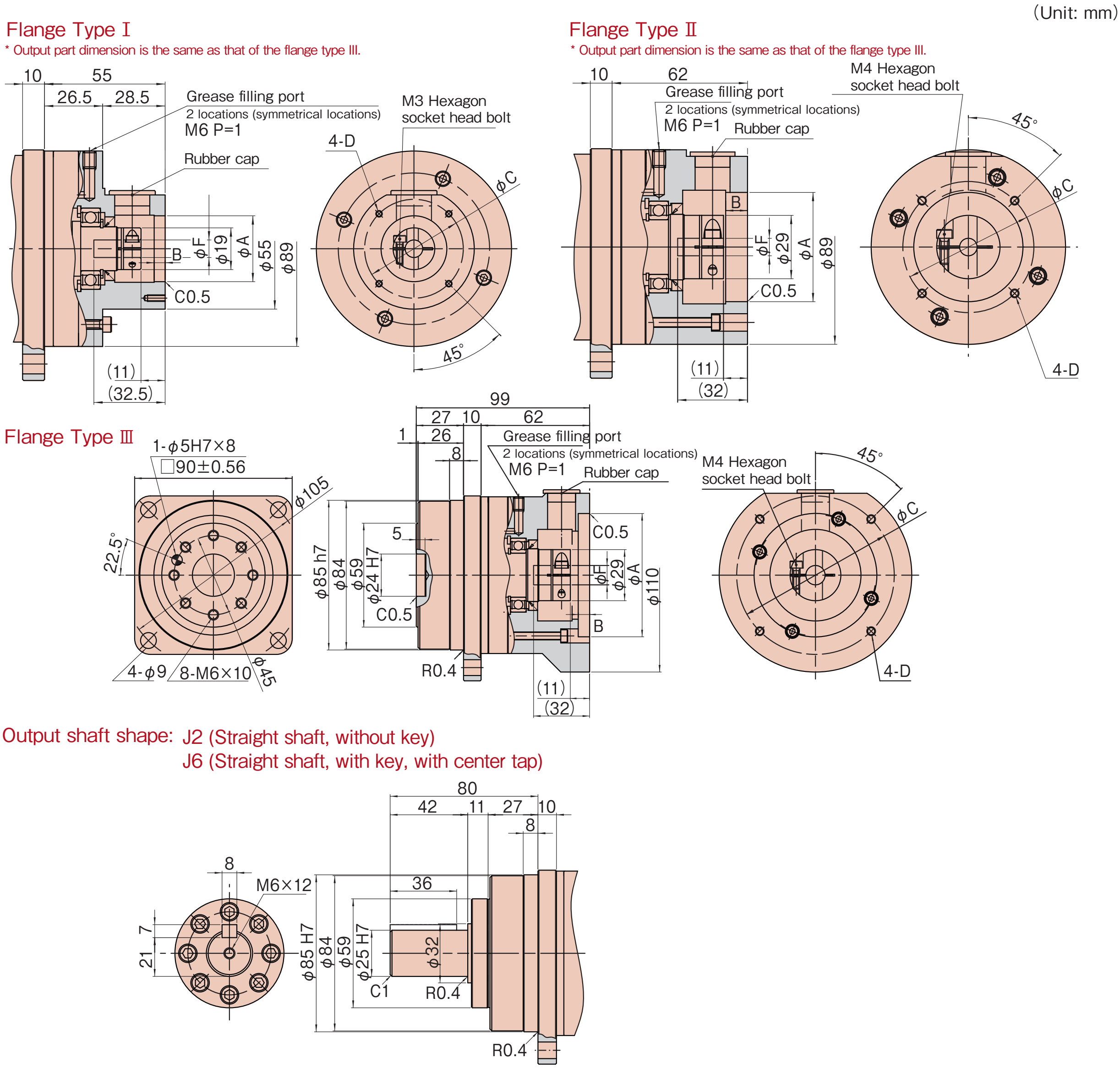
HPGP series HarmonicPlanetary® High-performance Gear Heads for Servo Motors series
HPG Series (Helical Gear Type) HarmonicPlanetary® High-performance Gear Heads for Servo Motors series
HPG Series (Standard Type) HarmonicPlanetary® High-performance Gear Heads for Servo Motors series
CSG-GH series HarmonicDrive® High-performance Gear Heads for Servo Motors series
CSF-GH series HarmonicDrive® High-performance Gear Heads for Servo Motors series
HPG series (Orthogonal Shaft Type) HarmonicPlanetary® High-performance Gear Heads for Servo Motors series

# Dimensional Outline Drawing – Model No. 20 CSG-GH

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.

Fig. 054-1

(Unit: mm)




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# Measurement Table

Table 054-1

Unit: mm

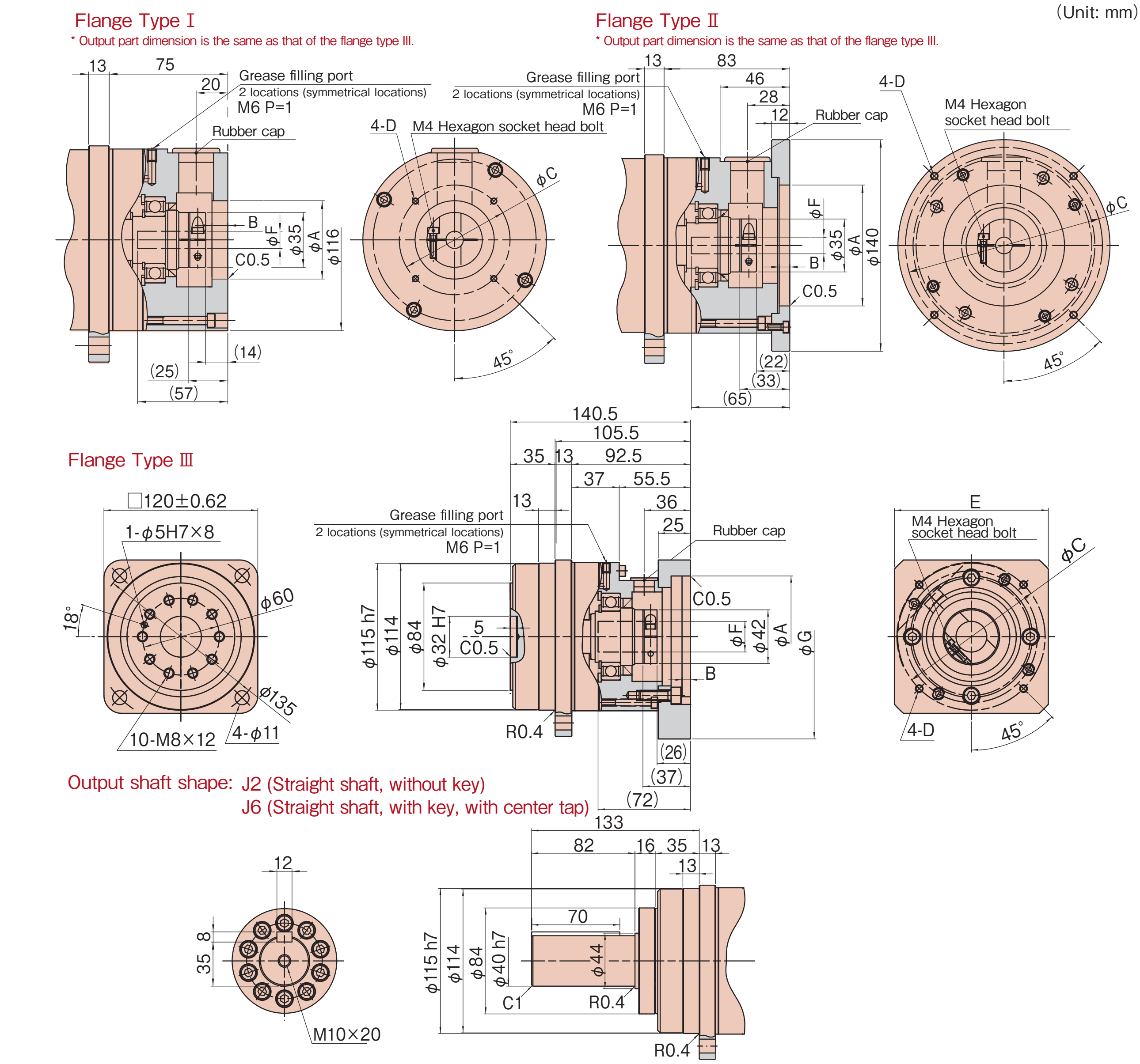
| | Shape symbol*1 | A(H7) | B | C | D | F(H7) Min | F(H7) Max | Mass (kg)*2 Shaft output | Mass (kg)*2 Flange output |
|---|---|---|---|---|---|---|---|---|---|
| Flange Type Ⅰ | EA□ | 30 | 5 | 45 | M3×8 | 7 | 8 | 2.3 | 1.9 |
| | EB□ | | | 46 | M4×10 | | | | |
| | EC□ | 34 | 6 | 48 | M3×8 | | | | |
| Flange Type Ⅱ | FA□ | 50 | 10 | 60 | M4×10 | 8 | 14 | 2.6 | 2.2 |
| | FB□ | | | 70 | | | | | |
| | FC□ | | | | M5×12 | | | | |
| Flange Type Ⅲ | GA□ | 70 | 6.5 | 90 | M5×12 | 8 | 14 | 2.8 | 2.4 |
| | GB□ | | | | M6×14 | | | | |

Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. The mass varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

# Dimensional Outline Drawing – Model No. 32 CSG-GH

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.

Fig. 055-1




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

## Measurement Table

Table 055-1
Unit: mm

| | Shape symbol[*1] | A(H7) | B | C | D | E | F(H7) Min | F(H7) Max | G | Mass (kg)[*2] Shaft output | Mass (kg)[*2] Flange output |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Flange Type Ⅰ | KA□ | 50 | 10 | 70 | M4×10 | – | 11 | 19 | – | 6.4 | 5 |
| | KB□ | | | | M5×12 | | | | | | |
| | KC□ | 60 | 7 | 99 | M6×14 | | | | | | |
| | KD□ | 70 | | 90 | M5×12 | | | | | | |
| | KE□ | | | | M6×14 | | | | | | |
| | KF□ | 80 | | 100 | | | | | | | |
| | KI□ | 50 | 10 | 60 | M4×10 | | | | | | |
| Flange Type Ⅱ | KG□ | 95 | 7 | 115 | M6×12 | – | 11 | 19 | – | 6.6 | 5.2 |
| | KH□ | | | | M8×12 | | | | | | |
| Flange Type Ⅲ | KP□ | 95 | 6.5 | 115 | M6×14 | □120 | 16 | 24 | 160 | 6.9 | 5.5 |
| | KQ□ | | | | M8×25 | | | | | | |
| | KR□ | 110 | | 145 | | □130 | | | 165 | | |
| | KS□ | 130 | | 165 | M10×25 | □180 | | | 233 | 7.9 | 6.5 |

Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. The mass varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

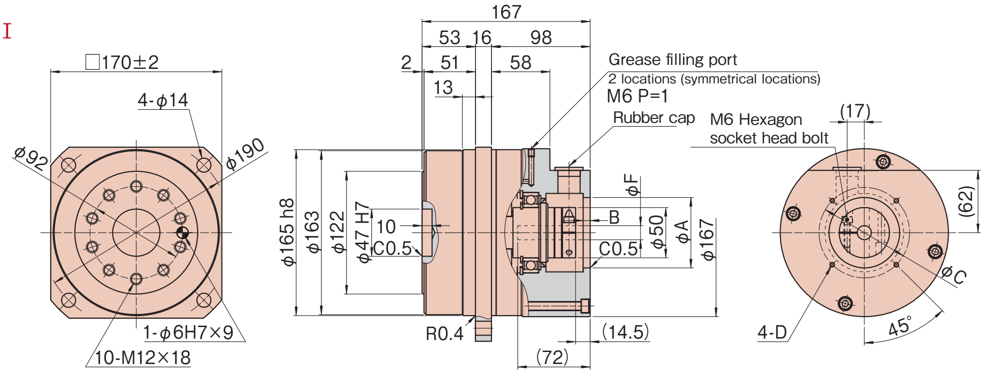
# Dimensional Outline Drawing – Model No. 45 CSG-GH

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.

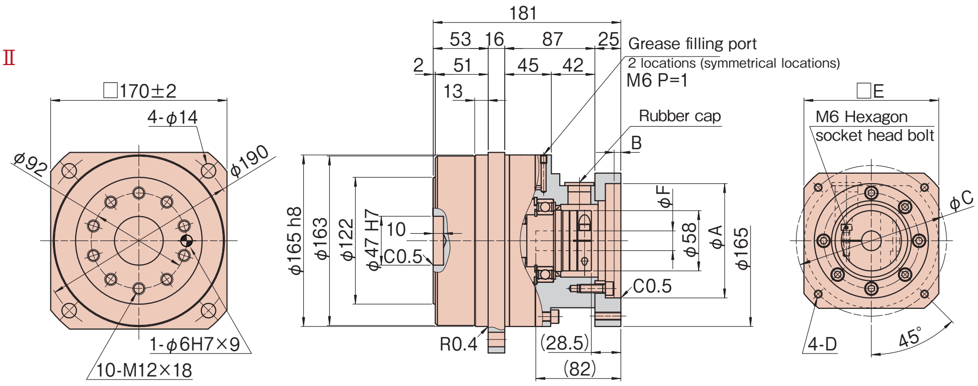
Fig. 056-1

(Unit: mm)

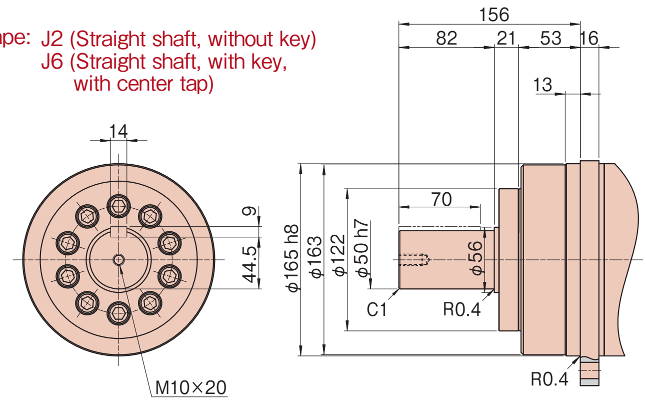
Flange Type Ⅰ




Flange Type Ⅱ




Output shaft shape: J2 (Straight shaft, without key)
J6 (Straight shaft, with key, with center tap)




(Note)
When using the output shaft type of the models 45 and 65 up to the "permissible peak torque for start and stop", the shaft shape must be "J2 type (straight shaft, no key)" due to the strength of the key surface pressure, and use of the abrasion type coupling joint is recommended.

* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# Measurement Table

Table 056-1
Unit: mm

| | Shape symbol[*1] | A(H7) | B | C | D | E | F(H7) | | Mass (kg)[*2] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Min | Max | Shaft output | Flange output |
| Flange Type Ⅰ | PA□ | 70 | 7 | 90 | M5×12 | – | 14 | 24 | 17.3 | 14.3 |
| | PB□ | | | | M6×14 | | | | | |
| | PC□ | 80 | 8 | 100 | | | | | | |
| | PD□ | 95 | | 115 | M8×20 | | | | | |
| | PE□ | | | | M6×14 | | | | | |
| | PF□ | 110 | | 130 | M8×20 | | | | | |
| | PG□ | | | 145 | | | | | | |
| Flange Type Ⅱ | PR□ | 110 | 6.5 | 145 | M8×20 | □130 | 19 | 24 | 16.7 | 13.7 |
| | PP□ | 114.3 | | 200 | M12×25 | □180 | | 35 | 17.7 | 14.7 |
| | PQ□ | 130 | | 165 | M10×25 | | | | | |

Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. The mass varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

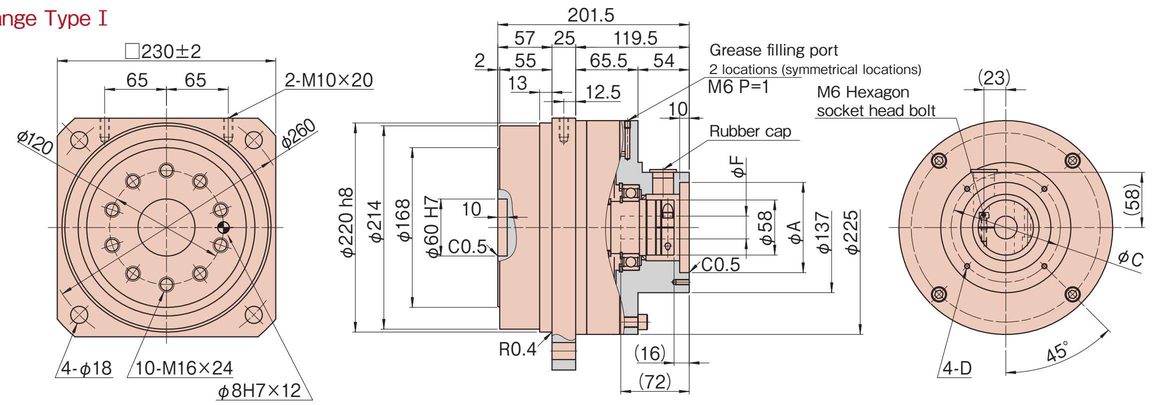
# Dimensional Outline Drawing – Model No. 65 CSG-GH

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.

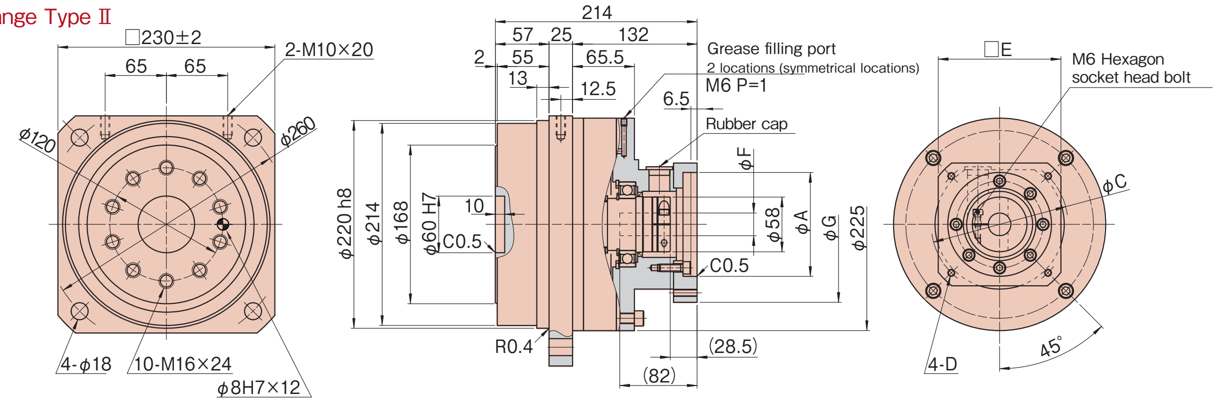
Fig. 057-1

(Unit: mm)

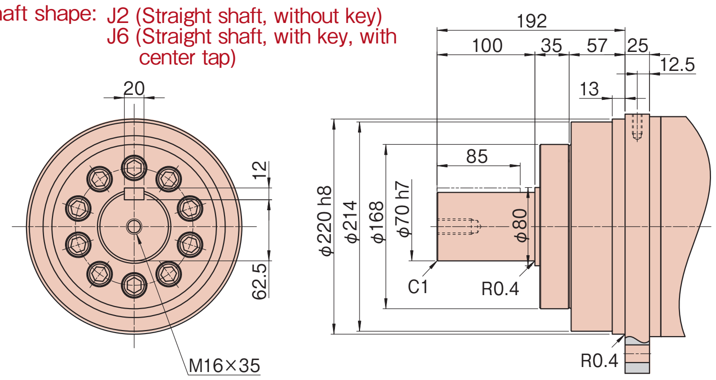
Flange Type Ⅰ




Flange Type Ⅱ




Output shaft shape: J2 (Straight shaft, without key)
J6 (Straight shaft, with key, with center tap)




(Note)
When using the output shaft type of the models 45 and 65 up to the "permissible peak torque for start and stop", the shaft shape must be "J2 type (straight shaft, no key)" due to the strength of the key surface pressure, and use of the abrasion type coupling joint is recommended.

* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# Measurement Table

Table 057-1
Unit: mm

| | Shape symbol[*1] | A(H7) | C | D | E | F(H7) Min | F(H7) Max | G | Mass (kg)[*2] Shaft output | Mass (kg)[*2] Flange output |
|---|---|---|---|---|---|---|---|---|---|---|
| Flange Type Ⅰ | UA□ | 95 | 115 | M6×14 | – | 19 | 35 | – | 36.3 | 27.7 |
| | UB□ | | | M8×20 | | | | | | |
| Flange Type Ⅱ | UF□ | 110 | 145 | M8×25 | □130 | 19 | 35 | 165 | 36.4 | 27.8 |
| | UG□ | 114.3 | 200 | M12×25 | □180 | | | 233 | 37.4 | 28.8 |
| | UH□ | 130 | 165 | M10×25 | | | | | | |
| | UI□ | 200 | 235 | M12×25 | □220 | | | 270 | 38.4 | 29.8 |

Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. The mass varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

# Rating Table CSF-GH

CSF-GH series is standard-torque type HarmonicDrive® gear head.
The HarmonicDrive® CSF-GH series is especially suitable for a wide range of high technology fields requiring precision motion control such as the semiconductor or LCD production equipment, robot and machine tool industries.

Table 058-1

| Model | Reduction ratio | Rated output torque at 2000 r/min. *1 | | Rated output torque at 3000 r/min. *2 *8 | | Permissible max. value of average load torque *3 | | Permissible peak torque on start/stop *4 | | Permissible max. momentary torque *5 | | Permissible average input rotational speed | Permissible max. input speed *6 | Mass of reducer itself *7 Shaft output | Mass of reducer itself *7 Flange output |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N·m | kgf·m | N·m | kgf·m | N·m | kgf·m | N·m | kgf·m | N·m | kgf·m | r/min | r/min | kg | kg |
| 14 | 50 | 5.4 | 0.55 | 4.7 | 0.48 | 6.9 | 0.70 | 18 | 1.8 | 35 | 3.6 | 3500 | 8500 | 0.62 | 0.50 |
| | 80 | 7.8 | 0.80 | 6.8 | 0.70 | 11 | 1.1 | 23 | 2.4 | 47 | 4.8 | | | | |
| | 100 | 7.8 | 0.80 | 6.8 | 0.70 | 11 | 1.1 | 28 | 2.9 | 54 | 5.5 | | | | |
| 20 | 50 | 25 | 2.5 | 22 | 2.2 | 34 | 3.5 | 56 | 5.7 | 98 | 10 | 3500 | 6500 | 1.8 | 1.4 |
| | 80 | 34 | 3.5 | 30 | 3.1 | 47 | 4.8 | 74 | 7.5 | 127 | 13 | | | | |
| | 100 | 40 | 4.1 | 35 | 3.6 | 49 | 5.0 | 82 | 8.4 | 147 | 15 | | | | |
| | 120 | 40 | 4.1 | 35 | 3.6 | 49 | 5.0 | 87 | 8.9 | 147 | 15 | | | | |
| | 160 | 40 | 4.1 | 35 | 3.6 | 49 | 5.0 | 92 | 9.4 | 147 | 15 | | | | |
| 32 | 50 | 76 | 7.8 | 66 | 6.8 | 108 | 11 | 216 | 22 | 382 | 39 | 3500 | 4800 | 4.6 | 3.2 |
| | 80 | 118 | 12 | 103 | 10 | 167 | 17 | 304 | 31 | 568 | 58 | | | | |
| | 100 | 137 | 14 | 120 | 12 | 216 | 22 | 333 | 34 | 647 | 66 | | | | |
| | 120 | 137 | 14 | 120 | 12 | 216 | 22 | 353 | 36 | 686 | 70 | | | | |
| | 160 | 137 | 14 | 120 | 12 | 216 | 22 | 372 | 38 | 686 | 70 | | | | |
| 45 | 50 | 176 | 18 | 154 | 16 | 265 | 27 | 500 | 51 | 950 | 97 | 3000 | 3800 | 13 | 10 |
| | 80 | 313 | 32 | 273 | 28 | 390 | 40 | 706 | 72 | 1270 | 130 | | | | |
| | 100 | 353 | 36 | 308 | 31 | 500 | 51 | 755 | 77 | 1570 | 160 | | | | |
| | 120 | 402 | 41 | 351 | 36 | 620 | 63 | 823 | 84 | 1760 | 180 | | | | |
| | 160 | 402 | 41 | 351 | 36 | 630 | 64 | 882 | 90 | 1910 | 195 | | | | |
| 65 | 80 | 745 | 76 | 651 | 66 | 1040 | 106 | 2110 | 215 | 3720 | 380 | 1900 | 2800 | 32 | 24 |
| | 100 | 951 | 97 | 831 | 85 | 1520 | 155 | 2300 | 235 | 4750 | 485 | | | | |
| | 120 | 951 | 97 | 831 | 85 | 1570 | 160 | 2510 | 256 | 4750 | 485 | | | | |
| | 160 | 951 | 97 | 831 | 85 | 1570 | 160 | 2630 | 268 | 4750 | 485 | | | | |

(Note) 1. Output torque set based on the life of $L_{10}$ = 7000 hours when input rotational speed is 2000 r/min, which is the rated rotational speed of ordinary servo motors.
2. Output torque set based on the life of $L_{10}$ = 7000 hours when input rotational speed is 3000 r/min, which is the rated rotational speed of ordinary servo motors.
3. Permissible maximum value of average load torque calculated based on a load torque pattern (page 048).
Note that exceeding this value may deteriorate the life or durability of the product.
4. Permissible maximum value of torque applied on start and stop in operation cycles.
5. Permissible maximum value for impact torque in an emergency stop and for external impact torque.
Operate within this range. Calculate the permissible frequency when selecting the model and check whether it meets the operating conditions.
6. Permissible maximum value of average load torque on non-continuous operation condition. The input rotational speed varies depending on operating environment or operating conditions. It is appropriate to regard the reference input speed during continuous operation as 3000 r/min.
(Note) If HarmonicDrive® CSF-GH series is installed with the output shaft facing downward (motor faces upward) and continuously operated in one direction under the constant load state, lubrication failure may occur. * In this case, please contact the sales office of Harmonic Drive Systems Inc.
7. The weight of a speed reducer itself. See dimension (pages 061 to 065) tables for values that include an input shaft coupling, motor flange and other parts.
8. The rated torque of the model number 65 is for input 2800 r/min.

# Ratcheting Torque CSF-GH

Table 058-2
Unit: N·m

| Model / Reduction ratio | 14 | 20 | 32 | 45 | 65 |
|---|---|---|---|---|---|
| 50 | 88 | 220 | 980 | 2700 | — |
| 80 | 110 | 350 | 1400 | 3900 | 11000 |
| 100 | 84 | 260 | 1000 | 3100 | 9400 |
| 120 | — | 240 | 980 | 2800 | 8300 |
| 160 | — | 220 | 980 | 2600 | 8000 |

# Buckling Torque CSF-GH

Table 058-3
Unit: N·m

| Model | 14 | 20 | 32 | 45 | 65 |
|---|---|---|---|---|---|
| Total reduction ratio | 190 | 560 | 2200 | 5800 | 17000 |

# Performance Table　CSF-GH

CSF-GH series is standard-torque type HarmonicDrive® gear head.
The HarmonicDrive® CSF-GH series is especially suitable for a wide range of high technology fields requiring precision motion control such as the semiconductor or LCD production equipment, robot and machine tool industries.

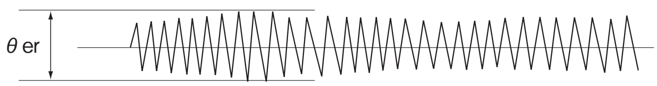
Table 059-1

| Model | Shape symbol on input side [*1] | Reduction ratio | Angle transmission precision [*2] | | Positioning Precision Repeatability [*3] | Starting torque [*4] | | Overdrive starting torque [*5] | | No-load running torque [*6] | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | arc-min | ×10⁻⁴rad | arc-sec | cN·m | kgf·cm | N·m | kgf·m | cN·m | kgf·cm |
| 14 | All products | 50 | 1.5 | 4.4 | ±10 | 8.2 | 0.8 | 2.9 | 0.3 | 5.6 | 0.6 |
| | | 80 | | | | 6.9 | 0.7 | 3.9 | 0.4 | 5.1 | 0.5 |
| | | 100 | | | | 6.6 | 0.7 | 4.7 | 0.5 | 4.6 | 0.5 |
| 20 | E□□ | 50 | 1.0 | 2.9 | ±8 | 13 | 1.3 | 7.8 | 0.8 | 11 | 1.2 |
| | | 80 | | | | 10 | 1.0 | 9.6 | 1.0 | 10 | 1.0 |
| | | 100 | | | | 9.6 | 1.0 | 12 | 1.2 | 10 | 1.0 |
| | | 120 | | | | 9.1 | 0.9 | 13 | 1.3 | 9.8 | 1.0 |
| | | 160 | | | | 8.6 | 0.9 | 17 | 1.7 | 9.6 | 1.0 |
| | F□□ G□□ | 50 | 1.0 | 2.9 | ±8 | 20 | 2.0 | 12 | 1.2 | 11 | 1.2 |
| | | 80 | | | | 17 | 1.7 | 16 | 1.6 | 10 | 1.0 |
| | | 100 | | | | 16 | 1.7 | 19 | 2.0 | 10 | 1.0 |
| | | 120 | | | | 16 | 1.6 | 23 | 2.3 | 9.8 | 1.0 |
| | | 160 | | | | 15 | 1.6 | 29 | 3.1 | 9.6 | 1.0 |
| 32 | KP□ KQ□ KR□ KS□ | 50 | 1.0 | 2.9 | ±6 | 58 | 5.9 | 35 | 3.6 | 47 | 4.8 |
| | | 80 | | | | 46 | 4.7 | 44 | 4.5 | 42 | 4.3 |
| | | 100 | | | | 45 | 4.6 | 54 | 5.5 | 41 | 4.2 |
| | | 120 | | | | 42 | 4.3 | 61 | 6.2 | 40 | 4.1 |
| | | 160 | | | | 41 | 4.2 | 79 | 8.1 | 40 | 4.1 |
| | Products other than above | 50 | 1.0 | 2.9 | ±6 | 50 | 5.1 | 30 | 3.1 | 47 | 4.8 |
| | | 80 | | | | 38 | 3.9 | 37 | 3.8 | 42 | 4.3 |
| | | 100 | | | | 37 | 3.8 | 45 | 4.6 | 41 | 4.2 |
| | | 120 | | | | 34 | 3.5 | 49 | 5.1 | 40 | 4.1 |
| | | 160 | | | | 33 | 3.4 | 64 | 6.6 | 40 | 4.1 |
| 45 | All products | 50 | 1.0 | 2.9 | ±5 | 123 | 13 | 74 | 7.8 | 120 | 12 |
| | | 80 | | | | 95 | 9.7 | 92 | 9.3 | 109 | 11 |
| | | 100 | | | | 89 | 9.1 | 107 | 11 | 107 | 11 |
| | | 120 | | | | 85 | 8.7 | 123 | 13 | 105 | 11 |
| | | 160 | | | | 79 | 8.1 | 152 | 16 | 103 | 11 |
| 65 | All products | 80 | 1.0 | 2.9 | ±4 | 186 | 19 | 179 | 18 | 297 | 30 |
| | | 100 | | | | 166 | 17 | 200 | 20 | 289 | 30 |
| | | 120 | | | | 156 | 16 | 226 | 23 | 285 | 29 |
| | | 160 | | | | 139 | 14 | 268 | 27 | 278 | 28 |

(Note) 1. The shape symbols indicate the motor flange shape and input shaft joint shape of the model (refer to P007). (Upper 2 digits indicate the motor flange shape, and lower 1 digit indicates the input shaft joint shape.)

2. Angle transmission precision indicates the difference between logical rotating angle and the actual rotating angle of output when any rotating angle is given as an input. The values in the table are maximum values.

Fig. 059-1

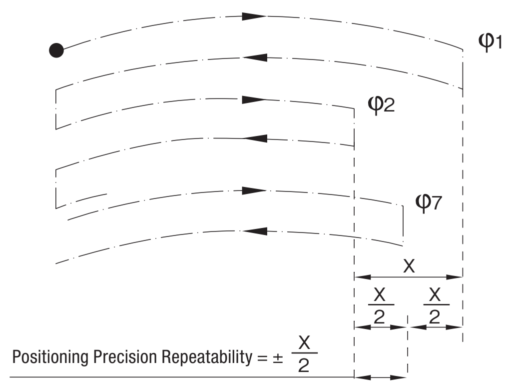



$\theta er$ : Angle transmission precision
$\theta_1$ : Input rotation angle
$\theta_2$ : Actual output rotation angle
R : Reduction ratio of CSF-GH series (i=1:R)

$$\theta er = \theta_2 - \frac{\theta_1}{R}$$

3. The positioning precision repeatability is determined by repeating positioning in a given position from the same direction seven times, by measuring stop positions of the output shaft and by calculating the maximum difference. Measured values are indicated in angles (degrees) and are prefixed with "±" to 1/2 of the maximum differences. The values in the table are maximum values.

Fig. 059-2




4. Starting torque means the momentary "starting torque" with which the output side starts rotation when a torque is applied on the input side. The values in the table are maximum values.

### Measuring condition

Table 059-2

| | |
|---|---|
| Load | No load |
| Speed reducer surface temperature | 25°C |

5. Overdrive starting torque means the momentary "starting torque" with which the input side starts rotation when a torque is applied on the output side. The values in the table are maximum values.

### Measuring condition

Table 059-3

| | |
|---|---|
| Load | No load |
| Speed reducer surface temperature | 25°C |

6. No-load running torque means the torque on the input side required to put the speed reducer under a no-load condition. The values in the table are average values.

### Measuring condition

Table 059-4

| | |
|---|---|
| Input speed | 2000 r/min |
| Load | No load |
| Speed reducer surface temperature | 25°C |

# Rigidity (Spring constant) CSF-GH

Table 060-1

| Symbol | | Model | 14 | 20 | 32 | 45 | 65 |
|---|---|---|---|---|---|---|---|
| | $T_1$ | N·m | 2.0 | 7.0 | 29 | 76 | 235 |
| | | kgf·m | 0.2 | 0.7 | 3.0 | 7.8 | 24 |
| | $T_2$ | N·m | 6.9 | 25 | 108 | 275 | 843 |
| | | kgf·m | 0.7 | 2.5 | 11 | 28 | 86 |
| Reduction ratio 50 | $K_1$ | $\times10^4$N·m/rad | 0.34 | 1.3 | 5.4 | 15 | – |
| | | kgf·m/arc-min | 0.1 | 0.38 | 1.6 | 4.3 | – |
| | $K_2$ | $\times10^4$N·m/rad | 0.47 | 1.8 | 7.8 | 20 | – |
| | | kgf·m/arc-min | 0.14 | 0.52 | 2.3 | 6.0 | – |
| | $K_3$ | $\times10^4$N·m/rad | 0.57 | 2.3 | 9.8 | 26 | – |
| | | kgf·m/arc-min | 0.17 | 0.67 | 2.9 | 7.6 | – |
| | $\theta_1$ | $\times10^{-4}$rad | 5.8 | 5.2 | 5.5 | 5.2 | – |
| | | arc-min | 2.0 | 1.8 | 1.9 | 1.8 | – |
| | $\theta_2$ | $\times10^{-4}$rad | 16 | 15.4 | 15.7 | 15.1 | – |
| | | arc-min | 5.6 | 5.3 | 5.4 | 5.2 | – |
| Reduction ratio 80 or more | $K_1$ | $\times10^4$N·m/rad | 0.47 | 1.6 | 6.7 | 18 | 54 |
| | | kgf·m/arc-min | 0.14 | 0.47 | 2.0 | 5.4 | 16 |
| | $K_2$ | $\times10^4$N·m/rad | 0.61 | 2.5 | 11 | 29 | 88 |
| | | kgf·m/arc-min | 0.18 | 0.75 | 3.2 | 8.5 | 26 |
| | $K_3$ | $\times10^4$N·m/rad | 0.71 | 2.9 | 12 | 33 | 98 |
| | | kgf·m/arc-min | 0.21 | 0.85 | 3.7 | 9.7 | 29 |
| | $\theta_1$ | $\times10^{-4}$rad | 4.1 | 4.4 | 4.4 | 4.1 | 4.4 |
| | | arc-min | 1.4 | 1.5 | 1.5 | 1.4 | 1.5 |
| | $\theta_2$ | $\times10^{-4}$rad | 12 | 11.3 | 11.6 | 11.1 | 11.3 |
| | | arc-min | 4.2 | 3.9 | 4.0 | 3.8 | 3.9 |

See page 046 for a description of terms. * The values in this table are average values.

# Hysteresis Loss CSF-GH

Reduction ratio 50: Approx. 5.8 x $10^{-4}$ rad (2arc-min)
Reduction ratio 80 or more: Approx. 2.9 x $10^{-4}$ rad (1arc-min)

See page 046 for a description of terms.

# Max. Backlash Quantity CSF-GH

Table 060-2

| Reduction ratio | Model | 14 | 20 | 32 | 45 | 65 |
|---|---|---|---|---|---|---|
| 50 | $\times10^{-5}$rad | 17.5 | 8.2 | 6.8 | 5.8 | – |
| | arc-sec | 36 | 17 | 14 | 12 | – |
| 80 | $\times10^{-5}$rad | 11.2 | 5.3 | 4.4 | 3.9 | 2.9 |
| | arc-sec | 23 | 11 | 9 | 8 | 6 |
| 100 | $\times10^{-5}$rad | 8.7 | 4.4 | 3.4 | 2.9 | 2.4 |
| | arc-sec | 18 | 9 | 7 | 6 | 5 |
| 120 | $\times10^{-5}$rad | – | 3.9 | 2.9 | 2.4 | 1.9 |
| | arc-sec | – | 8 | 6 | 5 | 4 |
| 160 | $\times10^{-5}$rad | – | 2.9 | 2.4 | 1.9 | 1.5 |
| | arc-sec | – | 6 | 5 | 4 | 3 |

See page 046 for a description of terms.

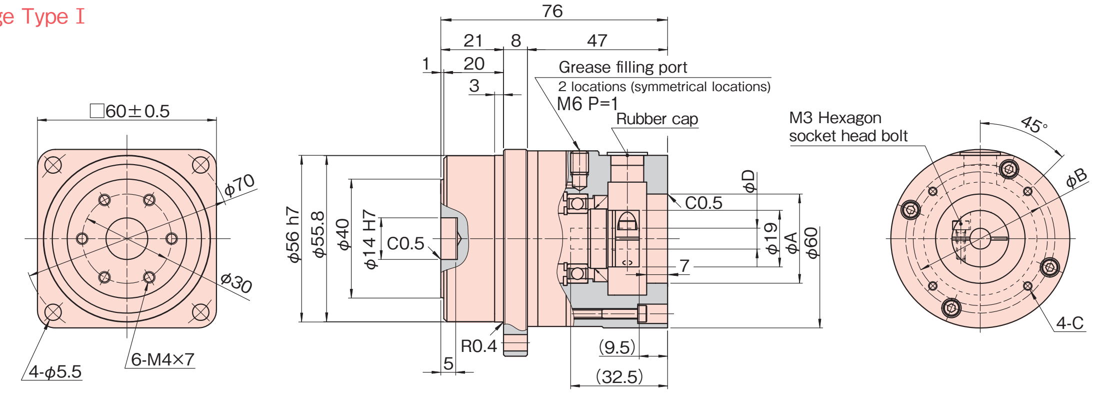
# Dimensional Outline Drawing – Model No. 14 CSF-GH

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.
You can download the CAD data of this product from the following homepage. URL: https://www.hds.co.jp/

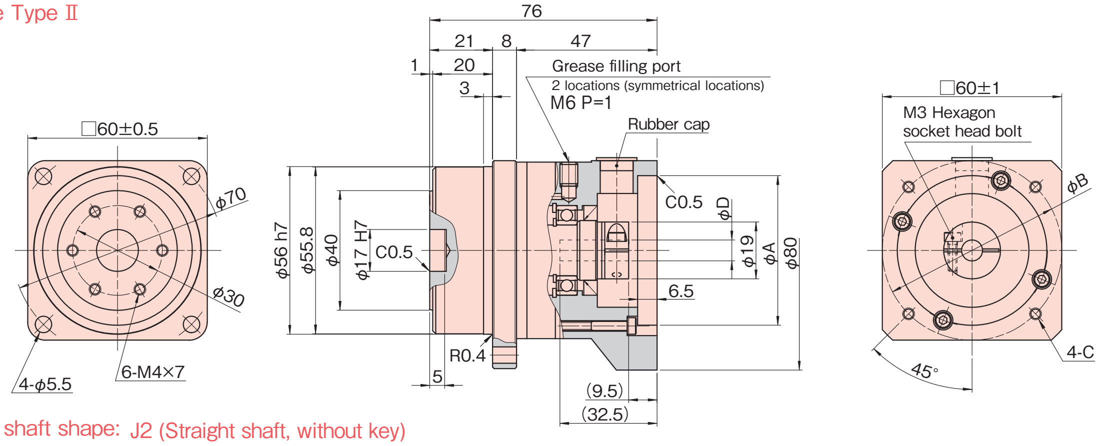
Fig. 061-1

(Unit: mm)

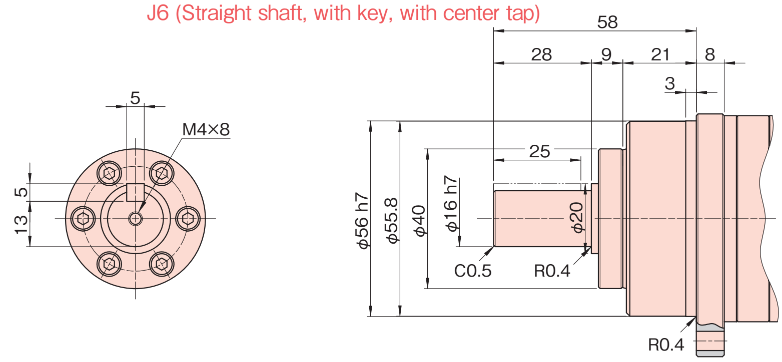
Flange Type I




Flange Type II




Output shaft shape: J2 (Straight shaft, without key)
J6 (Straight shaft, with key, with center tap)




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# Measurement Table

Table 061-1
Unit: mm

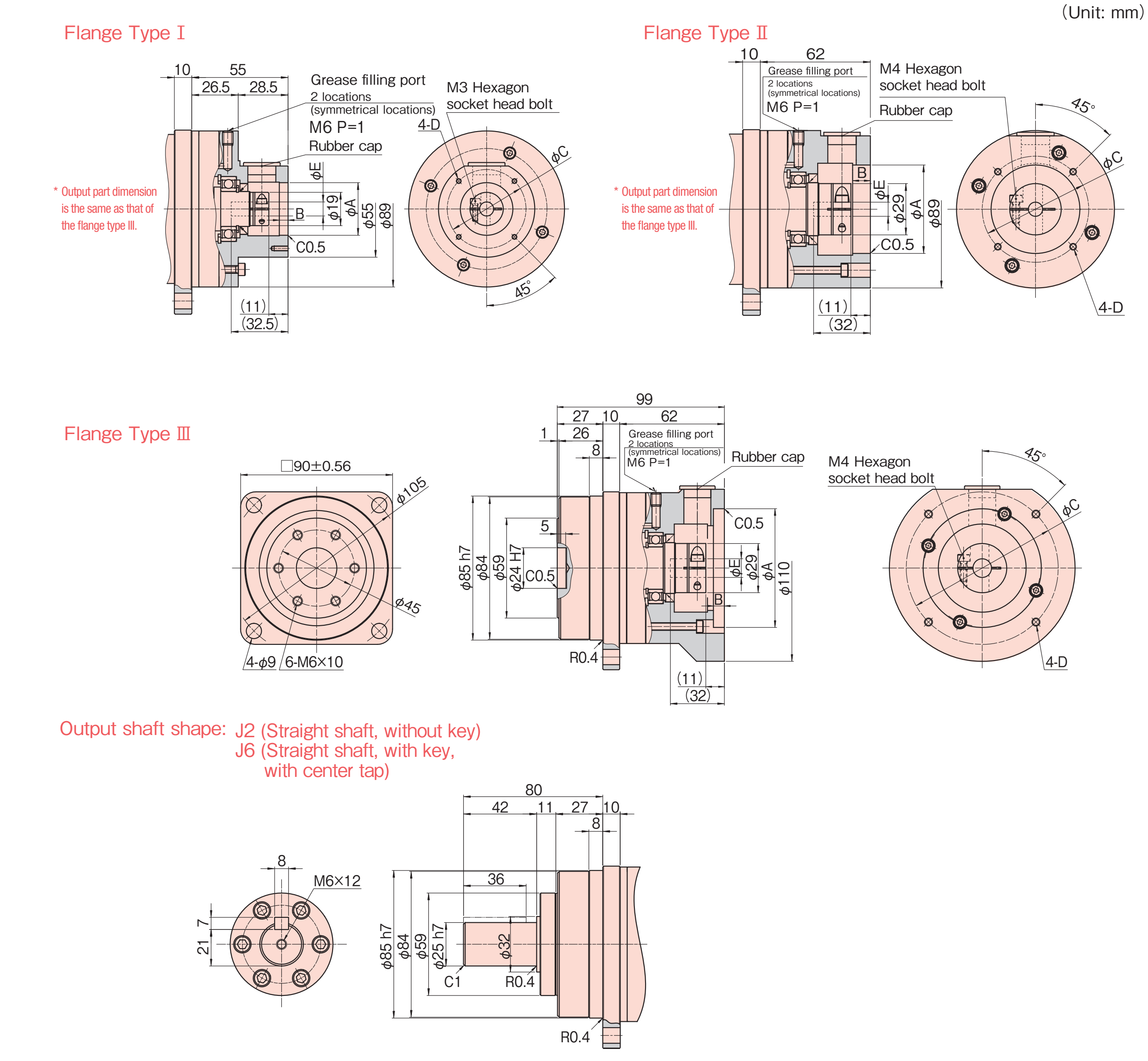
| | Shape symbol[1] | A(H7) | B | C | D(H7) | | Mass (kg)[2] | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Min | Max | Shaft output | Flange output |
| Flange Type I | AB□ | 30 | 45 | M3×8 | 6 | 8 | 0.88 | 0.76 |
| | AC□ | | 46 | M4×10 | | | | |
| | AD□ | 34 | 48 | M3×8 | | | | |
| Flange Type II | BA□ | 50 | 60 | M4×10 | 6 | 8 | 0.9 | 0.78 |
| | BB□ | | 70 | | | | | |
| | BC□ | | | M5×12 | | | | |

Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications. Contact us for information on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. The mass varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

# Dimensional Outline Drawing – Model No. 20 CSF-GH

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.
You can download the CAD data of this product from the following homepage. URL: https://www.hds.co.jp/

Fig. 062-1




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# Measurement Table

Table 062-1
Unit: mm

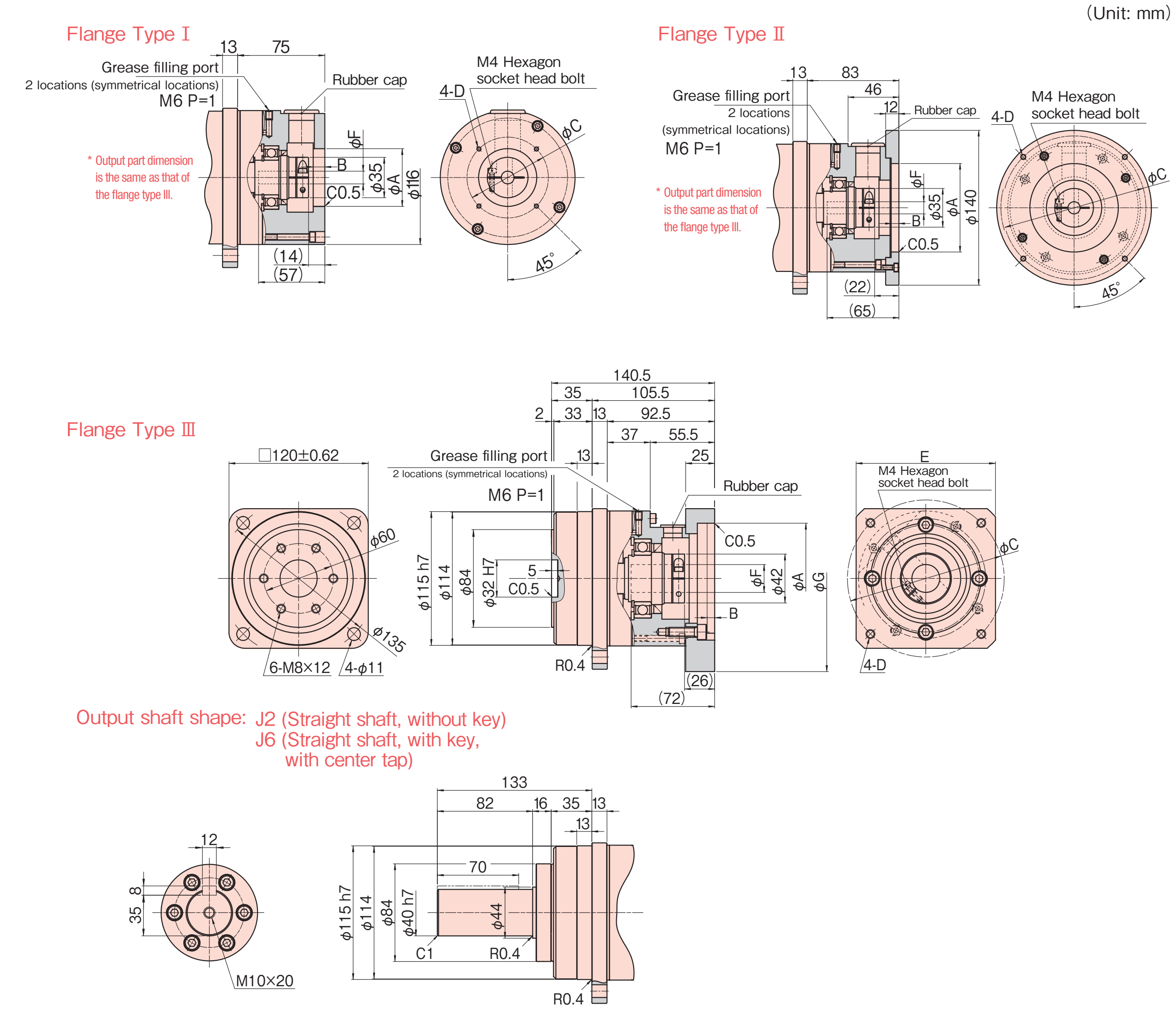
| | Shape symbol[*1] | A(H7) | B | C | D | E(H7) | | Mass (kg)[*2] | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Min | Max | Shaft output | Flange output |
| Flange Type Ⅰ | EA□ | 30 | 5 | 45 | M3×8 | 7 | 8 | 2.3 | 1.9 |
| | EB□ | | | 46 | M4×10 | | | | |
| | EC□ | 34 | 6 | 48 | M3×8 | | | | |
| Flange Type Ⅱ | FA□ | 50 | 10 | 60 | M4×10 | 8 | 14 | 2.6 | 2.2 |
| | FB□ | | | 70 | | | | | |
| | FC□ | | | | M5×12 | | | | |
| Flange Type Ⅲ | GA□ | 70 | 6.5 | 90 | M5×12 | 8 | 14 | 2.8 | 2.4 |
| | GB□ | | | | M6×14 | | | | |

Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. The mass varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

# Dimensional Outline Drawing – Model No. 32 CSF-GH

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.
You can download the CAD data of this product from the following homepage. URL: https://www.hds.co.jp/

Fig. 063-1




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# Measurement Table

Table 063-1
Unit: mm

| | Shape symbol[1] | A(H7) | B | C | D | E | F(H7) Min | F(H7) Max | G | Mass (kg)[2] Shaft output | Mass (kg)[2] Flange output |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Flange Type Ⅰ | KA□ | 50 | 10 | 70 | M4×10 | – | 11 | 19 | – | 6.4 | 5 |
| | KB□ | | | | M5×12 | | | | | | |
| | KC□ | 60 | 7 | 99 | M6×14 | | | | | | |
| | KD□ | 70 | | 90 | M5×12 | | | | | | |
| | KE□ | | | | M6×14 | | | | | | |
| | KF□ | 80 | | 100 | | | | | | | |
| | KI□ | 50 | 10 | 60 | M4×10 | | | | | | |
| Flange Type Ⅱ | KG□ | 95 | 7 | 115 | M6×12 | – | 11 | 19 | – | 6.6 | 5.2 |
| | KH□ | | | | M8×12 | | | | | | |
| Flange Type Ⅲ | KP□ | 95 | 6.5 | 115 | M6×14 | □120 | 16 | 24 | 160 | 6.9 | 5.5 |
| | KQ□ | | | | M8×25 | | | | | | |
| | KR□ | 110 | | 145 | | □130 | | | 165 | | |
| | KS□ | 130 | | 165 | M10×25 | □180 | | | 233 | 7.9 | 6.5 |

Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above. Check details of the dimensions and shape with the delivered specifications. Contact us for information on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. The mass varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

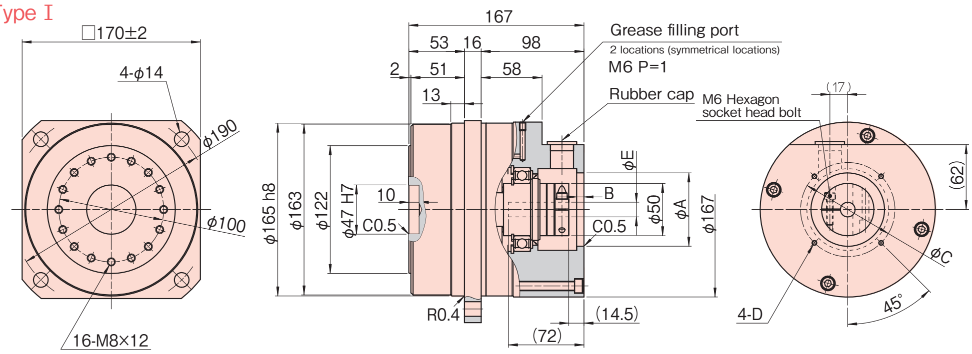
# Dimensional Outline Drawing – Model No. 45　CSF-GH

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.
You can download the CAD data of this product from the following homepage.  URL: https://www.hds.co.jp/

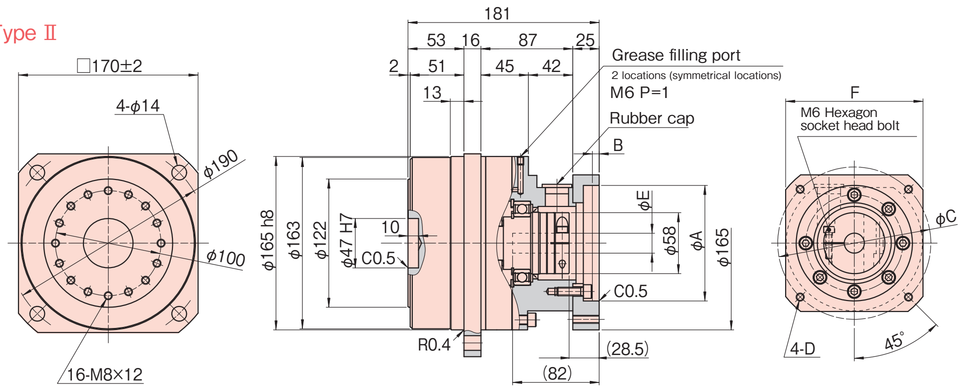
Fig. 064-1

(Unit: mm)

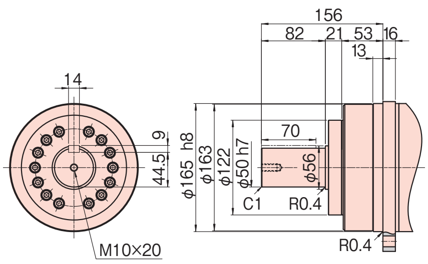
Flange Type Ⅰ




Flange Type Ⅱ




Output shaft shape: J2 (Straight shaft, without key)
J6 (Straight shaft, with key, with center tap)




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# Measurement Table

Table 064-1
Unit: mm

| | Shape symbol[*1] | A(H7) | B | C | D | E(H7) | | F | Mass (kg)[*2] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Min | Max | | Shaft output | Flange output |
| Flange Type Ⅰ | PA□ | 70 | 7 | 90 | M5×12 | 14 | 24 | – | 17.3 | 14.3 |
| | PB□ | | | | M6×14 | | | | | |
| | PC□ | 80 | 8 | 100 | | | | | | |
| | PD□ | 95 | | 115 | M8×20 | | | | | |
| | PE□ | | | | M6×14 | | | | | |
| | PF□ | 110 | | 130 | M8×20 | | | | | |
| | PG□ | | | 145 | | | | | | |
| Flange Type Ⅱ | PR□ | 110 | 6.5 | 145 | M8×20 | 19 | 24 | □130 | 16.7 | 13.7 |
| | PP□ | 114.3 | | 200 | M12×25 | | 35 | □180 | 17.7 | 14.7 |
| | PQ□ | 130 | | 165 | M10×25 | | | | | |

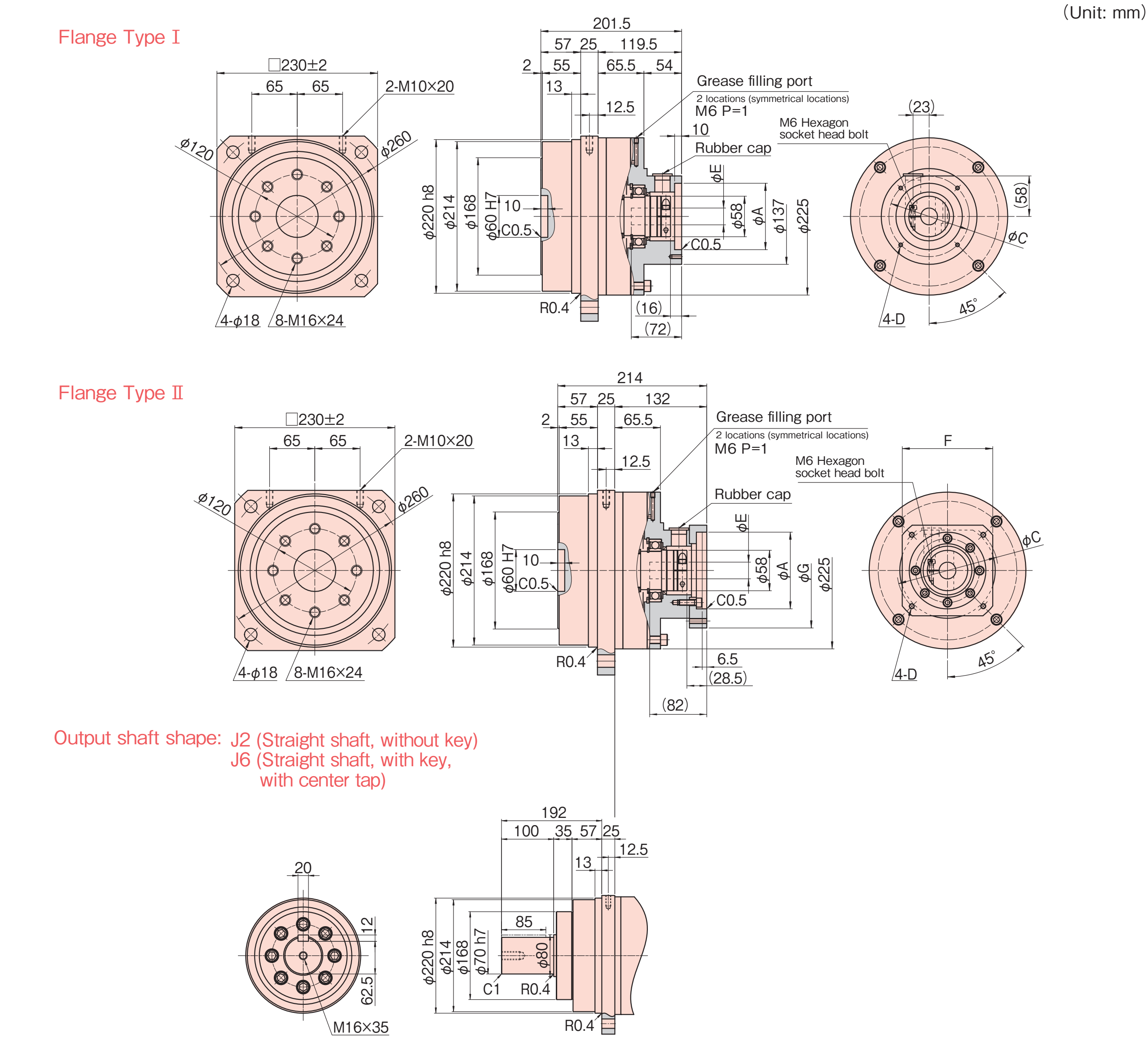
Dimensions of only typical products are shown.  Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols.  See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. The mass varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

# Dimensional Outline Drawing – Model No. 65 CSF-GH

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.
You can download the CAD data of this product from the following homepage. URL: https://www.hds.co.jp/

Fig. 065-1

(Unit: mm)




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# Measurement Table

Table 065-1
Unit: mm

| | Shape symbol[*1] | A(H7) | C | D | E(H7) | | F | G | Mass (kg)[*2] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Min | Max | | | Shaft output | Flange output |
| Flange Type Ⅰ | UA□ | 95 | 115 | M6×14 | 19 | 35 | — | — | 36.2 | 27.6 |
| | UB□ | | | M8×20 | | | | | | |
| Flange Type Ⅱ | UF□ | 110 | 145 | M8×25 | 19 | 35 | □130 | 165 | 36.3 | 27.7 |
| | UG□ | 114.3 | 200 | M12×25 | | | □180 | 233 | 37.3 | 28.7 |
| | UH□ | 130 | 165 | M10×25 | | | | | | |
| | UI□ | 200 | 235 | M12×25 | | | □220 | 270 | 38.3 | 29.7 |

Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)
2. The mass varies slightly depending on the reduction ratio and on the inside diameter of input shaft coupling.

HarmonicPlanetary®
HPG Series (Planetary speed reducer type)
HarmonicDrive®
CSG/CSF-GH Series (HarmonicDrive® speed reducer type)

# Gear Head Series
# CONTENTS

HarmonicPlanetary®
## HPG Series Orthogonal Shaft Type

# HarmonicPlanetary®

## HPG Orthogonal Shaft Type

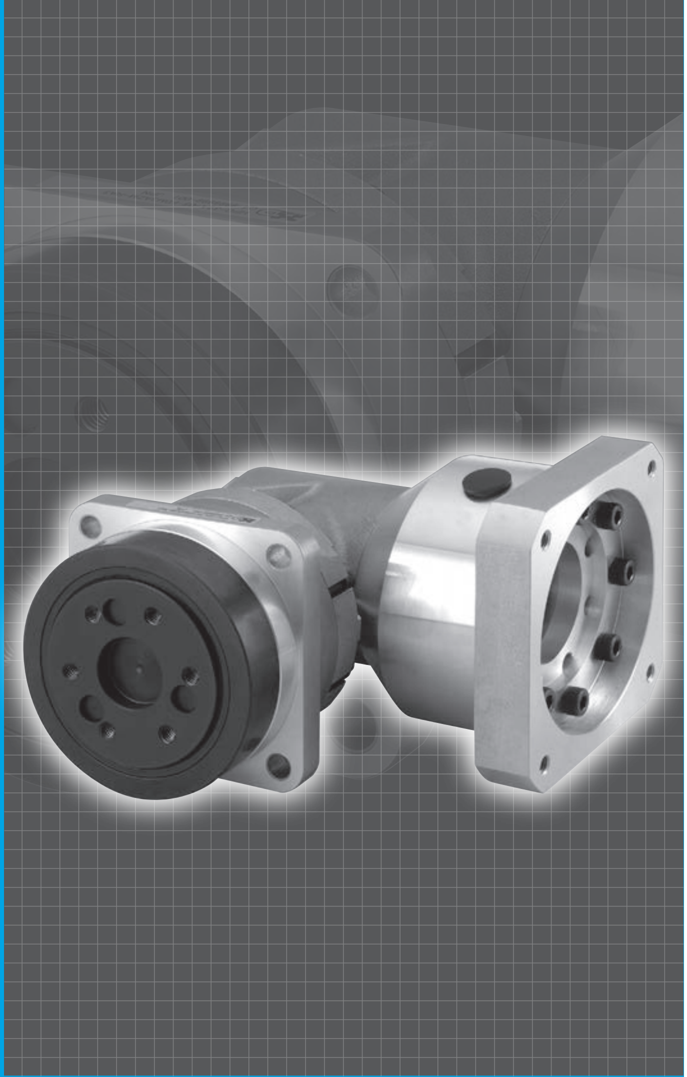
**Size** 3 Types
Model: 32, 50, 65

**Peak torque**
150 N·m to 2200 N·m

**Reduction ratio**
1-stage reduction=5
2-stage reduction= 11 to 50

**Small backlash**
Standard: 3 min. or less

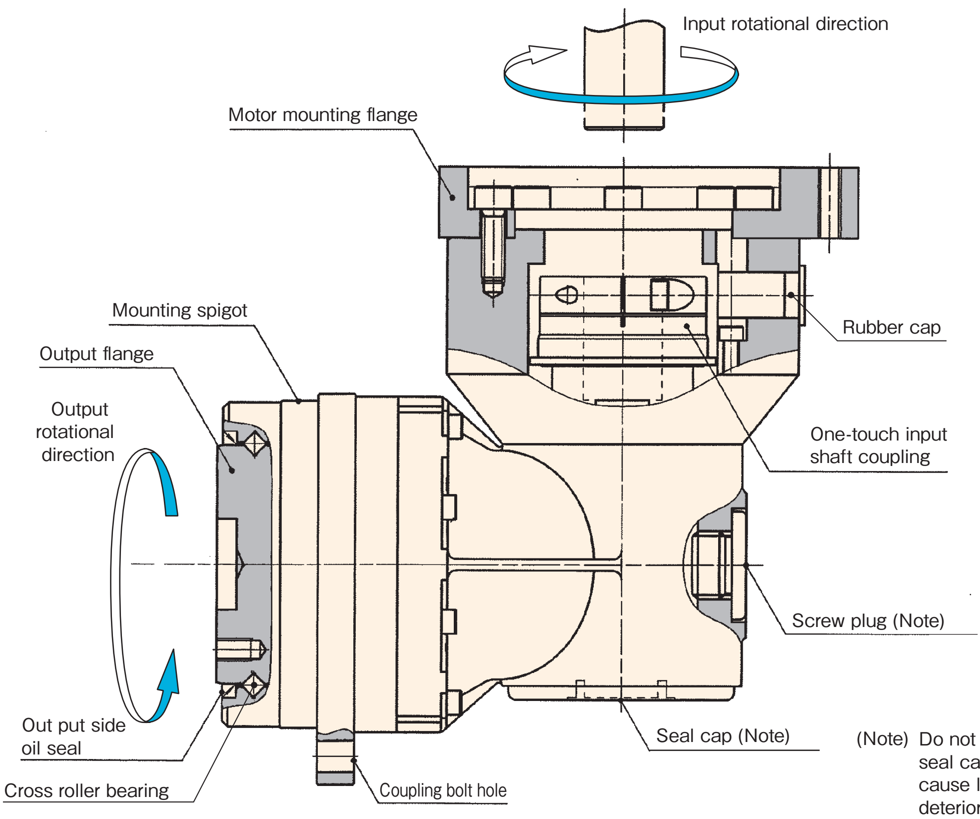
**Can be mounted to servo motors of many manufacturers**
Yasukawa Electric, Mitsubishi Electric, Fanuc, Panasonic, Sanyo Denki, Fuji Electric, Toshiba
For other servo motors, please feel free to contact the nearest sales office.



* See the model selection tool on the web page to find matching model on each company's servo motors. (URL:https://hds-tech.jp/)

### Structural drawing

Fig. 067-1




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

# Model Number Selection

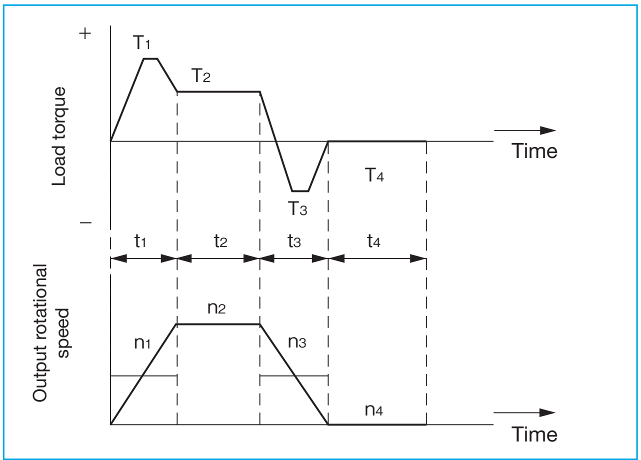
Check your operating conditions and select suitable model Nos. based on the flowchart to fully demonstrate the excellent performance of the Harmonic Planetary® HPG series.

In general, the servo system is rarely in a continuous constant load state. The load torque changes according to the input rotational speed variation and comparatively large torque are applied at start and stop. Unexpected impact torque may be applied.
Check your operating conditions against the following load torque pattern and select suitable model Nos. 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). (See the specification of the input side main bearing and the output side main bearing on pages 114 to 119.)

## ■Checking the load torque pattern

First, you need to look at the picture of the load torque pattern. Check the specifications shown in the figure below.

Graph 068-1




**Obtain the value of each load torque pattern.**

| | |
|---|---|
| Load torque | $T_1$ to $T_n$ (N·m) |
| Time | $t_1$ to $t_n$ (sec) |
| Output rotational speed | $n_1$ to $n_n$ (r/min) |

**<Normal operation pattern>**

| | |
|---|---|
| Starting time | $T_1$, $t_1$, $n_1$ |
| Steady operation time | $T_2$, $t_2$, $n_2$ |
| Stopping (slowing) time | $T_3$, $t_3$, $n_3$ |
| Break time | $T_4$, $t_4$, $n_4$ |

**<Maximum rotational speed>**

| | |
|---|---|
| Max. output rotational speed | $n_{o\,max} \geqq n_1$ to $n_n$ |
| Max. input rotational speed | $n_{i\,max} \geqq n_1 \times R$ to $n_n \times R$ |
| (Restricted by motors) | R: Reduction ratio |

**<Impact torque>**
When impact torque is applied $T_s$

**<Required life>**
$L_{10}$ = L (hours)

## ■Flowchart of model number selection

Select a model number according to the following flowchart.
If you find a value exceeding that from the ratings, you should review it with the upper-level model number or consider reduction of conditions including the load torque.

Calculate the average load torque applied on the output side of HarmonicDrive® from the load torque pattern: $T_{av}$ (N·m).

$$T_{av}=\sqrt[10/3]{\frac{|n_1|\cdot t_1\cdot|T_1|^{10/3}+|n_2|\cdot t_2\cdot|T_2|^{10/3}+\cdots+|n_n|\cdot t_n\cdot|T_n|^{10/3}}{n_1\cdot t_1+n_2\cdot t_2+\cdots+n_n\cdot t_n}}$$

Calculate the average output speed based on the load torque pattern: $n_{o\,av}$ (r/min)

$$n_{o\,av}=\frac{|n_1|\cdot t_1+|n_2|\cdot t_2+\cdots+|n_n|\cdot t_n}{t_1+t_2+\cdots+t_n}$$

▼

Select a model number temporarily with the following condition: $T_{av} \leqq$ Average load torque (See the rating table on page 070) — NG

OK

Determine the reduction ratio (R) based on the maximum output rotational speed ($n_{o\,max}$) and maximum input rotational speed ($n_{i\,max}$).

$$\frac{n_{i\,max}}{n_{o\,max}} \geqq R$$

(A limit is placed on $n_{i\,max}$ by motors.)
Calculate the maximum input rotational speed ($n_{i\,max}$) from the maximum output rotational speed ($n_{o\,max}$) and the reduction ratio (R).

$$n_{i\,max}=n_{o\,max}\cdot R$$

▼

Calculate the average input rotational speed ($n_{i\,av}$) from the average output rotational speed ($n_{o\,av}$) and the reduction ratio (R): $n_{i\,av} = n_{o\,av}\cdot R \leqq$ Permissible average input rotational speed ($n_r$). — NG

Check the description in Caution below.

OK

Check whether the maximum input rotational speed is equal to or less than the values in the rating table.
$n_{i\,max} \leqq$ maximum input rotational speed (r/min) — NG

OK

Check whether $T_1$ and $T_3$ are equal to or less than the permissible peak torque (N·m) value at start and stop from the ratings. — NG

OK

Check whether $T_s$ is equal to or less than the permissible maximum momentary torque (N·m) value from the ratings. — NG

OK

Calculate the lifetime and check whether it meets the specification requirement.
$T_r$: Output torque
$n_r$: Permissible average input rotational speed

$$L_{10}=20000\cdot\left(\frac{T_r}{T_{av}}\right)^{10/3}\cdot\left(\frac{n_r}{n_{i\,av}}\right) \quad \text{(Hour)}$$
— NG

OK

**The model number is determined.**

Review of the operation conditions, model No and reduction ratio.

**Caution**

Check impacts by speed reducer temperature rise, vibration during acceleration and deceleration and other factors if the operating conditions are as specified below. Study to "increase the speed reducer size", "review the operating conditions" and other means if it becomes necessary to study safety. Exercise reasonable caution especially when operating conditions are close to continuous operation.
Average load torque ($T_{av}$) > Permissible maximum value of average load torque (see page 070)
Calculate average input rotational speed ($n_{i\,av}$) > Permissible average input rotational speed ($n_r$)

## ■Example of Model Number Selection

### Value of each load torque pattern.

| | |
|---|---|
| Load torque | $T_n$ (N·m) |
| Time | $t_n$ (sec) |
| Output rotational speed | $n_n$ (r/min) |

<Normal operation pattern>

| | | | |
|---|---|---|---|
| Starting time | $T_1$ = 220 N·m, | $t_1$ = 0.5 sec, | $n_1$ = 60 r/min |
| Steady operation time | $T_2$ = 50 N·m, | $t_2$ = 2.7 sec, | $n_2$ = 120 r/min |
| Stopping (slowing) time | $T_3$ = 55 N·m, | $t_3$ = 0.8 sec, | $n_3$ = 60 r/min |
| Break time | $T_4$ = 0 N·m, | $t_4$ = 5 sec, | $n_4$ = 0 r/min |

<Maximum rotational speed>

| | |
|---|---|
| Max. output rotational speed | no *max* = 120 r/min |
| Max. input rotationalspeed | ni *max* = 5,000 r/min |
| | (Restricted by motors) |

<Impact torque>

When impact torque is applied $T_s$ = 180 N·m

<Required lifespan>

$L_{10}$ = 20,000 (hours)

Calculate the average load torque applied on the output side based on the load torque pattern: T*av* (N·m).

$$T_{av} = \sqrt[10/3]{\frac{|60\text{r/min}|\cdot 0.5\text{sec}\cdot|220\text{N·m}|^{10/3}+|120\text{r/min}|\cdot 2.7\text{sec}\cdot|55\text{N·m}|^{10/3}+|60\text{r/min}|\cdot 0.8\text{sec}\cdot|55\text{N·m}|^{10/3}}{|60\text{r/min}|\cdot 0.5\text{sec}+|120\text{r/min}|\cdot 2.7\text{sec}+|60\text{r/min}|\cdot 0.8\text{sec}}}$$

Calculate the average output rotational speed based on the load torque pattern: no *av* (r/min)

$$no\ av = \frac{|60\text{r/min}|\cdot 0.5\text{sec}+|120\text{r/min}|\cdot 2.7\text{sec}+|60\text{r/min}|\cdot 0.8\text{sec}+|0\text{r/min}|\cdot 5\text{sec}}{0.5\text{sec}+2.7\text{sec}+0.8\text{sec}+5\text{sec}}$$

Select a model number temporarily with the following conditions. T*av* = 104N·m ≦ 170N·m. (**HPG-32A-21-RA3** is temporarily selected based on the average load torque (see the rating table on page 070) of model No. 32 and reduction ratio of 21.)

NG

OK

Determine a reduction ratio (R) based on the maximum output rotational speed (no *max*) and maximum input rotational speed (ni *max*).

$$\frac{5{,}000\ \text{r/min}}{120\ \text{r/min}} = 41.7 \geqq 21$$

Calculate the maximum input rotational speed (ni *max*) from the maximum output rotational speed (no *max*) and reduction ratio (R): ni *max* = 120 r/min • 21 = 2,520 r/min

Calculate the average input rotational speed (ni *av*) from the average output speed (no *av*) and reduction ratio (R):
ni *av* = 44.7 r/min•21=939 r/min ≦ Permissible average input rotational speed of model No. 32 1500 (r/min)

NG

OK

Check whether the maximum input rotational speed is equal to or less than the values specified in the rating table.
ni *max* = 2520 r/min ≦ 6000 r/min (maximum input rotational speed of model No. 32)

NG

OK

Check whether $T_1$ and $T_3$ are equal to or less than the peak torques (N·m) on start and stop in the rating table.
$T_1$ = 220 N·m ≦ 300 N·m (Peak torques on start and stop of model No. 32)
$T_3$ = 55 N·m ≦ 300 N·m (Peak torques on start and stop of model No. 32)

NG

OK

Check whether Ts is equal to or less than the values of the momentary max. torque (N·m) in the rating table.
$T_s$ = 180 N·m ≦ 650 N·m (momentary max. torque of model No. 32)

NG

OK

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

$$L_{10} = 20{,}000 \cdot \left(\frac{98\ \text{N·m}}{104\ \text{N·m}}\right)^{10/3} \cdot \left(\frac{1{,}500\ \text{r/min}}{939\ \text{r/min}}\right) = 26{,}200\ \text{(hours)} \geqq 20{,}000\ \text{(hours)}$$

NG

OK

**As a result of the preceding steps, HPG-32A-21-RA3 is determined.**

Check the description in Caution at the bottom of page 068

Review of the operation conditions, model No and reduction ratio.

# Rating Table

HPG series orthogonal shaft type has a variety of 3 model numbers. For selecting the model number, refer to the rating table.

Table 070-1

| Model | Orthogonal model | Reduction ratio | Rated output torque *1 | | Permissible max. value of ave. load torque *2 | | Permissible peak torque at start/stop *3 | | Permissible max. momentary torque *4 | | Permissible ave. input rotational speed *5 | Permissible max. input rotational speed *6 | Inertia moment (equiv. value on input side) *7 | | Mass *8 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | Shaft output | Flange output | Shaft output | Flange output |
| | | | N·m | kgf·m | N·m | kgf·m | N·m | kgf·m | N·m | kgf·m | r/min | r/min | $\times10^{-4}$kg·m$^2$ | $\times10^{-4}$kg·m$^2$ | kg | kg |
| 32 | RA3 | 5 | 66 | 6.7 | 150 | 15 | 150 | 15 | 200 | 20 | 1500 | 6000 | 4.1 | 3.9 | 7.4 | 6.0 |
| | | 11 | 88 | 9.0 | 170 | 17 | 300 | 31 | 440 | 45 | | | 3.7 | 3.6 | 7.9 | 6.5 |
| | | 15 | 92 | 9.4 | | | | | 600 | 61 | | | 3.5 | 3.4 | | |
| | | 21 | 98 | 10 | | | | | 650 | 66 | | | 3.2 | 3.2 | | |
| | | 33 | 108 | 11 | 200 | 20 | | | | | | | 3.0 | 2.9 | | |
| | | 45 | 108 | 11 | | | | | | | | | 2.9 | 2.9 | | |
| 50 | RA3 | 5 | 150 | 15 | 150 | 15 | 150 | 15 | 200 | 20 | 1500 | 4500 | 9.9 | 8.6 | 20 | 17 |
| | | 11 | 200 | 20 | 330 | 34 | 330 | 34 | 440 | 45 | | | 6.8 | 6.5 | 21 | 18 |
| | | 15 | 230 | 24 | 450 | 46 | 450 | 46 | 600 | 61 | | | 6.2 | 6.1 | | |
| | | 21 | 260 | 27 | 500 | 51 | 630 | 64 | 840 | 86 | | | 4.9 | 4.8 | | |
| | | 33 | 270 | 28 | | | 850 | 87 | 1320 | 135 | | | 3.8 | 3.8 | | |
| | | 45 | 270 | 28 | | | | | 1800 | 184 | | | 3.8 | 3.7 | | |
| | RA5 | 5 | 170 | 17 | 340 | 35 | 400 | 41 | 500 | 51 | 1300 | 4500 | 32 | 31 | 21 | 18 |
| | | 11 | 200 | 20 | 400 | 41 | 850 | 87 | 1100 | 112 | | | 29 | 28 | 22 | 19 |
| | | 15 | 230 | 24 | 450 | 46 | | | 1500 | 153 | | | 28 | 28 | | |
| | | 21 | 260 | 27 | 500 | 51 | | | 1850 | 189 | | | 27 | 27 | | |
| | | 33 | 270 | 28 | | | | | | | | | 26 | 26 | | |
| | | 45 | 270 | 28 | | | | | | | | | 26 | 26 | | |
| 65 | RA5 | 5 | 400 | 41 | 400 | 41 | 400 | 41 | 500 | 51 | 1300 | 3000 | 55 *9 | 46 | 45 *9 | 35 |
| | | 12 | 600 | 61 | 960 | 98 | 960 | 98 | 1200 | 122 | | | 44 *9 | 42 | 60 *9 | 50 |
| | | 15 | 730 | 75 | 1200 | 122 | 1200 | 122 | 1500 | 153 | | | 43 *9 | 41 | | |
| | | 20 | 800 | 82 | 1500 | 153 | 1600 | 163 | 2000 | 204 | | | 33 *9 | 32 | | |
| | | 25 | 850 | 87 | | | 2000 | 204 | 2500 | 255 | | | 32 *9 | 32 | | |
| | | 40 | 640 | 65 | 1300 | | 1900 | 194 | 4000 | 408 | | | 27 *9 | 27 | | |
| | | 50 | 750 | 77 | 1500 | | 2200 | 224 | 4500 | 460 | | | 27 *9 | 27 | | |

(Note) 1. Output torque set based on the life of $L_{10}$ = 20000 hours when input rotational speed is 3000 r/min, which is the rated rotational speed of ordinary servo motors. Models 50 and 65 are set at 2000 r/min as the rated rotational speed and at $L_{10}$ = 20000 hours as the life for the servo motor to be combined.
2. Permissible maximum value of average load torque calculated based on a load torque pattern (page 068). A life of 2000 hours or more is a criterion when operated at an input speed of 2000 r/min.
3. Permissible maximum value of torque applied on start and stop in operation cycles.
4. Permissible maximum value for impact torque in an emergency stop and for external impact torque. Operation exceeding these ranges may cause damages to reducers.
5. Permissible maximum value of average input rotational speed during operations. Make it a point to operate below this value especially when the operation mode is near continuous operation.
6. Permissible maximum input rotational speed in operation modes other than continuous operation.
7. The value for a speed reducer itself. Values that include the input shaft coupling are shown in the model selection tool on the web page. (URL:https://hds-tech.jp/)
8. The weight of a speed reducer itself. Please ask for details.
9. The standard specification is flange output. Shaft output is a customized specification.

HPGP series HarmonicPlanetary® High-performance Gear Heads for Servo Motors series
HPG Series (Helical Gear Type) HarmonicPlanetary® High-performance Gear Heads for Servo Motors series
HPG Series (Standard Type) HarmonicPlanetary® High-performance Gear Heads for Servo Motors series
CSG-GH series HarmonicDrive® High-performance Gear Heads for Servo Motors series
CSF-GH series HarmonicDrive® High-performance Gear Heads for Servo Motors series
HPG series (Orthogonal Shaft Type) HarmonicPlanetary® High-performance Gear Heads for Servo Motors series

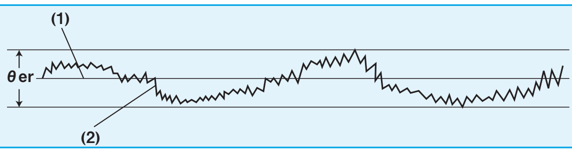
# Performance Table

Table 071-1

| Model | Orthogonal model | Reduction ratio | Angle transmission precision *1 | | Repeatability *2 | Starting torque *3 | | Overdrive starting torque *4 | | No-load running torque *5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | arc-min | ×10⁻⁴rad | arc-sec | cN·m | kgf·cm | N·m | kgf·m | cN·m | kgf·cm |
| 32 | RA3 | 5 | 4.0 | 11.6 | ±15 | 64 | 6.5 | 3.3 | 0.34 | 179 | 18 |
| | | 11 | | | | 58 | 5.9 | 6.8 | 0.69 | 162 | 17 |
| | | 15 | | | | 56 | 5.7 | 8.9 | 0.91 | 155 | 16 |
| | | 21 | | | | 53 | 5.4 | 12 | 1.2 | | |
| | | 33 | | | | 48 | 4.9 | 17 | 1.7 | 150 | 15 |
| | | 45 | | | | 47 | 4.8 | 23 | 2.3 | | |
| 50 | RA3 | 5 | 4.0 | 11.6 | ±15 | 111 | 11 | 5.8 | 0.59 | 241 | 25 |
| | | 11 | | | | 76 | 7.8 | 8.9 | 0.91 | 198 | 20 |
| | | 15 | | | | 71 | 7.2 | 11 | 1.2 | 173 | 18 |
| | | 21 | | | | 69 | 7.0 | 15 | 1.6 | | |
| | | 33 | | | | 61 | 6.2 | 21 | 2.2 | 161 | 16 |
| | | 45 | | | | 59 | 6.0 | 28 | 2.9 | | |
| | RA5 | 5 | 3.0 | 8.7 | ±15 | 132 | 14 | 6.9 | 0.70 | 496 | 51 |
| | | 11 | | | | 97 | 9.9 | 11 | 1.2 | 459 | 47 |
| | | 15 | | | | 92 | 9.4 | 15 | 1.5 | 437 | 45 |
| | | 21 | | | | 90 | 9.2 | 20 | 2.1 | | |
| | | 33 | | | | 82 | 8.4 | 29 | 2.9 | 427 | 44 |
| | | 45 | | | | 80 | 8.2 | 38 | 3.9 | | |
| 65 | RA5 | 5 | 3.0 | 8.7 | ±15 | 292 | 30 | 15 | 1.6 | 647 | 66 |
| | | 12 | | | | 177 | 18 | 23 | 2.3 | 532 | 54 |
| | | 15 | | | | 162 | 17 | 26 | 2.6 | 513 | 52 |
| | | 20 | | | | 147 | 15 | 31 | 3.2 | 494 | 50 |
| | | 25 | | | | 136 | 14 | 36 | 3.7 | 481 | 49 |
| | | 40 | | | | 127 | 13 | 51 | 5.2 | 460 | 47 |
| | | 50 | | | | 122 | 12 | 61 | 6.2 | 453 | 46 |

(Note) 1. Angle transmission precision indicates the difference between (1) logical rotating angle and (2) actual rotating angle of output when any rotating angle is given as an input. The values in the table are maximum values.

Fig. 071-1




$\theta er$ : Angle transmission precision

$\theta_1$ : Input rotating angle

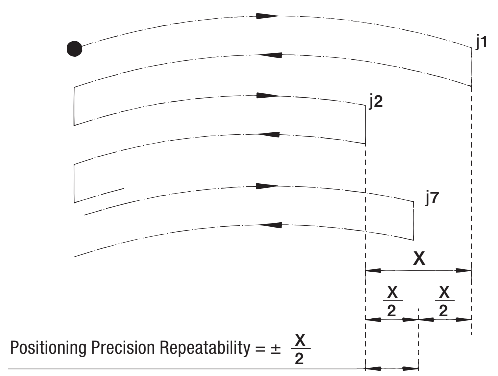
$\theta_2$ : Actual output rotating angle

R : Reduction ratio of HPG series

$$\theta er = \theta_2 - \frac{\theta_1}{R}$$

2. The repeatability is determined by repeating positioning in a given position from the same direction seven times, by measuring stop positions of the output shaft and by calculating the maximum difference. Measured values are indicated in angles (degrees) and are prefixed with "±" to 1/2 of the maximum differences. The values in the table are maximum values.

Fig. 071-2




3. Starting torque means the momentary "starting torque" with which the output side starts rotation when a torque is applied on the input side. The values in the table are maximum values.

Table 071-2

| Load | No load |
|---|---|
| HPG speed reducer surface temperature | 25°C |

4. Overdrive starting torque means the momentary "starting torque" with which the input side starts rotation when a torque is applied on the output side. The values in the table are maximum values.

Table 071-3

| Load | No load |
|---|---|
| HPG speed reducer surface temperature | 25°C |

5. No-load running torque means the torque on the input side required to put the speed reducer under a no-load condition. The values in the table are average values.

Table 071-4

| Input speed | Orthogonal model RA3 | 1500r/min |
|---|---|---|
| | Orthogonal model RA5 | 1300r/min |
| Load | | No load |
| HPG speed reducer surface temperature | | 25°C |

# Torque – Torsion Characteristic

■Orthogonal Shaft Type

Table 072-1

| Model | Orthogonal model | Reduction ratio | Backlash arc-min | Backlash $\times10^{-4}$rad | Torsional quantity on one side at $T_R$ X 0.15 D arc-min | Torsional quantity on one side at $T_R$ X 0.15 D $\times10^{-4}$rad | Torsional rigidity A/B kgf·m/arc-min | Torsional rigidity A/B ×100N·m/rad |
|---|---|---|---|---|---|---|---|---|
| 32 | RA3 | 5 | 3.0 | 8.7 | 1.9 | 5.5 | 2.2 | 740 |
| | | 11 | | | | | 2.4 | 820 |
| | | 15 | | | | | 2.5 | 850 |
| | | 21 | | | | | 2.6 | 880 |
| | | 33 | | | | | 2.7 | 900 |
| | | 45 | | | | | | 910 |
| 50 | RA3 | 5 | 3.0 | 8.7 | 2.7 | 7.9 | 3.9 | 1300 |
| | | 11 | | | 2.1 | 6.1 | 9.3 | 3100 |
| | | 15 | | | | | 11 | 3800 |
| | | 21 | | | | | 13 | 4300 |
| | | 33 | | | | | 14 | 4700 |
| | | 45 | | | | | | 4800 |
| | RA5 | 5 | 3.0 | 8.7 | 1.7 | 4.9 | 7.5 | 2500 |
| | | 11 | | | 1.8 | 5.2 | 12 | 4100 |
| | | 15 | | | | | 13 | 4500 |
| | | 21 | | | | | 14 | 4700 |
| | | 33 | | | | | 15 | 4900 |
| | | 45 | | | | | | 5000 |
| 65 | RA5 | 5 | 3.0 | 8.7 | 2.3 | 6.7 | 10 | 3400 |
| | | 12 | | | 2.0 | 5.8 | 26 | 8600 |
| | | 15 | | | | | 29 | 9800 |
| | | 20 | | | | | 32 | 11000 |
| | | 25 | | | | | 34 | |
| | | 40 | | | | | 36 | 12000 |
| | | 50 | | | | | 37 | |

## ■Torsional rigidity (windup curve)

Anchoring the speed reducer input and casing and applying a torque to the output part will generate torsion in the output part in accordance with the applied torque. Change the torque slowly in the order of: (1) Forward output torque, (2) Zero, (3) Reverse output torque, (4) Zero and (5) Forward output torque. A loop of (1) → (2) → (3) → (4) → (5) will be drawn in Fig. 072-1.

The inclination in the region from "0.15 x output torque" to "Output torque" is small. The torsional rigidity of the HPG series is an average value of this inclination. The inclination in the region from "zero torque" to "0.15 x output torque" is large. This is caused by uneven distribution such as fine uneven contact of the engaging parts and load of the planet gears under a light load.

## ■Calculation of total torsional quantity (Windup)

The method to calculate the total torsional quantity (average value) on one side when the speed reducer applies a load in a no-load state.

Formula 072-1

● Calculation formula

$$\theta = D + \frac{T - T_L}{\frac{A}{B}}$$

Symbols in calculation formula

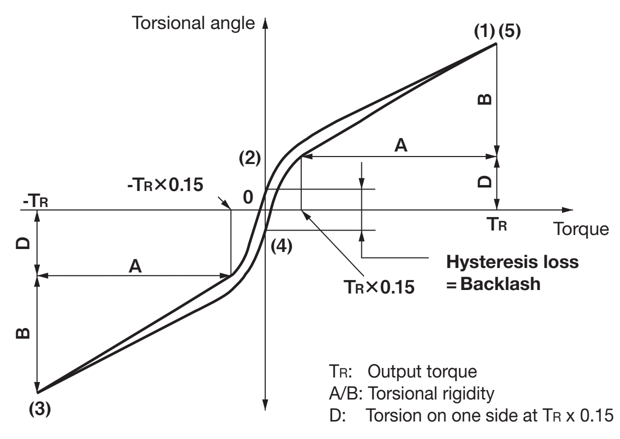
| | | |
|---|---|---|
| $\theta$ | Total torsional quantity | ―― |
| D | Torsional quantity on one side at output torque x 0.15 torque | See Fig. 072-1, Table 072-1 |
| T | Load torque | ―― |
| $T_L$ | Output torque x 0.15 torque (=$T_R$ x 0.15) | See Fig. 072-1 |
| A/B | Torsional rigidity | See Fig. 072-1, Table 072-1 |

## ■Backlash (Hysteresis loss)

The zero-torque width (2) - (4) in Fig. 072-1 "Torque-torsional angle diagram" is called a hysteresis loss. The hysteresis loss between "Forward output torque" and "Reverse output torque" is defined as backlash of the HPG series. At the time of pre-shipment factory inspection, the backlash of the HPG series is less than 3 minutes.

Fig. 072-1

**Torque-torsional angle diagram**

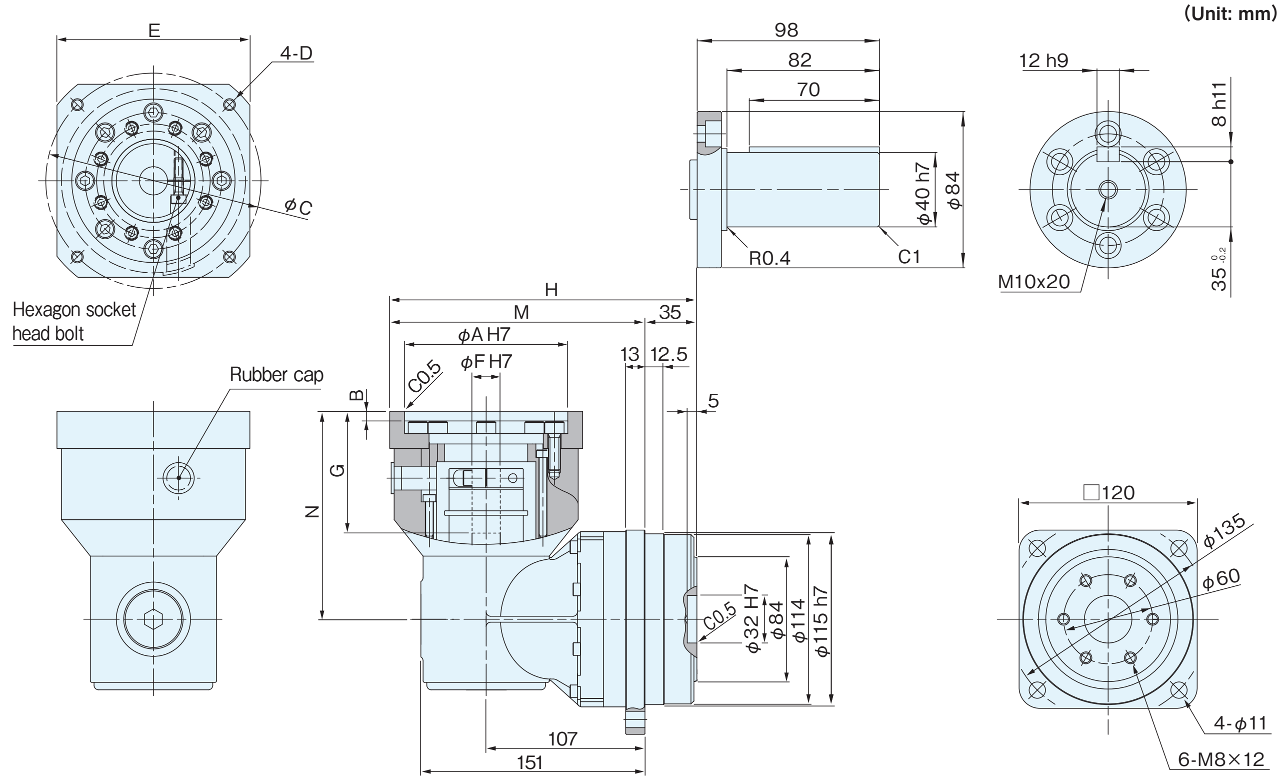


# Dimensional Outline Drawing – Model No. 32

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.
You can download the CAD data of this product from the following homepage. URL: https://www.hds.co.jp/

Fig. 073-1

(Unit: mm)




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# Measurement Table

Table 073-1
Unit: mm

| | Shape symbol [*1] | A(H7) | B | C | D | E | F(H7) Min | F(H7) Max | G | H | M | N | Mass (kg) Shaft output | Mass (kg) Flange output |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Single-stage speed reduction type (Reduction ratio = 5) | NF□ | 95 | 10 | 115 | M8×18 | φ135 | 10 | 24 | 56 | 209.5 | 174.5 | 115 | 9.7 | 8.3 |
| | NJ□ | | | | M6×12 | | | | | | | | | |
| | BA□ | 110 | 6.5 | 145 | M8×25 | □130 | | 35 | 81 | 207 | 172 | 140 | 10.3 | 8.9 |
| | BB□ | 114.3 | | 200 | M12×25 | □180 | | | | 232 | 197 | | 11.3 | 9.9 |
| Dual-stage speed reduction type (Reduction ratio = 11, 15, 21, 33, 45) | NF□ | 95 | 10 | 115 | M8×18 | φ135 | 10 | 24 | 56 | 209.5 | 174.5 | 115 | 10.1 | 8.7 |
| | NJ□ | | | | M6×12 | | | | | | | | | |
| | BA□ | 110 | 6.5 | 145 | M8×25 | □130 | | 35 | 81 | 207 | 172 | 140 | 10.7 | 9.3 |
| | BB□ | 114.3 | | 200 | M12×25 | □180 | | | | 232 | 197 | | 11.7 | 10.3 |

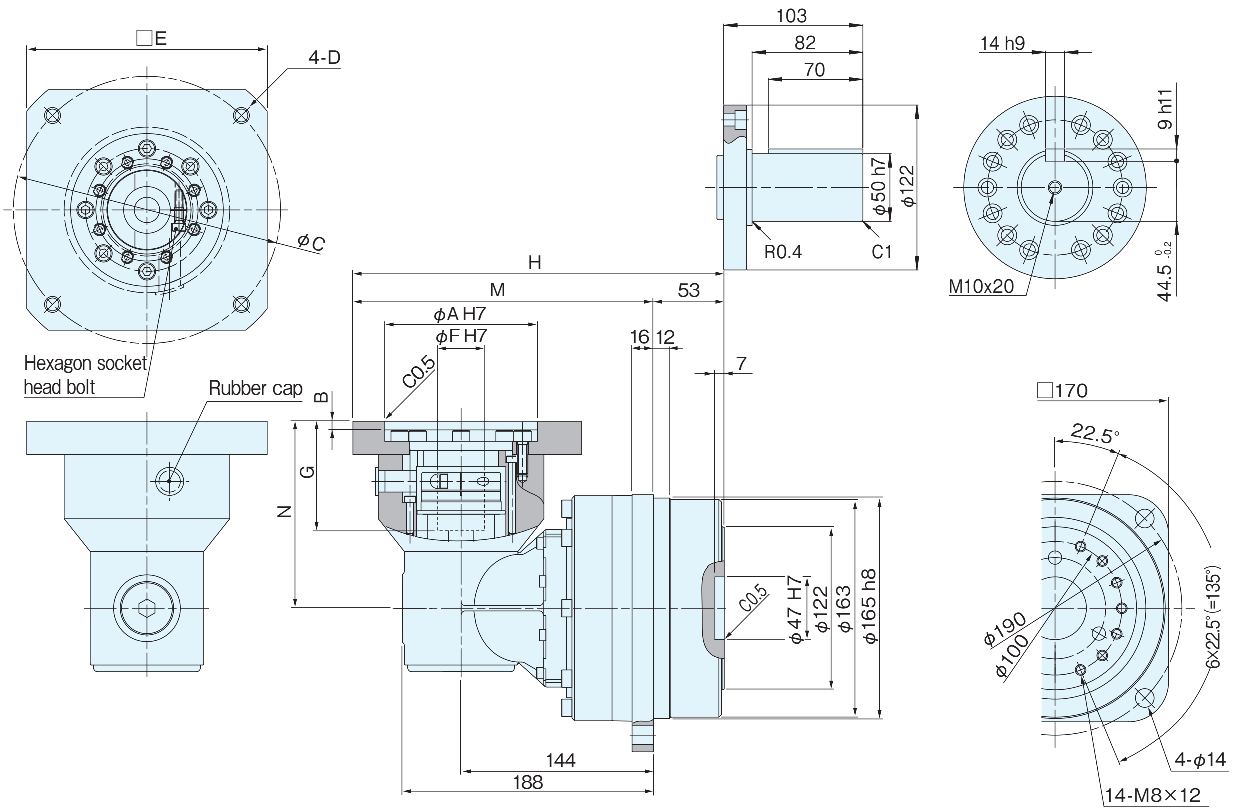
Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on speed reducers only and on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)

# Dimensional Outline Drawing – Model No. 50 RA3

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.
You can download the CAD data of this product from the following homepage. URL: https://www.hds.co.jp/

Fig. 074-1

(Unit: mm)




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# Measurement Table

Table 074-1
Unit: mm

| | Shape symbol [*1] | A(H7) | B | C | D | E | F(H7) Min | F(H7) Max | G | H | M | N | Mass (kg) Shaft output | Mass (kg) Flange output |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dual-stage speed reduction type (Reduction ratio = 11, 15, 21, 33, 45) | BA□ | 110 | 6.5 | 145 | M8×25 | □130 | 10 | 35 | 81 | 262 | 209 | 140 | 24 | 21 |
| | BB□ | 114.3 | | 200 | M12×25 | □180 | | | | 287 | 234 | | 25 | 22 |
| | NF□ | 95 | 10 | 115 | M8×18 | ϕ135 | | 24 | 57 | 264.5 | 211.5 | 115 | 23.4 | 20.4 |
| | NJ□ | | | | M6×12 | | | | | | | | | |

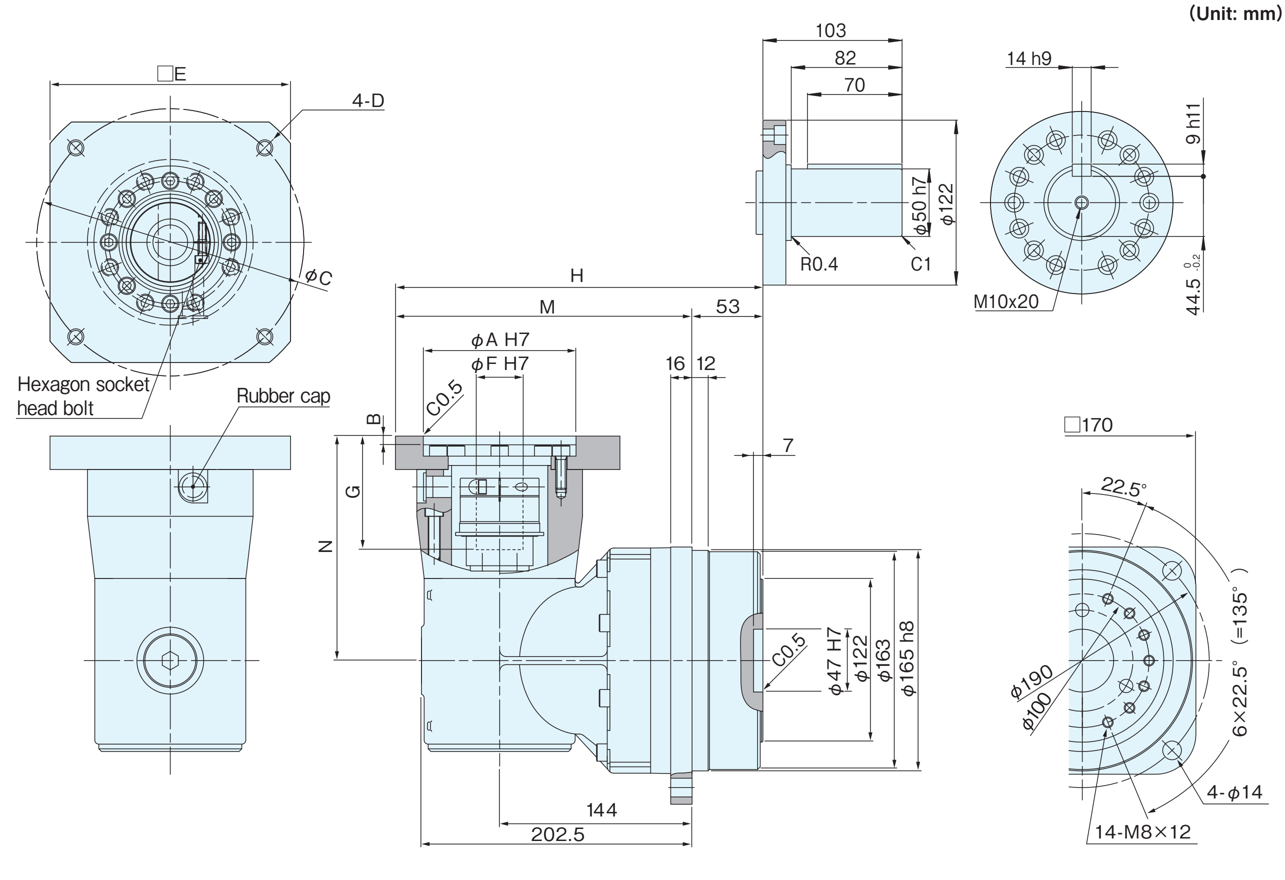
Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above and reduction ratio = 5.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on speed reducers only and on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)

# Dimensional Outline Drawing – Model No. 50 RA5

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.
You can download the CAD data of this product from the following homepage. URL: https://www.hds.co.jp/

Fig. 075-1

(Unit: mm)




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
  Contact us for the differential range of the size that is not described.

# Measurement Table

Table 075-1
Unit: mm

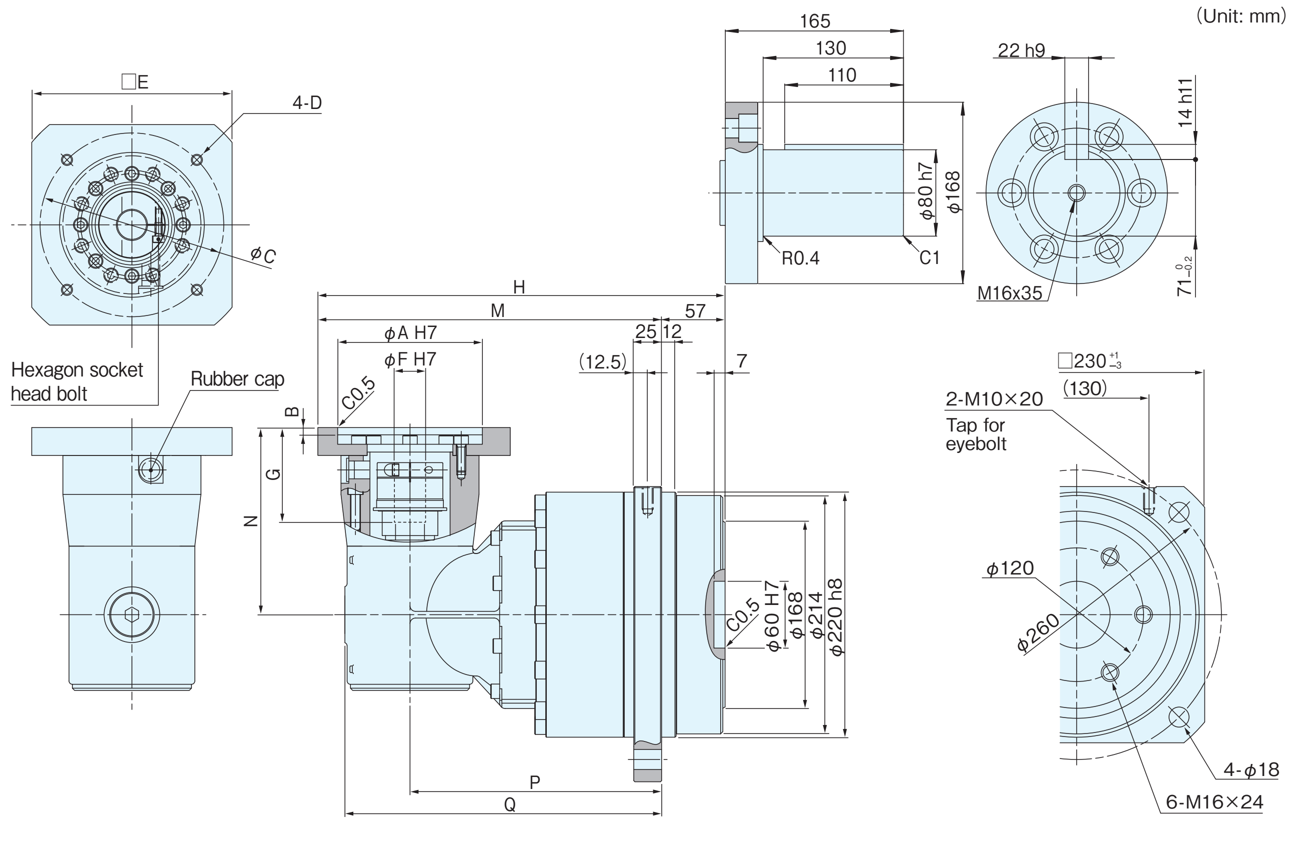
<table>
<tr><th rowspan="2"></th><th rowspan="2">Shape symbol *1</th><th rowspan="2">A(H7)</th><th rowspan="2">B</th><th rowspan="2">C</th><th rowspan="2">D</th><th rowspan="2">E</th><th colspan="2">F(H7)</th><th rowspan="2">G</th><th rowspan="2">H</th><th rowspan="2">M</th><th rowspan="2">N</th><th colspan="2">Mass (kg)</th></tr>
<tr><th>Min</th><th>Max</th><th>Shaft output</th><th>Flange output</th></tr>
<tr><td rowspan="4">Single-stage speed reduction type (Reduction ratio = 5)</td><td>BA□</td><td>110</td><td rowspan="4">6.5</td><td>145</td><td>M8×25</td><td>□130</td><td rowspan="4">19</td><td rowspan="4">42</td><td rowspan="2">84</td><td>262</td><td>209</td><td rowspan="3">168</td><td>23.7</td><td>20.7</td></tr>
<tr><td>BB□</td><td>114.3</td><td>200</td><td>M12×25</td><td rowspan="3">□180</td><td rowspan="3">287</td><td rowspan="3">234</td><td rowspan="2">24.9</td><td rowspan="2">21.9</td></tr>
<tr><td>BF□</td><td>130</td><td>165</td><td rowspan="2">M10×25</td><td>85</td></tr>
<tr><td>CB□</td><td>114.3</td><td>200</td><td>116</td><td>200</td><td>25.9</td><td>22.9</td></tr>
<tr><td rowspan="4">Dual-stage speed reduction type (Reduction ratio = 11, 15, 21, 33, 45)</td><td>BA□</td><td>110</td><td rowspan="4">6.5</td><td>145</td><td>M8×25</td><td>□130</td><td rowspan="4">19</td><td rowspan="4">42</td><td rowspan="2">84</td><td>262</td><td>209</td><td rowspan="3">168</td><td>25.3</td><td>22.3</td></tr>
<tr><td>BB□</td><td>114.3</td><td>200</td><td>M12×25</td><td rowspan="3">□180</td><td rowspan="3">287</td><td rowspan="3">234</td><td rowspan="2">26.5</td><td rowspan="2">23.5</td></tr>
<tr><td>BF□</td><td>130</td><td>165</td><td rowspan="2">M10×25</td><td>85</td></tr>
<tr><td>CB□</td><td>114.3</td><td>200</td><td>116</td><td>200</td><td>27.5</td><td>24.5</td></tr>
</table>

Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on speed reducers only and on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)

## Dimensional Outline Drawing – Model No. 65

Only principal dimensions are shown in the dimension diagrams. Check the details of the dimensions with the delivered specifications.
You can download the CAD data of this product from the following homepage. URL: https://www.hds.co.jp/

Fig. 076-1




* While the flange output is for standard, the shaft output is for special specification.
* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

## Measurement Table

Table 076-1
Unit: mm

| | Shape symbol *1 | A(H7) | B | C | D | E | F(H7) | | G | H | M | N | P | Q | Mass (kg) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Min | Max | | | | | | | Shaft output | Flange output |
| Single-stage speed reduction type (Reduction ratio = 5) | CB□ | 114.3 | 6.5 | 200 | M12×25 | □180 | 19 | 42 | 116 | 319 | 262 | 200 | 172 | 230.5 | 50.5 | 40.5 |
| Dual-stage speed reduction type (Reduction ratio = 12, 15, 20, 25, 40, 50) | BA□ | 110 | 6.5 | 145 | M8×25 | □130 | 19 | 42 | 84 | 348 | 291 | 168 | 226 | 284.5 | 57.6 | 47.6 |
| | BB□ | 114.3 | 6.5 | 200 | M12×25 | □180 | 19 | 42 | 84 | 373 | 316 | 168 | 226 | 284.5 | 58.8 | 48.8 |
| | BF□ | 130 | 6.5 | 165 | M10×25 | □180 | 19 | 42 | 85 | 373 | 316 | 168 | 226 | 284.5 | 58.8 | 48.8 |
| | CB□ | 114.3 | 6.5 | 200 | M12×25 | □180 | 19 | 42 | 116 | 373 | 316 | 200 | 226 | 284.5 | 59.8 | 49.8 |

Dimensions of only typical products are shown. Please contact us for dimensions of products not listed above.
Check details of the dimensions and shape with the delivered specifications.
Contact us for information on speed reducers only and on special installation method.
(Note) 1. A symbol for input shaft coupling is supplied in "□" in shape symbols. See the model selection tool on the web page. (URL:https://hds-tech.jp/)

■MEMO

HarmonicPlanetary®

Planetary Speed Reducer Unit Series

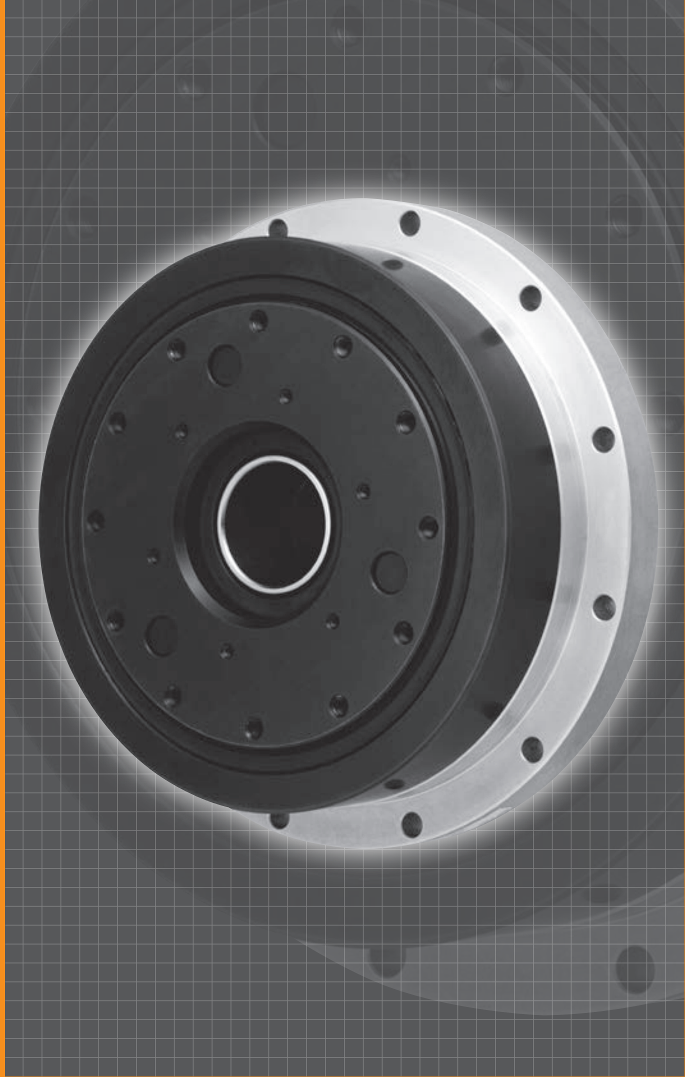
# CONTENTS

## HPF Hollow Shaft Unit Type



## HPG Input Shaft Unit Type

# HarmonicPlanetary®
## HPF Hollow Shaft Unit Type



**Size** — 2 Types
Model: 25, 32

**Peak torque**
Model: 25 = 100 N·m
Model: 32 = 220 N·m

**Reduction ratio**
1／11

**Small backlash**
Standard: 3 min. or less

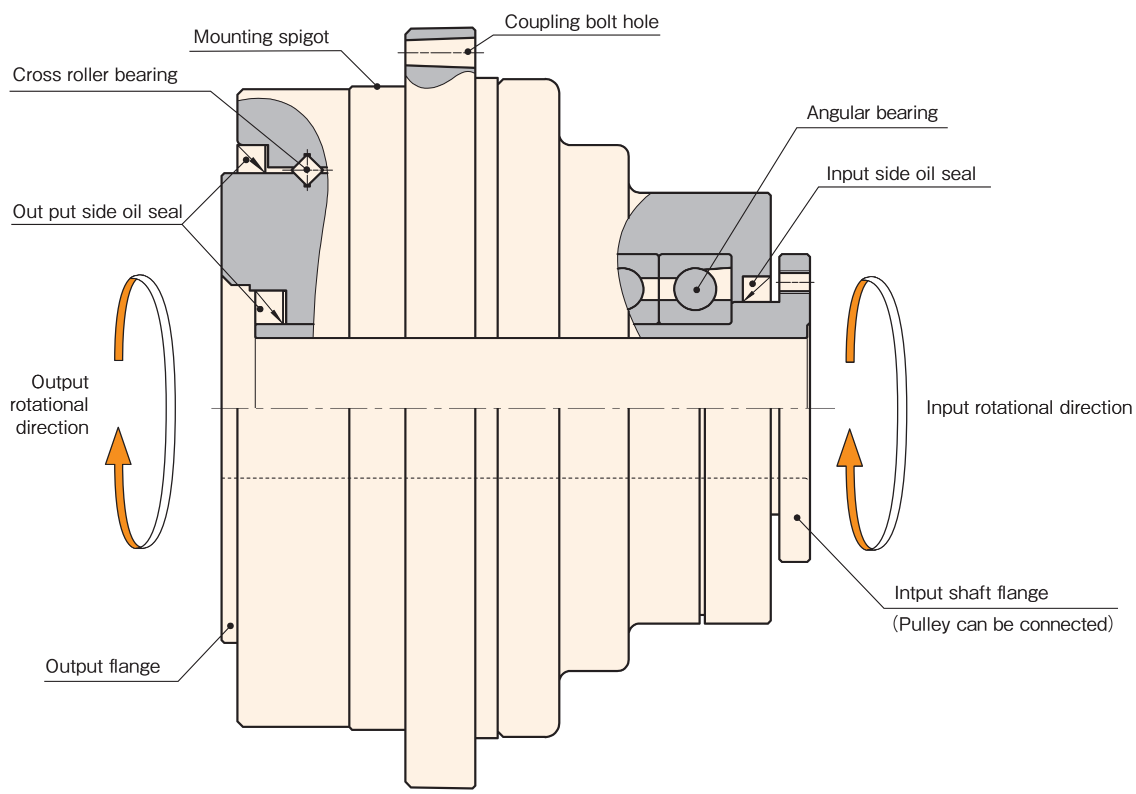
**Inside diameter of the hollow shaft**
Model: 25 = $\phi$25 mm
Model: 32 = $\phi$30 mm

The hollow structure unit has been developed based on Harmonic Planetary®. The superior performance and specifications of HPG series has been succeeded. Additionally, a hollow structure has been newly introduced to enjoy the shape advantage. The pass-through hole with the coaxial I/O shaft provides the compactly-designed devices to meet diversified customer needs, such as piping, wiring, and passing-through laser light or combining with a ball screw.



Structural drawing

Fig. 079-1



# Model Number Selection

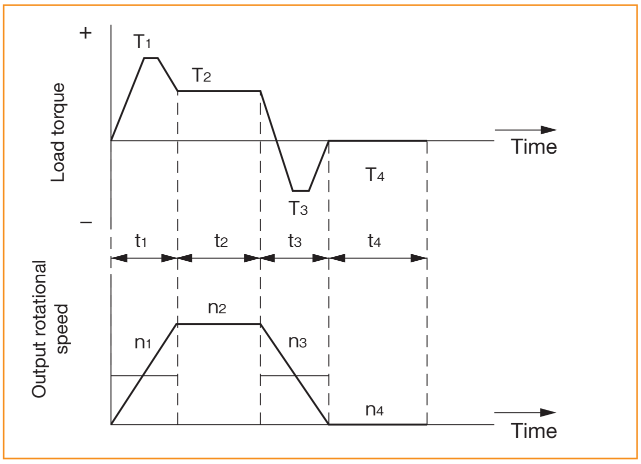
Check your operating conditions and select suitable model Nos. based on the flowchart to fully demonstrate the excellent performance of the Harmonic Planetary® HPF series.

In general, the servo system is rarely in a continuous constant load state. The load torque changes according to the input rotational speed variation and comparatively large torque are applied at start and stop. Unexpected impact torque may be applied.
Check your operating conditions against the following load torque pattern and select suitable model Nos. 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). (See the specification of the input side main bearing and the output side main bearing on pages 114 to 119.)

## ■Checking the load torque pattern

First, you need to look at the picture of the load torque pattern. Check the specifications shown in the figure below.

Graph 080-1




**Obtain the value of each load torque pattern.**

| | |
|---|---|
| Load torque | $T_1$ to $T_n$ (N·m) |
| Time | $t_1$ to $t_n$ (sec) |
| Output rotational speed | $n_1$ to $n_n$ (r/min) |

**<Normal operation pattern>**

| | |
|---|---|
| Starting time | $T_1$, $t_1$, $n_1$ |
| Steady operation time | $T_2$, $t_2$, $n_2$ |
| Stopping (slowing) time | $T_3$, $t_3$, $n_3$ |
| Break time | $T_4$, $t_4$, $n_4$ |

**<Maximum rotational speed>**

| | |
|---|---|
| Max. output rotational speed | $n_{o\,max} \geqq n_1$ to $n_n$ |
| Max. input rotational speed | $n_{i\,max} \geqq n_1 \times R$ to $n_n \times R$ |
| (Restricted by motors) | R: Reduction ratio |

**<Impact torque>**
When impact torque is applied $T_s$

**<Required life>**
$L_{10}$ = L (hours)

## ■Flowchart of model number selection

Select a model number according to the following flowchart.
If you find a value exceeding that from the ratings, you should review it with the upper-level model number or consider reduction of conditions including the load torque.

Calculate the average load torque applied on the output side of HarmonicDrive® from the load torque pattern: $T_{av}$ (N·m).

$$T_{av} = \sqrt[10/3]{\frac{|n_1|\cdot t_1\cdot|T_1|^{10/3}+|n_2|\cdot t_2\cdot|T_2|^{10/3}+\cdots+|n_n|\cdot t_n\cdot|T_n|^{10/3}}{|n_1|\cdot t_1+|n_2|\cdot t_2+\cdots+|n_n|\cdot t_n}}$$

Calculate the average output speed based on the load torque pattern: no av (r/min)

$$n_{o\,av} = \frac{|n_1|\cdot t_1+|n_2|\cdot t_2+\cdots+|n_n|\cdot t_n}{t_1+t_2+\cdots+t_n}$$

▼

Tentatively select a model No. under the following condition:
$T_{av} \leqq$ Average load torque (See the rating table on page 082) — NG

OK

Determine the reduction ratio (R) based on the maximum output rotational speed (no *max*) and maximum input rotational speed (ni *max*).

$$\frac{n_{i\,max}}{n_{o\,max}} \geqq R$$

(A limit is placed on ni *max* by motors.)
Calculate the maximum input rotational speed (ni *max*) from the maximum output rotational speed (no *max*) and the reduction ratio (R).

$$n_{i\,max} = n_{o\,max} \cdot R$$

▼

Calculate the average input rotational speed (ni *av*) from the average output rotational speed (no *av*) and the reduction ratio (R): ni *av* = no *av*·R ≦ Permissible average input rotational speed (nr). — NG

OK

Check whether the maximum input rotational speed is equal to or less than the values in the rating table.
ni *max* ≦ maximum input rotational speed (r/min) — NG

OK

Check whether $T_1$ and $T_3$ are equal to or less than the permissible peak torque (N·m) value at start and stop from the ratings. — NG

OK

Check whether $T_s$ is equal to or less than the permissible maximum momentary torque (N·m) value from the ratings. — NG

OK

Calculate the lifetime and check whether it meets the specification requirement.
Tr: Output torque
$n_r$: Permissible average input rotational speed

$$L_{10} = 20{,}000 \cdot \left(\frac{T_r}{T_{av}}\right)^{10/3} \cdot \left(\frac{n_r}{n_{i\,av}}\right) \text{(Hour)}$$

— NG

OK

**The model number is determined.**

Check the description in Caution below.

Review of the operation conditions, model No and reduction ratio.

**Caution**

Check impacts by speed reducer temperature rise, vibration during acceleration and deceleration and other factors if the operating conditions are as specified below. Study to "increase the speed reducer size", "review the operating conditions" and other means if it becomes necessary to study safety. Exercise reasonable caution especially when operating conditions are close to continuous operation.
Average load torque (*Tav*) > Permissible maximum value of average load torque (see page 082)
Calculate average input rotational speed (ni *av*) > Permissible average input rotational speed (nr)

## Example of model number Selection

### Value of each load torque pattern.

| | |
|---|---|
| Load torque | $T_n$ (N·m) |
| Time | $t_n$ (sec) |
| Output rotational speed | $n_n$ (r/min) |

<Normal operation pattern>

| | | | |
|---|---|---|---|
| Starting time | $T_1$ = 70 N·m, | $t_1$ = 0.3 sec, | $n_1$ = 60 r/min |
| Steady operation time | $T_2$ = 18 N·m, | $t_2$ = 3 sec, | $n_2$ = 120 r/min |
| Stopping (slowing) time | $T_3$ = 35 N·m, | $t_3$ = 0.4 sec, | $n_3$ = 60 r/min |
| Break time | $T_4$ = 0 N·m, | $t_4$ = 5 sec, | $n_4$ = 0 r/min |

<Maximum rotational speed>

| | |
|---|---|
| Max. output rotational speed | $n_{o\,max}$ = 120 r/min |
| Max. input rotational speed | $n_{i\,max}$ = 5,000 r/min (Restricted by motors) |

<Impact torque>

When impact torque is applied $T_s$ = 120 N·m

<Required life>

$L_{10}$ = 30,000 (hours)

---

Calculate the average load torque applied to the output side based on the load torque pattern: $T_{av}$ (N·m).

$$T_{av}=\sqrt[10/3]{\frac{|60r/min|\cdot 0.3sec\cdot|70N\cdot m|^{10/3}+|120r/min|\cdot 3sec\cdot|18N\cdot m|^{10/3}+|60r/min|\cdot 0.4sec\cdot|35N\cdot m|^{10/3}}{|60r/min|\cdot 0.3sec+|120r/min|\cdot 3sec+|60r/min|\cdot 0.4sec}}$$

Calculate the average output rotational speed based on the load torque pattern: $n_{o\,av}$ (r/min)

$$n_{o\,av}=\frac{|60r/min|\cdot 0.3sec+|120r/min|\cdot 3sec+|60r/min|\cdot 0.4sec+|0r/min|\cdot 5sec}{0.3sec+3sec+0.4sec+5sec}$$

▼

Select a model number temporarily with the following conditions. $T_{av}$ = 30.2 N·m ≦ 48 N·m. (**HPF-25A-11** is tentatively selected based on the average load torque (see the rating table on page 082) of model No. 25 and reduction ratio of 11.) — NG

OK ▼

Determine a reduction ratio (R) from the maximum output rotational speed ($n_{o\,max}$) and maximum input rotational speed ($n_{i\,max}$).

$$\frac{5{,}000\ r/min}{120\ r/min}=41.7\geqq 21$$

Calculate the maximum input rotational speed ($n_{i\,max}$) from the maximum output rotational speed ($n_{o\,max}$) and reduction ratio (R): $n_{i\,max}$ = 120 r/min · 11 = 1,320 r/min

▼

Calculate the average input rotational speed ($n_{i\,av}$) from the average output rotational speed ($n_{o\,av}$) and reduction ratio (R):
$n_{i\,av}$ = 46.2 r/min·11= 508 r/min ≦ Permissible average input rotational speed of model No. 25 3,000 (r/min) — NG

OK ▼

Check whether the maximum input rotational speed is equal to or less than the values specified in the rating table.
$n_{i\,max}$ = 1,320 r/min ≦ 5,600 r/min (maximum rotational input speed of model No. 25) — NG

OK ▼

Check whether $T_1$ and $T_3$ are equal to or less than the peak torques (N·m) on start and stop in the rating table.
$T_1$ = 70 N·m ≦ 100 N·m (Peak torques on start and stop of model No. 25)
$T_3$ = 35 N·m ≦ 100 N·m (Peak torques on start and stop of model No. 25) — NG

OK ▼

Check whether $T_s$ is equal to or less than the values of the momentary max. torque (N·m) in the rating table.
$T_s$ = 120 N·m ≦ 170 N·m (momentary max. torque of model No. 25) — NG

OK ▼

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

$$L_{10}=20{,}000\cdot\left(\frac{21\ N\cdot m}{30.2\ N\cdot m}\right)^{10/3}\cdot\left(\frac{3{,}000\ r/min}{508\ r/min}\right)=35{,}182\ (hours)\geqq 30{,}000\ (hours)$$ — NG

OK ▼

**As a result of the preceding steps, HPF-25A-11 is determined.**

Check the description in Caution at the bottom of page 080

Review of the operation conditions, model No and reduction ratio.

# Rating Table

The hollow shaft type of the HPF series is unique high-precision speed reducer unit of 1/11 low speed reduction. This features the hollow shaft that can be coaxial with the I/O shaft.

Table 082-1

| Model | Reduction ratio | Rated output torque [*1] | | Permissible max. value of ave. load torque [*2] | | Permissible peak torque at start/stop [*3] | | Permissible max. momentary torque [*4] | | Permissible ave. input rotational speed [*5] | Permissible max. input rotational speed [*6] | Inertia moment Flange output | Mass Flange output |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N·m | kgf·m | N·m | kgf·m | N·m | kgf·m | N·m | kgf·m | r/min | r/min | $\times 10^{-4}$ kg·m² | kg |
| 25 | 11 | 21 | 2.1 | 48 | 4.9 | 100 | 10.2 | 170 | 17.3 | 3000 | 5600 | 1.63 | 3.8 |
| 32 | 11 | 44 | 4.5 | 100 | 10.2 | 220 | 22.4 | 450 | 45.9 | 3000 | 4800 | 3.84 | 7.2 |

(Note) 1. Output torque set based on the life of $L_{10}$ = 20000 hours when input rotational speed is 3000 r/min, which is the rated rotational speed of ordinary servo motors.
2. Permissible maximum value of average load torque calculated based on a load torque pattern (page 080). A life of 2000 hours or more is a criterion when operated at an input speed of 2000 r/min.
3. Permissible maximum value of torque applied on start and stop in operation cycles.
4. Permissible maximum value for impact torque in an emergency stop and for external impact torque.Operation exceeding these ranges may cause damages to reducers.
5. The permissible average input rotational speed is set so as to limit the temperature rise due to the heat generated by the speed reducer.
The value of the temperature rise depending on the heat radiation conditions of the speed reducer installation parts (housing) arranged by the customers and on the ambient temperature. It is appropriate to regard the surface temperature 70ºC of the speed reducer as the reference upper limit. Especially for the model No. 32, pay careful attention to the values of temperature rise caused by the generated heat. Cool the unit or lower the average input rotational speed as necessary to set the operation pattern.
6. Permissible maximum input rotational speed in operation modes other than continuous operation.

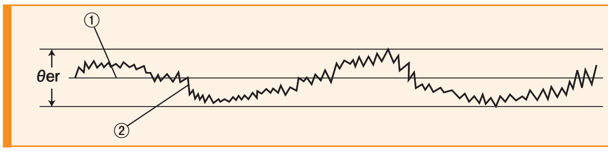
# Performance Table

Table 082-2

| Model | Reduction ratio | Angle transmission precision [*1] | | Repeatability [*2] | Starting torque [*3] | | Overdrive starting torque [*4] | | No-load running torque [*5] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | arc-min | $\times 10^{-4}$rad | arc-sec | cN·m | kgf·cm | N·m | kgf·m | cN·m | kgf·cm |
| 25 | 11 | 4 | 11.6 | ±15 | 59 | 6.0 | 6.5 | 0.66 | 78 | 8.0 |
| 32 | 11 | 4 | 11.6 | ±15 | 75 | 7.7 | 8.3 | 0.85 | 105 | 10.7 |

(Note) 1. Angle transmission precision indicates the difference between (1) logical rotating angle and (2) actual rotating angle of output when any rotating angle is given as an input. The values in the table are maximum values.

Fig. 082-1

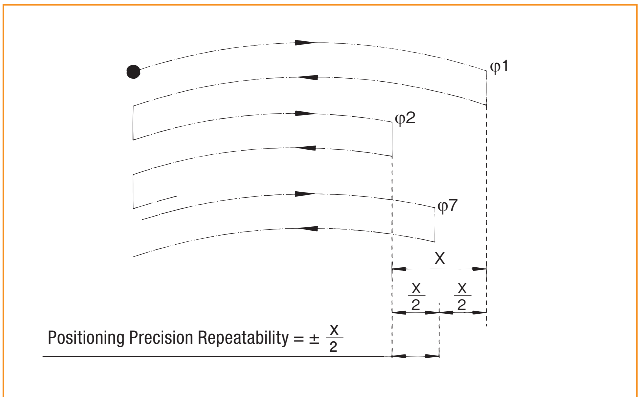



$\theta er$ : Angle transmission precision
$\theta_1$ : Input rotating angle
$\theta_2$ : Actual output rotating angle
R : Reduction ratio of HPG series

$$\theta er = \theta_2 - \frac{\theta_1}{R}$$

2. The repeatability is determined by repeating positioning in a given position from the same direction seven times, by measuring stop positions of the output shaft and by calculating the maximum difference. Measured values are indicated in angles (degrees) and are prefixed with "±" to 1/2 of the maximum differences. The values in the table are maximum values.

Fig. 082-2




3. Starting torque means the momentary "starting torque" with which the output side starts rotation when a torque is applied on the input side. The values in the table are maximum values.

Table 082-3

| Load | No load |
|---|---|
| HPF speed reducer surface temperature | 25°C |

4. Overdrive starting torque means the momentary "starting torque" with which the input side starts rotation when a torque is applied on the output side. The values in the table are maximum values.

Table 082-4

| Load | No load |
|---|---|
| HPF speed reducer surface temperature | 25°C |

5. No-load running torque means the torque on the input side required to put the speed reducer under a no-load condition. The values in the table are average values.

Table 082-5

| Input speed | 3000 r/min |
|---|---|
| Load | No load |
| HPF speed reducer surface temperature | 25°C |

# Torque – Torsion Characteristic

■Hollow Shaft Unit Type Standard Item

Table 083-1

| Model | Reduction ratio | Backlash | | Torsional quantity on one side at $T_R$ X 0.15 D | | Torsional rigidity A/B | |
|---|---|---|---|---|---|---|---|
| | | arc-min | ×10$^{-4}$rad | arc-min | ×10$^{-4}$rad | kgf·m/arc-min | ×100N·m/rad |
| 25 | 11 | 3.0 | 8.7 | 2.0 | 5.8 | 1.7 | 570 |
| 32 | 11 | 3.0 | 8.7 | 1.7 | 4.9 | 3.5 | 1173 |

## ■Torsional rigidity (windup curve)

Anchoring the speed reducer input and casing and applying a torque to the output part will generate torsion in the output part in accordance with the applied torque. Change the torque slowly in the order of: (1) Forward output torque, (2) Zero, (3) Reverse output torque, (4) Zero and (5) Forward output torque. A loop of (1) → (2) → (3) → (4) → (5) (return to (1)) will be drawn in Fig. 083-1. The inclination in the region from “0.15 x output torque” to “Output torque” is small. The torsional rigidity of the HPF series is an average value of this inclination. The inclination in the region from “zero torque” to “0.15 x output torque” is large. This is caused by uneven distribution such as fine uneven contact of the engaging parts and load of the planet gears under a light load.

## ■Calculation of total torsional quantity (Windup)

The method to calculate the total torsional quantity (average value) on one side when the speed reducer applies a load in a no-load state.

Formula 083-1

● Calculation formula

$$\theta = D + \frac{T - T_L}{\frac{A}{B}}$$

Symbols in calculation formula

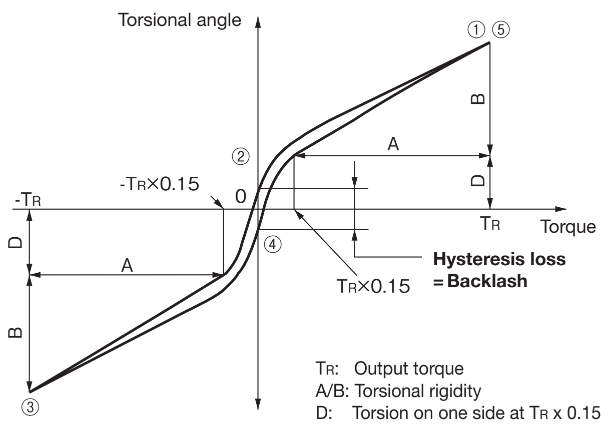
| | | |
|---|---|---|
| $\theta$ | Total torsional quantity | —— |
| D | Torsional quantity on one side at output torque x 0.15 torque | See Fig. 083-1, Table 083-1 |
| T | Load torque | —— |
| $T_L$ | Output torque x 0.15 torque (=$T_R$ x 0.15) | See Fig. 083-1 |
| A／B | Torsional rigidity | See Fig. 083-1, Table 083-1 |

## ■Backlash (Hysteresis Loss)

The zero-torque width (2) - (4) in Fig. 083-1 “Torque-torsional angle diagram” is called a hysteresis loss. The hysteresis loss between “Forward output torque” and “Reverse output torque” is defined as backlash of the HPF series. At the time of pre-shipment factory inspection, the backlash of the HPF series is less than 3 minutes.

Fig. 083-1

**Torque-torsional angle diagram**




$T_R$: Output torque
A/B: Torsional rigidity
D: Torsion on one side at $T_R$ x 0.15

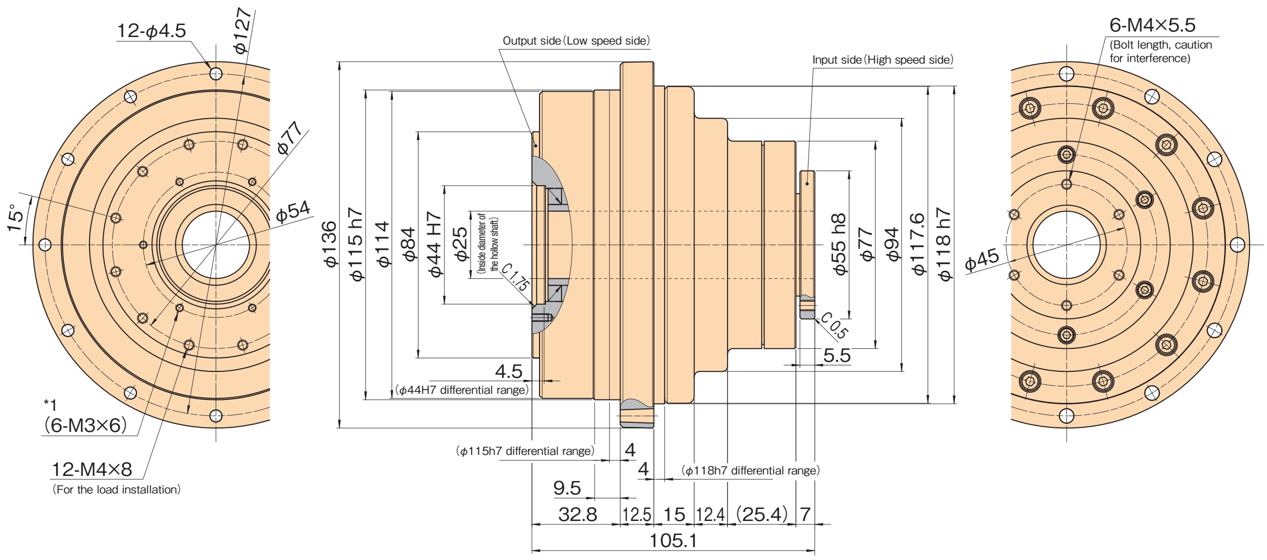
# Dimensional Outline Drawing

Only principal dimensions are shown in the dimension diagrams. For detailed dimensions and shapes, refer to the delivery specification drawings we provide.
For the specifications of the input side bearing of the hollow shaft unit type, refer to page 118.
You can download the CAD data of this product from the following homepage. URL: https://www.hds.co.jp/

## ■Dimensional outline drawing – Model No. 25

Fig. 084-1

(Unit: mm)



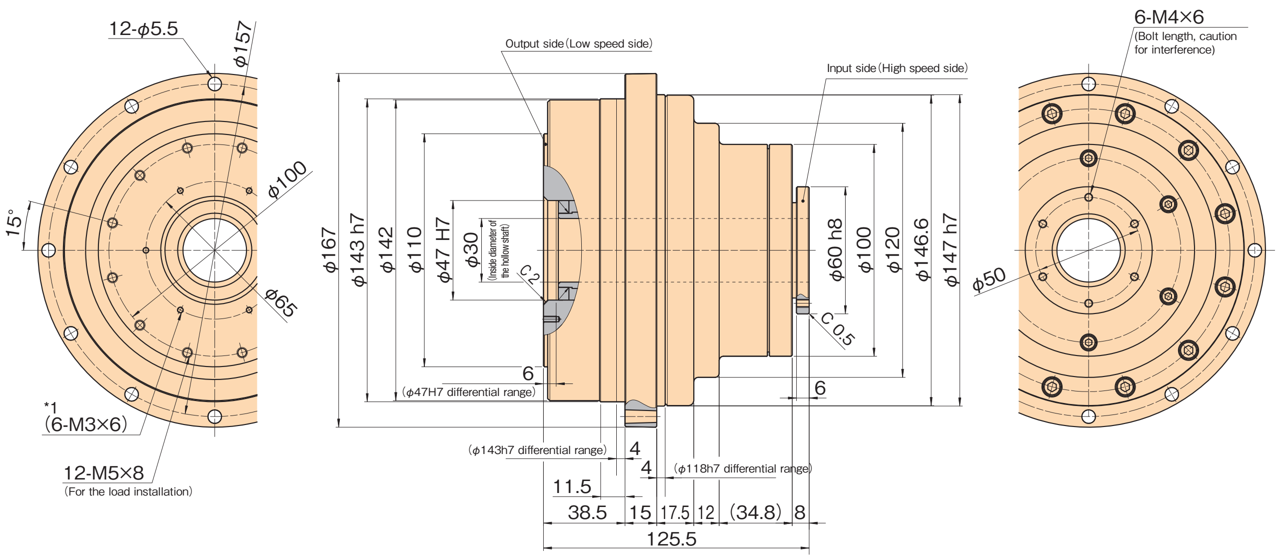

*1: Inside diameter part of the hollow shaft is synchronized with the input shaft and rotates.
Use it when installing the inside diameter sleeve from output side to input side. (This is not for the load installation).

* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

## ■Dimensional outline drawing – Model No. 32

Fig. 084-2

(Unit: mm)




*1: Inside diameter part of the hollow shaft is synchronized with the input shaft and rotates.
Use it when installing the inside diameter sleeve from output side to input side. (This is not for the load installation).

* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# HarmonicPlanetary®
## HPG Input Shaft Unit Type



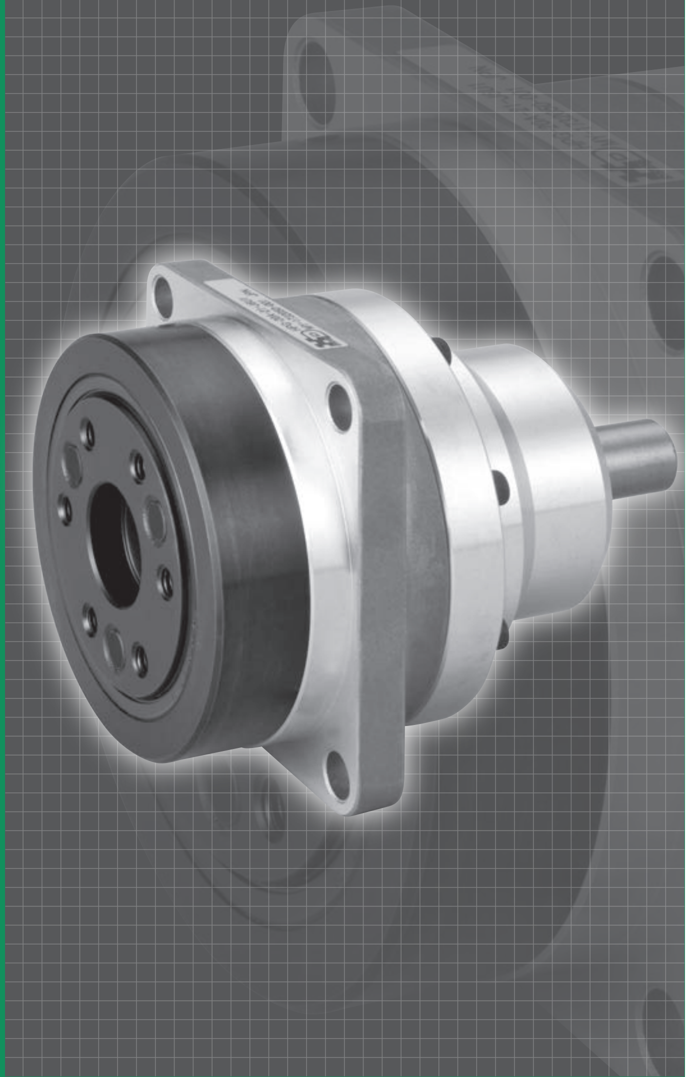
**Size** 6 Types
Model: 11, 14, 20, 32, 50, 65

**Peak torque**
3.9 N·m to 2200 N·m

**Reduction ratio**
1-stage reduction = 3 to 9
2-stage reduction = 11 to 50

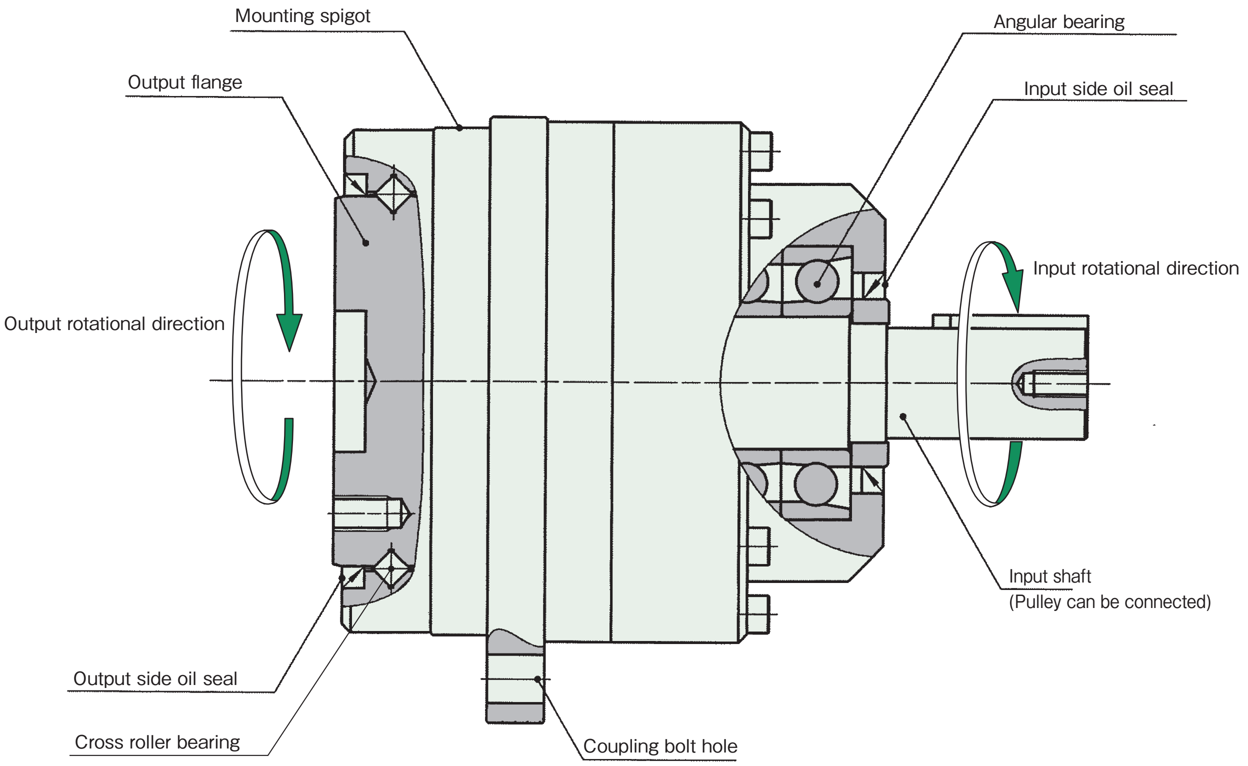
**Small backlash**
Standard: 3 min. or less
Customized: 1 min. or less

**High efficiency**
90% or higher
(85% for Models 11 and 14)



Structural drawing

Fig. 085-1



# Model Number Selection

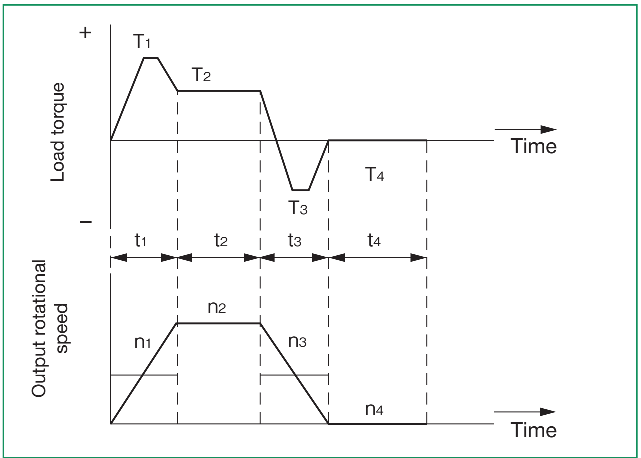
Check your operating conditions and select suitable model Nos. based on the flowchart to fully demonstrate the excellent performance of the Harmonic Planetary® HPG series.

In general, the servo system is rarely in a continuous constant load state. The load torque changes according to the input rotational speed variation and comparatively large torque are applied at start and stop. Unexpected impact torque may be applied.
Check your operating conditions against the following load torque pattern and select suitable model Nos. 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). (See the specification of the input side main bearing and the output side main bearing on pages 114 to 119.)

## ■Checking the load torque pattern

First, you need to look at the picture of the load torque pattern.
Check the specifications shown in the figure below.

Graph 086-1




**Obtain the value of each load torque pattern.**

| | |
|---|---|
| Load torque | $T_1$ to $T_n$ (N·m) |
| Time | $t_1$ to $t_n$ (sec) |
| Output rotational speed | $n_1$ to $n_n$ (r/min) |

**<Normal operation pattern>**

| | |
|---|---|
| Starting time | $T_1$, $t_1$, $n_1$ |
| Steady operation time | $T_2$, $t_2$, $n_2$ |
| Stopping (slowing) time | $T_3$, $t_3$, $n_3$ |
| Break time | $T_4$, $t_4$, $n_4$ |

**<Maximum rotational speed>**

| | |
|---|---|
| Max. output rotational speed | $n_{o\,max} \geqq n_1$ to $n_n$ |
| Max. input rotational speed | $n_{i\,max} \geqq n_1 \times R$ to $n_n \times R$ |
| (Restricted by motors) | R: Reduction ratio |

**<Impact torque>**

| | |
|---|---|
| When impact torque is applied | $T_s$ |

**<Required life>**

$L_{10}$ = L (hours)

## ■Flowchart of model number selection

Select a model number according to the following flowchart.
If you find a value exceeding that from the ratings, you should review it with the upper-level model number or consider reduction of conditions including the load torque.

Calculate the average load torque applied on the output side from the load torque pattern: *Tav* (N·m).

$$Tav = \sqrt[10/3]{\frac{|n_1|\cdot t_1\cdot|T_1|^{10/3}+|n_2|\cdot t_2\cdot|T_2|^{10/3}+\cdots+|n_n|\cdot t_n\cdot|T_n|^{10/3}}{|n_1|\cdot t_1+|n_2|\cdot t_2+\cdots+|n_n|\cdot t_n}}$$

Calculate the average output rotational speed based on the load torque pattern: no av (r/min)

$$n_o\,av = \frac{|n_1|\cdot t_1+|n_2|\cdot t_2+\cdots+|n_n|\cdot t_n}{t_1+t_2+\cdots+t_n}$$

▼

Select a model number temporarily with the following condition: *Tav* ≦ Average load torque (See the rating table on page 088) — NG

OK

Determine the reduction ratio (R) based on the maximum output rotational speed (no *max*) and maximum input rotational speed (ni *max*).

$$\frac{n_i\,max}{n_o\,max} \geqq R$$

(A limit is placed on ni *max* by motors.)
Calculate the maximum input rotational speed (ni *max*) from the maximum output rotational speed (no *max*) and the reduction ratio (R).

$$n_i\,max = n_o\,max \cdot R$$

▼

Calculate the average input rotational speed (ni *av*) from the average output rotational speed (no *av*) and the reduction ratio (R): ni *av* = no *av*·R ≦ Permissible average input rotational speed (nr). — NG

OK

Check whether the maximum input rotational speed is equal to or less than the values in the rating table. ni *max* ≦ maximum input rotational speed (r/min) — NG

OK

Check whether $T_1$ and $T_3$ are equal to or less than the permissible peak torque (N·m) value at start and stop from the ratings. — NG

OK

Check whether $T_s$ is equal to or less than the permissible maximum momentary torque (N·m) value from the ratings. — NG

OK

Calculate the lifetime and check whether it meets the specification requirement.
Tr: Output torque
$n_r$: Permissible average input rotational speed

$$L_{10} = 20{,}000 \cdot \left(\frac{T_r}{Tav}\right)^{10/3} \cdot \left(\frac{n_r}{n_i\,av}\right) \text{(Hour)}$$

— NG

OK

**The model number is determined.**

Check the description in Caution below.

Review of the operation conditions, model No and reduction ratio.

**Caution**

Check impacts by speed reducer temperature rise, vibration during acceleration and deceleration and other factors if the operating conditions are as specified below. Study to "increase the speed reducer size", "review the operating conditions" and other means if it becomes necessary to study safety. Exercise reasonable caution especially when operating conditions are close to continuous operation.
Average load torque (*Tav*) > Permissible maximum value of average load torque (see page 088)
Calculate average input rotational speed (ni *av*) > Permissible average input rotational speed (nr)

## ■Example of Model Number Selection

### Value of each load torque pattern.

| | |
|---|---|
| Load torque | $T_n$ (N·m) |
| Time | $t_n$ (sec) |
| Output rotational speed | $n_n$ (r/min) |

<Normal operation pattern>

| | | | |
|---|---|---|---|
| Starting time | $T_1$ = 70 N·m, | $t_1$ = 0.3 sec, | $n_1$ = 60 r/min |
| Steady operation time | $T_2$ = 18 N·m, | $t_2$ = 3 sec, | $n_2$ = 120 r/min |
| Stopping (slowing) time | $T_3$ = 35 N·m, | $t_3$ = 0.4 sec, | $n_3$ = 60 r/min |
| Break time | $T_4$ = 0 N·m, | $t_4$ = 5 sec, | $n_4$ = 0 r/min |

<Maximum rotational speed>

| | |
|---|---|
| Max. output rotational speed | no *max* = 120 r/min |
| Max. input rotational speed | ni *max* = 5,000 r/min |
| | (Restricted by motors) |

<Impact torque>

When impact torque is applied $T_s$ = 180 N·m

<Required lifespan>

$L_{10}$ = 30,000 (hours)

Calculate the average load torque applied on the output side based on the load torque pattern: T*av* (N·m).

$$T_{av}=\sqrt[10/3]{\frac{|60r/min|\cdot 0.3sec\cdot|70N\cdot m|^{10/3}+|120r/min|\cdot 3sec\cdot|18N\cdot m|^{10/3}+|60r/min|\cdot 0.4sec\cdot|35N\cdot m|^{10/3}}{|60r/min|\cdot 0.3sec+|120r/min|\cdot 3sec+|60r/min|\cdot 0.4sec}}$$

Calculate the average output rotational speed based on the load torque pattern: no *av* (r/min)

$$no\ av=\frac{|60r/min|\cdot 0.3sec+|120r/min|\cdot 3sec+|60r/min|\cdot 0.4sec+|0r/min|\cdot 5sec}{0.3sec+3sec+0.4sec+5sec}$$

Select a model number temporarily with the following conditions. T*av* = 30.2N·m ≦ 60N·m. (**HPG-20A-33** is tentatively selected based on the average load torque (see the rating table on page 088) of model No. 20 and reduction ratio of 33.)

NG / OK

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

$$\frac{5{,}000\ r/min}{120\ r/min}=41.7\geqq 33$$

Calculate the maximum input rotational speed (ni *max*) from the maximum output rotational speed (no *max*) and reduction ratio (R): ni *max* = 120 r/min・33 = 3,960 r/min

Calculate the average input rotational speed (ni *av*) from the average output rotational speed (no *av*) and reduction ratio (R):
ni *av* = 46.2 r/min·33= 1,525 r/min ≦ Permissible average input rotational speed of model No. 20 3,000 (r/min)

NG / OK

Check whether the maximum input rotational speed is equal to or less than the values specified in the rating table.
ni *max* = 3,960 r/min ≦ 6,000 r/min (maximum input rotational speed of model No. 20)

NG / OK

Check whether $T_1$ and $T_3$ are equal to or less than the peak torques (N·m) on start and stop in the rating table.
$T_1$ = 70 N·m ≦ 100 N·m (Peak torques on start and stop of model No. 20)
$T_3$ = 35 N·m ≦ 100 N·m (Peak torques on start and stop of model No. 20)

NG / OK

Check whether Ts is equal to or less than the values of the momentary max. torque (N·m) in the rating table.
$T_s$ = 180 N·m ≦ 217 N·m (momentary max. torque of model No. 20)

NG / OK

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

$$L_{10}=20{,}000\cdot\left(\frac{29\ N\cdot m}{30.2\ N\cdot m}\right)^{10/3}\cdot\left(\frac{3{,}000\ r/min}{1{,}525\ r/min}\right)=34{,}543\ (hours)\geqq 30{,}000\ (hours)$$

NG / OK

**As a result of the preceding steps, HPG-20A-33 is determined.**

Check the description in Caution at the bottom of page 086

Review of the operation conditions, model No and reduction ratio.

# Rating Table

HPG series input shaft unit type has an extensive variety of 6 model numbers. For selecting the model number, refer to the rating table.

Table 088-1

| Model | Reduction ratio | Rated output torque *1 | | Permissible max. value of ave. load torque *2 | | Permissible peak torque at start/stop *3 | | Permissible max. momentary torque *4 | | Permissible ave. input rotational speed *5 | Permissible max. input rotational speed *6 | Inertia moment | | Mass | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Shaft output | Flange output | Shaft output | Flange output |
| | | N·m | kgf·m | N·m | kgf·m | N·m | kgf·m | N·m | kgf·m | r/min | r/min | $\times10^{-4}$kg·m² | $\times10^{-4}$kg·m² | kg | kg |
| 11 | 5 | 2.5 | 0.26 | 5.0 | 0.51 | 7.8 | 0.80 | 20 | 2.0 | 3000 | 10000 | 0.0087 | 0.0072 | 0.24 | 0.20 |
| | 9 | 2.5 | 0.26 | 3.9 | 0.40 | 3.9 | 0.40 | | | | | 0.0063 | 0.0058 | | |
| | 21 | 3.4 | 0.35 | 6.0 | 0.61 | 9.8 | 1.0 | | | | | 0.0064 | 0.0063 | 0.30 | 0.26 |
| | 37 | 3.4 | 0.35 | | | | | | | | | 0.0052 | 0.0052 | | |
| | 45 | 3.4 | 0.35 | | | | | | | | | 0.0050 | 0.0050 | | |
| 14 | 3 | 2.9 | 0.30 | 6.4 | 0.65 | 15 | 1.5 | 37 | 3.8 | 3000 | 5000 | 0.12 | 0.11 | 0.80 | 0.70 |
| | 5 | 5.9 | 0.60 | 13 | 1.3 | 23 | 2.3 | 56 | 5.7 | | 6000 | 0.073 | 0.067 | | |
| | 11 | 7.8 | 0.80 | 15 | 1.5 | | | | | | | 0.059 | 0.058 | 0.90 | 0.80 |
| | 15 | 9.0 | 0.90 | | | | | | | | | 0.057 | 0.056 | | |
| | 21 | 8.8 | 0.90 | | | | | | | | | 0.049 | 0.049 | | |
| | 33 | 10 | 1.0 | | | | | | | | | 0.043 | 0.043 | | |
| | 45 | 10 | 1.0 | | | | | | | | | | | | |
| 20 | 3 | 8.8 | 0.90 | 19 | 2.0 | 64 | 6.5 | 124 | 13 | 3000 | 4000 | 0.80 | 0.69 | 2.4 | 2.0 |
| | 5 | 16 | 1.6 | 35 | 3.6 | 100 | 10 | 217 | 22 | | 6000 | 0.44 | 0.40 | | |
| | 11 | 20 | 2.0 | 45 | 4.6 | | | | | | | 0.32 | 0.31 | 2.7 | 2.1 |
| | 15 | 24 | 2.4 | 53 | 5.4 | | | | | | | 0.30 | 0.30 | | |
| | 21 | 25 | 2.5 | 55 | 5.6 | | | | | | | 0.23 | 0.23 | | |
| | 33 | 29 | 3.0 | 60 | 6.1 | | | | | | | 0.19 | 0.19 | | |
| | 45 | 29 | 3.0 | | | | | | | | | 0.18 | 0.18 | | |
| 32 | 3 | 31 | 3.2 | 71 | 7.2 | 225 | 23 | 507 | 52 | 3000 | 3600 | 4.2 | 3.4 | 6.3 | 4.9 |
| | 5 | 66 | 6.7 | 150 | 15 | 300 | 31 | 650 | 66 | | 6000 | 2.4 | 2.2 | | |
| | 11 | 88 | 9.0 | 170 | 17 | | | | | | | 2.0 | 1.9 | 6.9 | 5.3 |
| | 15 | 92 | 9.4 | | | | | | | | | 1.8 | 1.8 | | |
| | 21 | 98 | 10 | | | | | | | | | 1.5 | 1.5 | | |
| | 33 | 108 | 11 | 200 | 20 | | | | | | | 1.3 | 1.3 | | |
| | 45 | 108 | 11 | | | | | | | | | | | | |
| 50 | 3 | 97 | 9.9 | 195 | 20 | 657 | 67 | 1200 | 122 | 2000 | 3000 | 21 | 18 | 17 | 14 |
| | 5 | 170 | 17 | 340 | 35 | 850 | 87 | 1850 | 189 | | 4500 | 11 | 9.2 | | |
| | 11 | 200 | 20 | 400 | 41 | | | | | | | 7.4 | 7.1 | 19 | 16 |
| | 15 | 230 | 24 | 450 | 46 | | | | | | | 6.8 | 6.7 | | |
| | 21 | 260 | 27 | 500 | 51 | | | | | | | 5.5 | 5.4 | | |
| | 33 | 270 | 28 | | | | | | | | | 4.4 | 4.3 | | |
| | 45 | 270 | 28 | | | | | | | | | 4.3 | 4.3 | | |
| 65*7 | 4 | 500 | 51 | 900 | 92 | 2200 | 225 | 4500 | 460 | 2000 | 2500 | 58 | 44 | 43 | 33 |
| | 5 | 530 | 54 | 1000 | 102 | | | | | | 3000 | 43 | 34 | | |
| | 12 | 600 | 61 | 1100 | 112 | | | | | | | 33 | 32 | 58 | 48 |
| | 15 | 730 | 75 | 1300 | 133 | | | | | | | 32 | 31 | | |
| | 20 | 800 | 81 | 1500 | 153 | | | | | | | 22 | 21 | | |
| | 25 | 850 | 87 | | | | | | | | | 21 | 21 | | |
| | 40 | 640 | 66 | 1300 | 133 | 1900 | 194 | | | | | 16 | 16 | | |
| | 50 | 750 | 77 | 1500 | 153 | 2200 | 225 | | | | | 16 | 16 | | |

(Note) 1. Output torque set based on the life of $L_{10}$ = 20000 hours when input rotational speed is 3000 r/min, which is the rated rotational speed of ordinary servo motors. Models 50 and 65 are set at 2000 r/min as the rated rotational speed and at $L_{10}$ = 20000 hours as the life for the servo motor to be combined.
2. Permissible maximum value of average load torque calculated based on a load torque pattern (page 086). A life of 2000 hours or more is a criterion when operated at an input speed of 2000 r/min.
3. Permissible maximum value of torque applied on start and stop in operation cycles.
4. Permissible maximum value for impact torque in an emergency stop and for external impact torque.Operation exceeding these ranges may cause damages to reducers.
5. Permissible maximum value of average input rotational speed during operations. Make it a point to operate below this value especially when the operation mode is near continuous operation.
6. Permissible maximum input rotational speed in operation modes other than continuous operation.
7. Model 65 of Input Shaft Type is build-to-order.

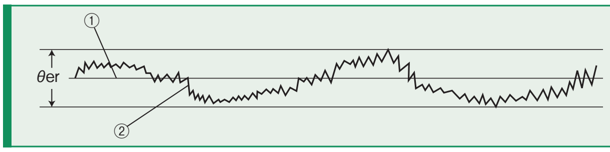
# Performance Table

Table 089-1

| Model | Reduction ratio | Angle transmission precision [*1] | | Repeatability [*2] | Starting torque [*3] | | Overdrive starting torque [*4] | | No-load running torque [*5] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | arc-min | $\times10^{-4}$rad | arc-sec | cN·m | kgf·cm | N·m | kgf·m | cN·m | kgf·cm |
| 11 | 5 | 5 | 14.5 | ±30 | 7.9 | 0.81 | 0.40 | 0.040 | 8.9 | 0.91 |
| | 9 | | | | 7.6 | 0.77 | 0.68 | 0.069 | 6.3 | 0.65 |
| | 21 | | | | 6.8 | 0.69 | 1.4 | 0.14 | 5.2 | 0.53 |
| | 37 | | | | 5.5 | 0.57 | 2.0 | 0.21 | 4.8 | 0.49 |
| | 45 | | | | 5.3 | 0.55 | 2.4 | 0.25 | 4.7 | 0.48 |
| 14 | 3 | 4 | 11.6 | ±20 | 22 | 2.2 | 0.66 | 0.067 | 26 | 2.7 |
| | 5 | | | | 17 | 1.7 | 0.83 | 0.085 | 15 | 1.5 |
| | 11 | | | | 16 | 1.6 | 1.8 | 0.18 | 10 | 1.0 |
| | 15 | | | | 15 | | 2.3 | 0.23 | 8.2 | 0.84 |
| | 21 | | | | 13 | 1.4 | 2.9 | 0.30 | | |
| | 33 | | | | 11 | 1.2 | 3.8 | 0.39 | 7.3 | 0.74 |
| | 45 | | | | | 1.1 | 4.8 | 0.49 | | |
| 20 | 3 | 4 | 11.6 | ±15 | 46 | 4.7 | 1.4 | 0.14 | 61 | 6.2 |
| | 5 | | | | 34 | 3.4 | 1.7 | 0.17 | 39 | 4.0 |
| | 11 | | | | 30 | 3.1 | 3.3 | 0.34 | 26 | 2.6 |
| | 15 | | | | 27 | 2.8 | 4.0 | 0.41 | 22 | 2.2 |
| | 21 | | | | 24 | 2.5 | 5.1 | 0.52 | 20 | 2.0 |
| | 33 | | | | 21 | 2.2 | 7.1 | 0.72 | 17 | 1.7 |
| | 45 | | | | 20 | 2.0 | 8.9 | 0.91 | 16 | 1.6 |
| 32 | 3 | 4 | 11.6 | ±15 | 92 | 9.4 | 2.8 | 0.28 | 146 | 15 |
| | 5 | | | | 69 | 7.1 | 3.5 | 0.35 | 100 | 10 |
| | 11 | | | | 63 | 6.4 | 6.9 | 0.70 | 66 | 6.8 |
| | 15 | | | | 61 | 6.2 | 9.1 | 0.93 | 57 | 5.9 |
| | 21 | | | | 58 | 6.0 | 12 | 1.3 | 52 | 5.3 |
| | 33 | | | | 52 | 5.3 | 17 | 1.7 | 42 | 4.3 |
| | 45 | | | | 46 | 4.8 | 21 | 2.1 | 41 | 4.2 |
| 50 | 3 | 3 | 8.7 | ±15 | 197 | 20 | 5.9 | 0.60 | 300 | 31 |
| | 5 | | | | 140 | 14 | 7.0 | 0.71 | 180 | 18 |
| | 11 | | | | 110 | 11 | 12 | 1.2 | 110 | 11 |
| | 15 | | | | 100 | 10 | 15 | 1.5 | 97 | 9.9 |
| | 21 | | | | 98 | | 21 | 2.1 | 90 | 9.2 |
| | 33 | | | | 88 | 8.9 | 29 | 3.0 | 74 | 7.6 |
| | 45 | | | | 83 | 8.4 | 37 | 3.8 | 70 | 7.1 |
| 65 | 4 | 3 | 8.7 | ±15 | 406 | 41 | 16 | 1.7 | 576 | 59 |
| | 5 | | | | 358 | 36 | 18 | 1.8 | 517 | 53 |
| | 12 | | | | 243 | 25 | 29 | 3.0 | 341 | 35 |
| | 15 | | | | 228 | 23 | 34 | 3.5 | 311 | 32 |
| | 20 | | | | 213 | 22 | 43 | 4.3 | 282 | 29 |
| | 25 | | | | 202 | 21 | 51 | 5.2 | 262 | 27 |
| | 40 | | | | 193 | 20 | 77 | 7.9 | 230 | 24 |
| | 50 | | | | 188 | 19 | 94 | 9.6 | 219 | 22 |

(Note) 1. Angle transmission precision indicates the difference between (1) logical rotating angle and (2) actual rotating angle of output when any rotating angle is given as an input. The values in the table are maximum values.

Fig. 089-1

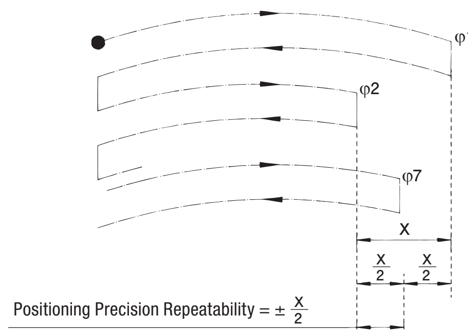



$\theta er$ : Angle transmission precision
$\theta_1$ : Input rotating angle
$\theta_2$ : Actual output rotating angle
R : Reduction ratio of HPG series

$$\theta er = \theta_2 - \frac{\theta_1}{R}$$

2. The repeatability is determined by repeating positioning in a given position from the same direction seven times, by measuring stop positions of the output shaft and by calculating the maximum difference. Measured values are indicated in angles (degrees) and are prefixed with “±” to 1/2 of the maximum differences. The values in the table are maximum values.

Fig. 089-2




Positioning Precision Repeatability = $\pm\frac{X}{2}$

3. Starting torque means the momentary “starting torque” with which the output side starts rotation when a torque is applied on the input side. The values in the table are maximum values.

Table 089-2

| Load | No load |
|---|---|
| HPG speed reducer surface temperature | 25°C |

4. Overdrive starting torque means the momentary “starting torque” with which the input side starts rotation when a torque is applied on the output side. The values in the table are maximum values.

Table 089-3

| Load | No load |
|---|---|
| HPG speed reducer surface temperature | 25°C |

5. No-load running torque means the torque on the input side required to put the speed reducer under a no-load condition. The values in the table are average values.

Table 089-4

| Input speed | 3000 r/min |
|---|---|
| Load | No load |
| HPG speed reducer surface temperature | 25°C |

# Torque – Torsion Characteristic

## ■Input Shaft Unit Type Standard Item

Table 090-1

| Model | Reduction ratio | Backlash arc-min | Backlash $\times10^{-4}$rad | Torsional quantity on one side at $T_R$ X 0.15 D arc-min | D $\times10^{-4}$rad | Torsional rigidity A/B kgf·m/arc-min | A/B $\times$100N·m/rad |
|---|---|---|---|---|---|---|---|
| 11 | 5, 9 | 3.0 | 8.7 | 2.5 | 7.3 | 0.060 | 20 |
| 11 | 21, 37, 45 | 3.0 | 8.7 | 3.0 | 8.7 | 0.065 | 22 |
| 14 | 3, 5 | 3.0 | 8.7 | 2.2 | 6.4 | 0.13 | 44 |
| 14 | 11, 15, 21, 33, 45 | 3.0 | 8.7 | 2.7 | 7.9 | 0.14 | 47 |
| 20 | 3, 5 | 3.0 | 8.7 | 1.5 | 4.4 | 0.50 | 170 |
| 20 | 11, 15, 21, 33, 45 | 3.0 | 8.7 | 2.0 | 5.8 | 0.55 | 180 |
| 32 | 3 | 3.0 | 8.7 | 1.3 | 3.8 | 1.7 | 570 |
| 32 | 5 | 3.0 | 8.7 | 1.3 | 3.8 | 2.0 | 670 |
| 32 | 11, 15, 21, 33, 45 | 3.0 | 8.7 | 1.7 | 4.9 | 2.2 | 740 |
| 50 | 3 | 3.0 | 8.7 | 1.3 | 3.8 | 8.4 | 2800 |
| 50 | 5 | 3.0 | 8.7 | 1.3 | 3.8 | 11 | 3700 |
| 50 | 11, 15, 21, 33, 45 | 3.0 | 8.7 | 1.7 | 4.9 | 14 | 4700 |
| 65 | 4, 5 | 3.0 | 8.7 | 1.3 | 3.8 | 30 | 10000 |
| 65 | 12, 15, 20, 25, 40, 50 | 3.0 | 8.7 | 1.7 | 4.9 | 37 | 12500 |

## ■Input Shaft Unit Type BL1 Specification (backlash of 1 min. or less)

Table 090-2

| Model | Reduction ratio | Backlash arc-min | Backlash $\times10^{-4}$rad | Torsional quantity on one side at $T_R$ X 0.15 D arc-min | D $\times10^{-4}$rad | Torsional rigidity A/B kgf·m/arc-min | A/B $\times$100N·m/rad |
|---|---|---|---|---|---|---|---|
| 14 | 3, 5 | 1.0 | 2.9 | 1.1 | 3.2 | 0.13 | 44 |
| 14 | 9, 21, 33, 45 | 1.0 | 2.9 | 1.7 | 4.9 | 0.14 | 47 |
| 20 | 3, 5 | 1.0 | 2.9 | 0.6 | 1.7 | 0.50 | 170 |
| 20 | 11, 15, 21, 33, 45 | 1.0 | 2.9 | 1.1 | 3.2 | 0.55 | 180 |
| 32 | 3 | 1.0 | 2.9 | 0.5 | 1.5 | 1.7 | 570 |
| 32 | 5 | 1.0 | 2.9 | 0.5 | 1.5 | 2.0 | 670 |
| 32 | 11, 15, 21, 33, 45 | 1.0 | 2.9 | 1.0 | 2.9 | 2.2 | 740 |
| 50 | 3 | 1.0 | 2.9 | 0.5 | 1.5 | 8.4 | 2800 |
| 50 | 5 | 1.0 | 2.9 | 0.5 | 1.5 | 11 | 3700 |
| 50 | 11, 15, 21, 33, 45 | 1.0 | 2.9 | 1.0 | 2.9 | 14 | 4700 |
| 65 | 4, 5 | 1.0 | 2.9 | 0.5 | 1.5 | 30 | 10000 |
| 65 | 12, 15, 20, 25, 40, 50 | 1.0 | 2.9 | 1.0 | 2.9 | 37 | 12500 |

## ■Torsional rigidity (Windup curve)

Anchoring the speed reducer input and casing and applying a torque to the output part will generate torsion in the output part in accordance with the applied torque. Change the torque slowly in the order of: (1) Forward output torque, (2) Zero, (3) Reverse output torque, (4) Zero and (5) Forward output torque. A loop of (1) → (2) → (3) → (4) → (5) (return to (1)) will be drawn in Fig. 090-1. The inclination in the region from "0.15 x output torque" to "Output torque" is small. The torsional rigidity of the HPG series is an average value of this inclination. The inclination in the region from "zero torque" to "0.15 x output torque" is large. This is caused by uneven distribution such as fine uneven contact of the engaging parts and load of the planet gears under a light load.

## ■Calculation of total torsional quantity (Windup)

The method to calculate the total torsional quantity (average value) on one side when the speed reducer applies a load in a no-load state.

Formula 090-1

● Calculation formula

$$\theta = D + \frac{T - T_L}{\frac{A}{B}}$$

Symbols in calculation formula

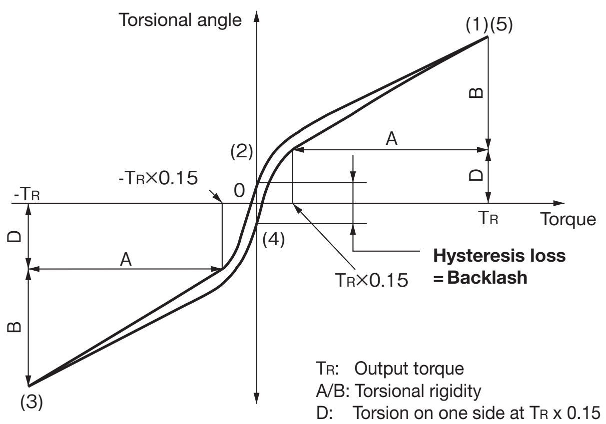
| | | |
|---|---|---|
| $\theta$ | Total torsional quantity | —— |
| D | Torsional quantity on one side at output torque x 0.15 torque | See Fig. 090-1, Table 090-1 to 2 |
| T | Load torque | —— |
| $T_L$ | Output torque x 0.15 torque (=TR x 0.15) | See Fig. 090-1 |
| A/B | Torsional rigidity | See Fig. 090-1, Table 090-1 to 2 |

## ■Backlash (Hysteresis loss)

The zero-torque width (2) - (4) in Fig. 090-1 "Torque-torsional angle diagram" is called a hysteresis loss. The hysteresis loss between "Forward output torque" and "Reverse output torque" is defined as backlash of the HPG series. At the time of pre-shipment factory inspection, the backlash of the HPG series is less than 3 minutes (1 minute or less for customized products).

Fig. 090-1

**Torque-torsional angle diagram**




$T_R$: Output torque
A/B: Torsional rigidity
D: Torsion on one side at $T_R$ x 0.15

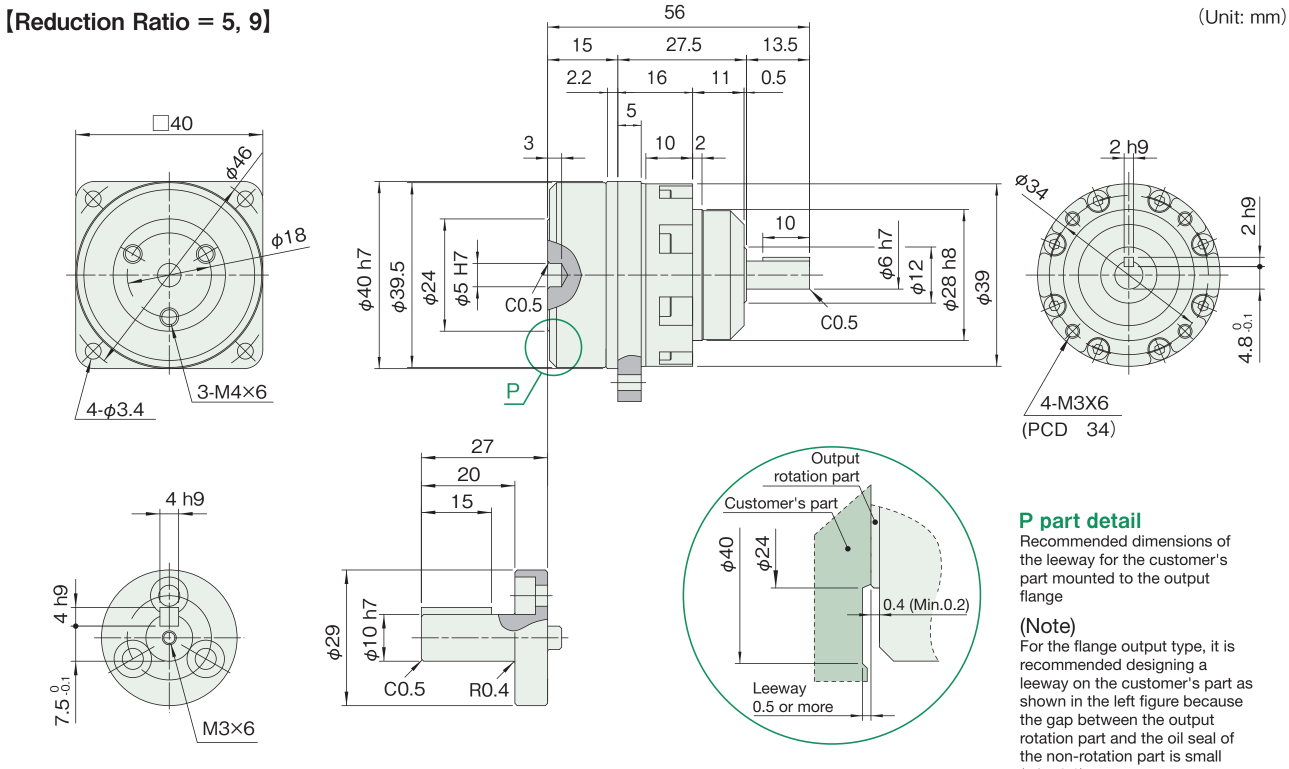
# Dimensional Outline Drawing

Only principal dimensions are shown in the dimension diagrams. For detailed dimensions and shapes, refer to the delivery specification drawings we provide.
For the specifications of the input side bearing of the input shaft unit type, refer to page 118.
You can download the CAD data of this product from the following homepage. URL: https://www.hds.co.jp/

## ■Dimensional outline drawing – Model No. 11

Fig. 091-1

【Reduction Ratio = 5, 9】 (Unit: mm)



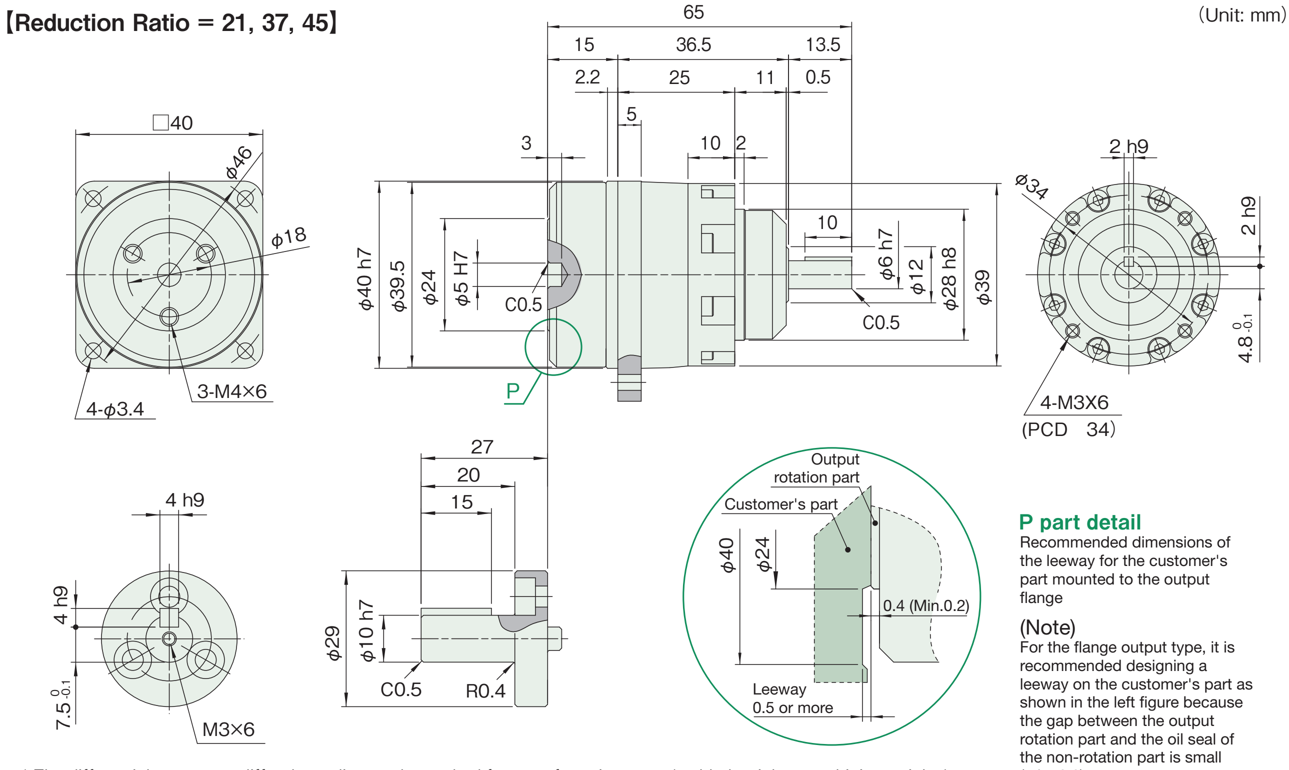

**P part detail**
Recommended dimensions of the leeway for the customer's part mounted to the output flange

(Note)
For the flange output type, it is recommended designing a leeway on the customer's part as shown in the left figure because the gap between the output rotation part and the oil seal of the non-rotation part is small (min. 0.2).

* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles). Contact us for the differential range of the size that is not described.

Fig. 091-2

【Reduction Ratio = 21, 37, 45】 (Unit: mm)




**P part detail**
Recommended dimensions of the leeway for the customer's part mounted to the output flange

(Note)
For the flange output type, it is recommended designing a leeway on the customer's part as shown in the left figure because the gap between the output rotation part and the oil seal of the non-rotation part is small (min. 0.2).

* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles). Contact us for the differential range of the size that is not described.

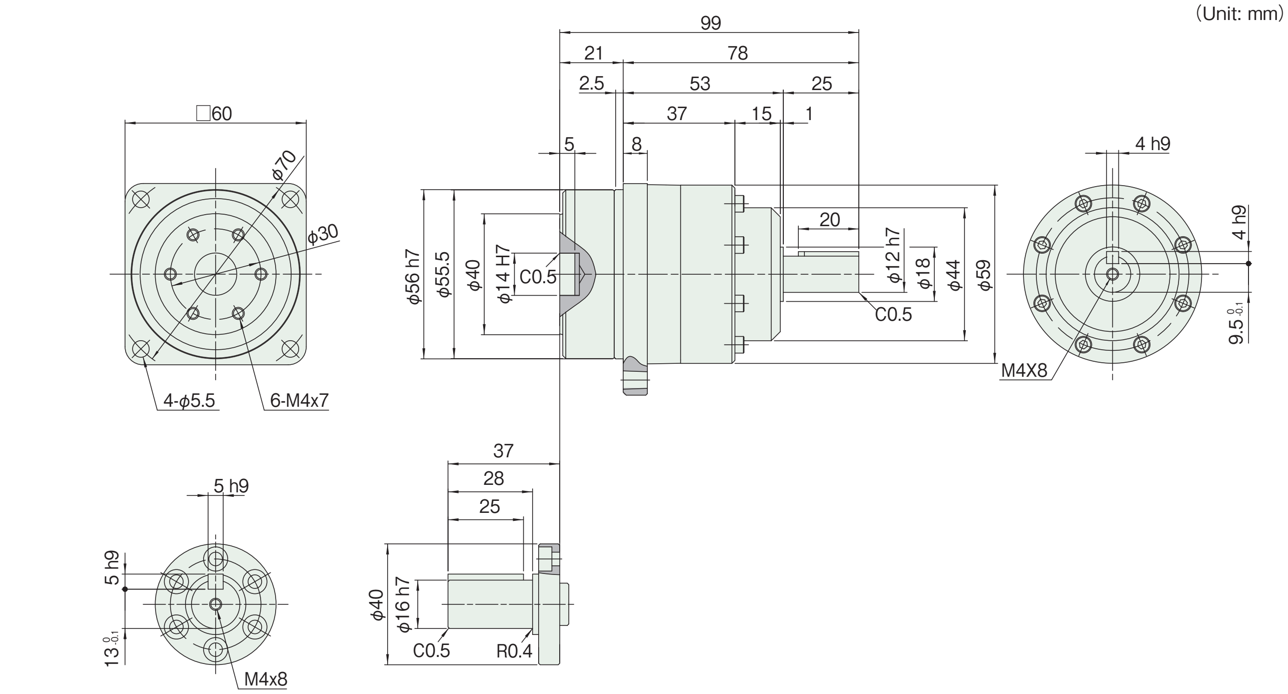
# Dimensional Outline Drawing

Only principal dimensions are shown in the dimension diagrams. For detailed dimensions and shapes, refer to the delivery specification drawings we provide.
For the specifications of the input side bearing of the input shaft unit type, refer to page 118.
You can download the CAD data of this product from the following homepage.  URL: https://www.hds.co.jp/

## ■Dimensional outline drawing – Model No. 14

Fig. 092-1

(Unit: mm)

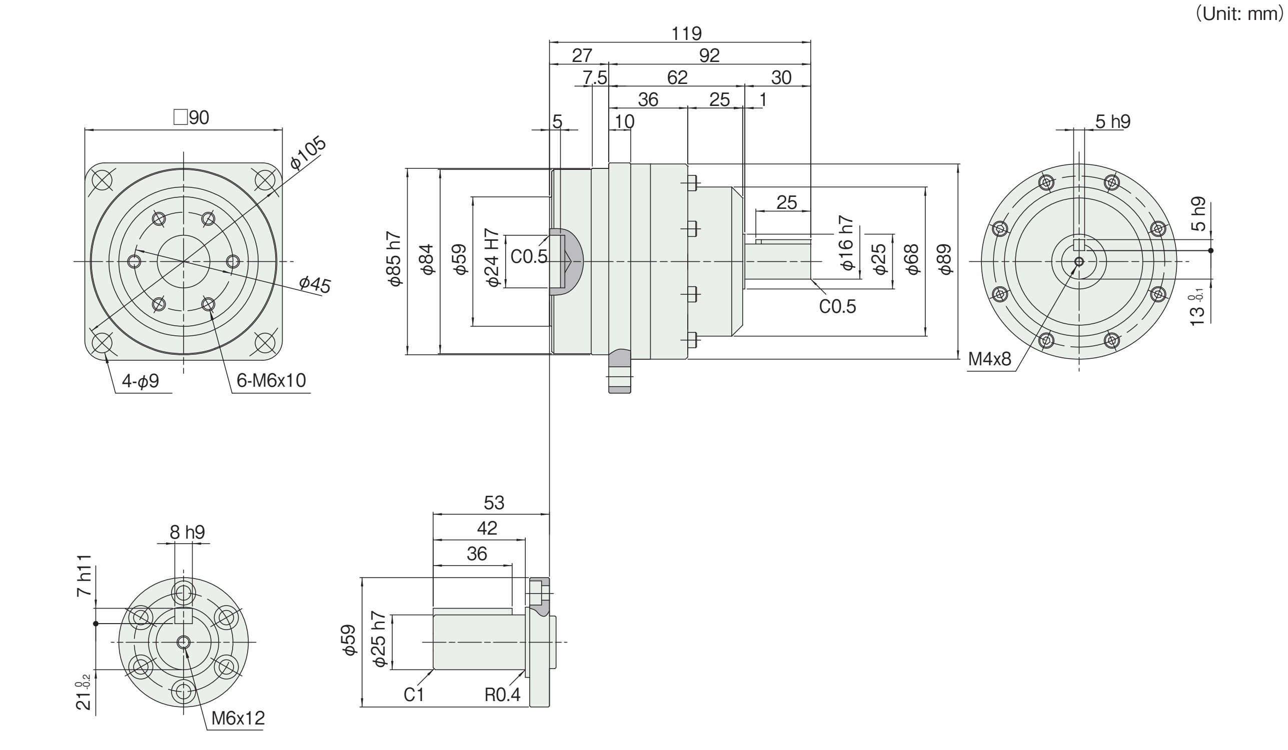



* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
  Contact us for the differential range of the size that is not described.

## ■Dimensional outline drawing – Model No. 20

Fig. 092-2

(Unit: mm)




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
  Contact us for the differential range of the size that is not described.

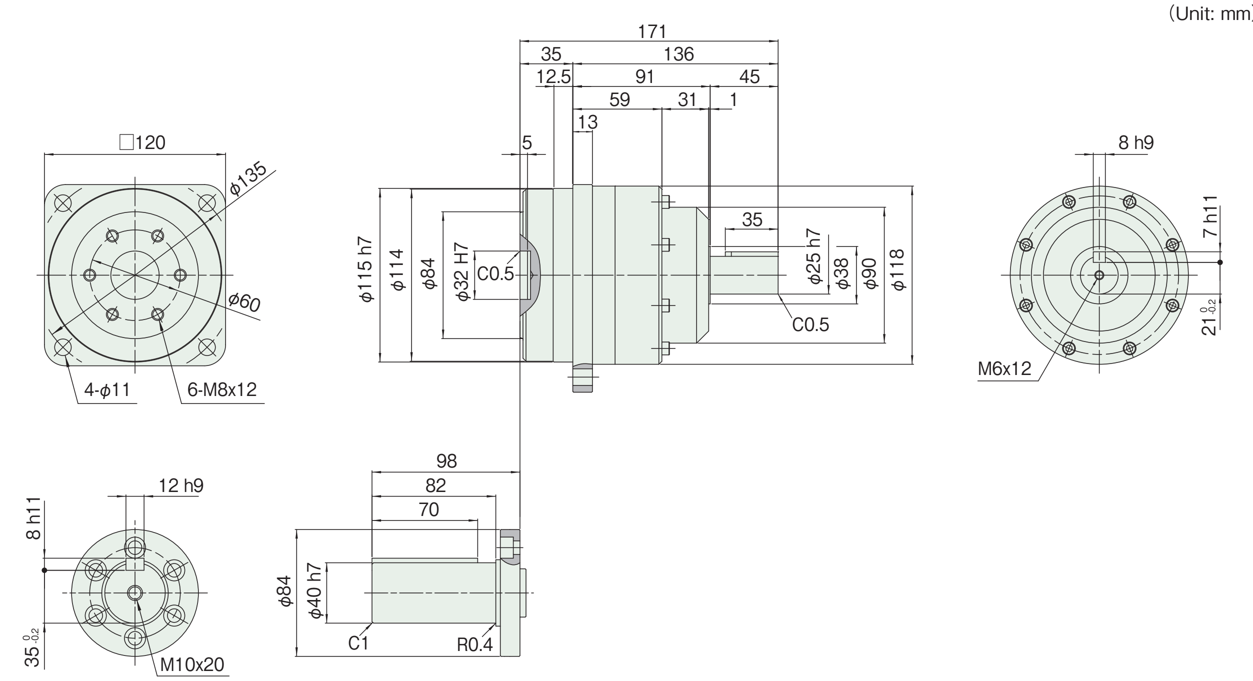
# Dimensional Outline Drawing

Only principal dimensions are shown in the dimension diagrams. For detailed dimensions and shapes, refer to the delivery specification drawings we provide.
For the specifications of the input side bearing of the input shaft unit type, refer to page 118.
You can download the CAD data of this product from the following homepage. URL: https://www.hds.co.jp/

## ■Dimensional outline drawing – Model No. 32

Fig. 093-1

(Unit: mm)

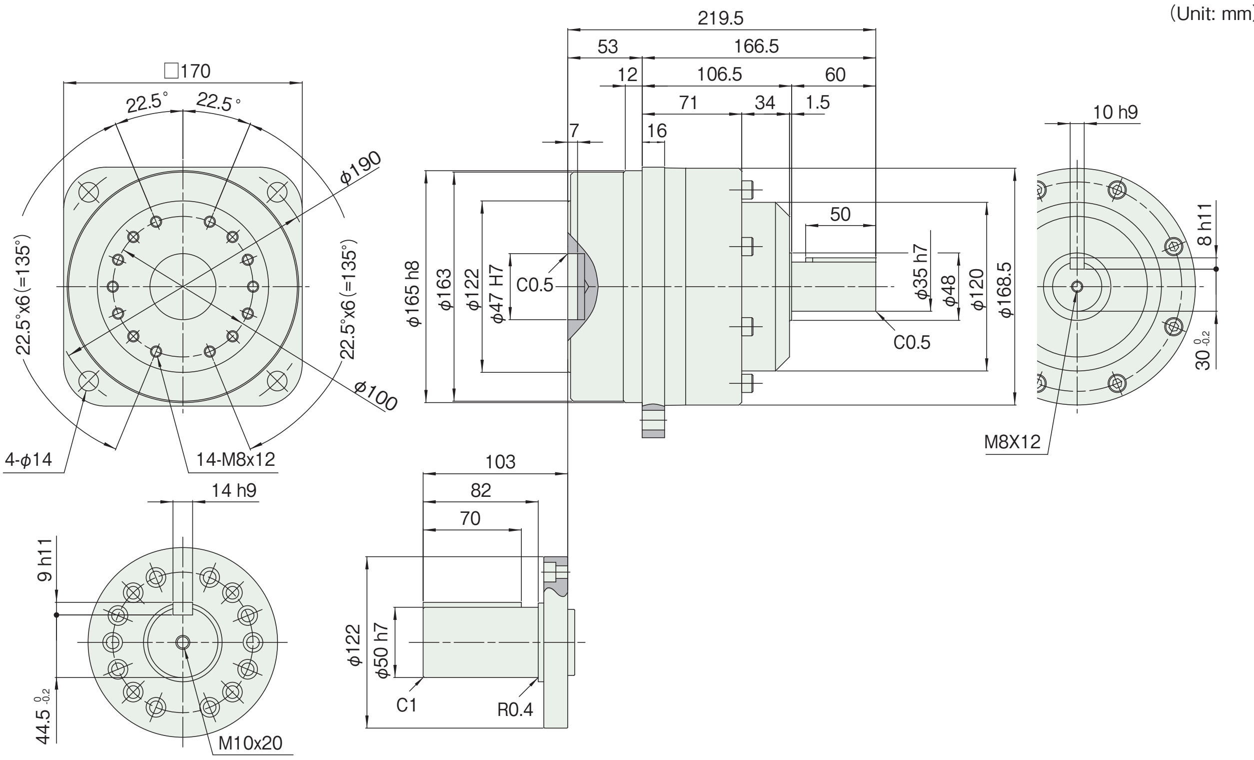



* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

## ■Dimensional outline drawing – Model No. 50

Fig. 093-2

(Unit: mm)




* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

# Dimensional Outline Drawing

Only principal dimensions are shown in the dimension diagrams. For detailed dimensions and shapes, refer to the delivery specification drawings we provide.

For the specifications of the input side bearing of the input shaft unit type, refer to page 118.

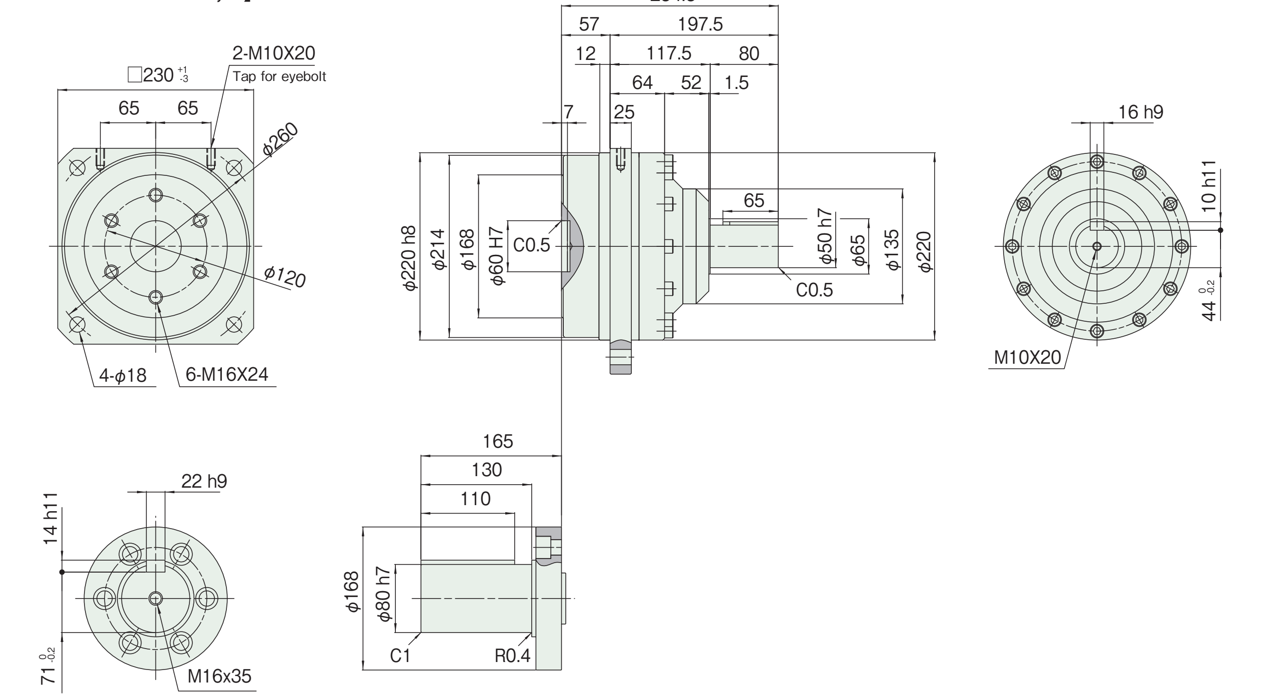
You can download the CAD data of this product from the following homepage. URL: https://www.hds.co.jp/

## ■Dimensional outline drawing – Model No. 65

Fig. 094-1

【Reduction Ratio = 4, 5】

(Unit: mm)

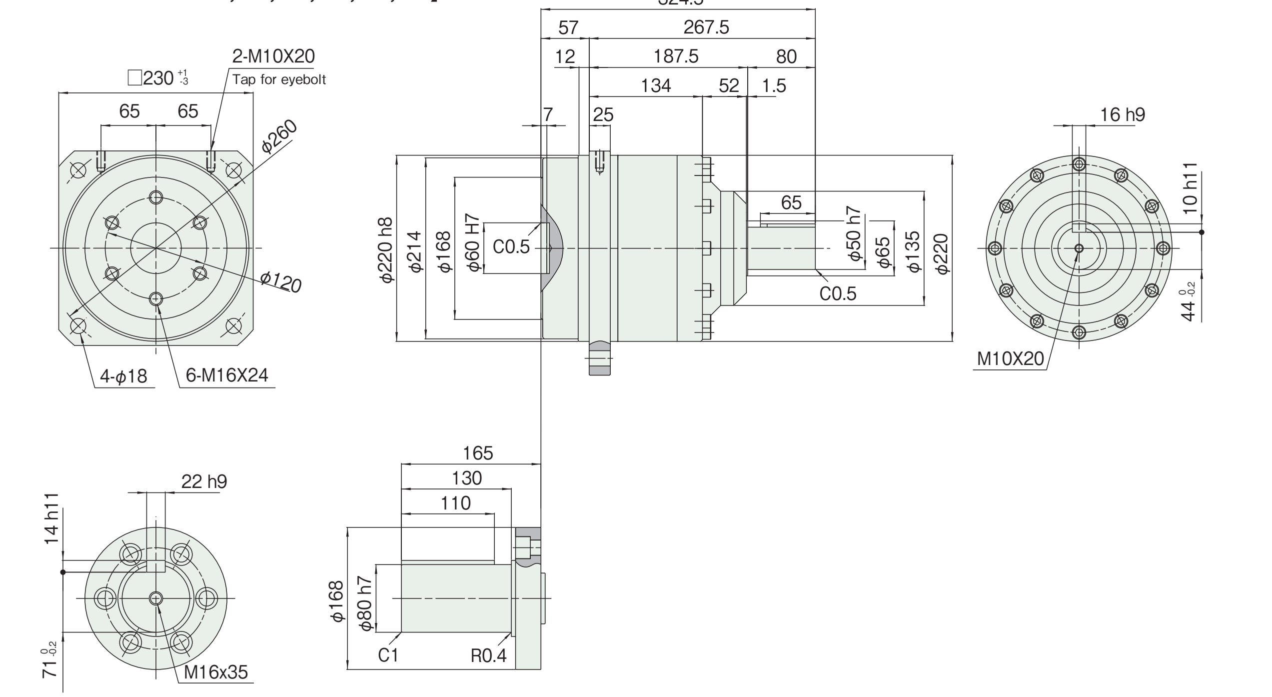



* While the flange output is for standard, the shaft output is for special specification.
* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

Fig. 094-2

【Reduction Ratio = 12, 15, 20, 25, 40, 50】

(Unit: mm)




* While the flange output is for standard, the shaft output is for special specification.
* The differential range may differ depending on the method for manufacturing parts (molded articles, machining articles).
Contact us for the differential range of the size that is not described.

## ■MEMO

MEMO

HarmonicPlanetary®
HarmonicDrive®

# Technical Information



# Handling Explanation



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 Characteristics

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 098-1

| | |
|---|---|
| Input rotational speed | HPGP / HPG / HPF: 3000r/min<br>CSG-GH / CSF-GH: Indicated on each efficiency graph. |
| Ambient temperature | 25°C |
| Lubricant | Use standard lubricant for each model. (See pages 124 and 125 for details.) |

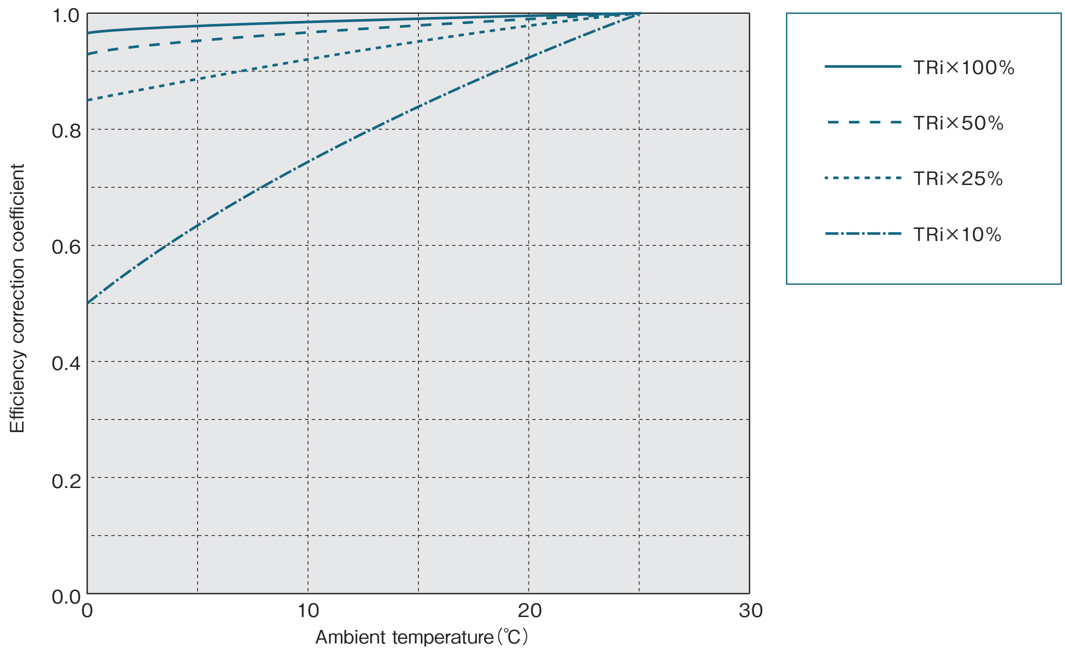
## ■Efficiency compensated for low temperature

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.

**HPGP** **HPG** **HPF**

* TRi is an input torque (see pages 016, 034, 082 and 088) corresponding to output torque at 25°C.

Graph 098-1

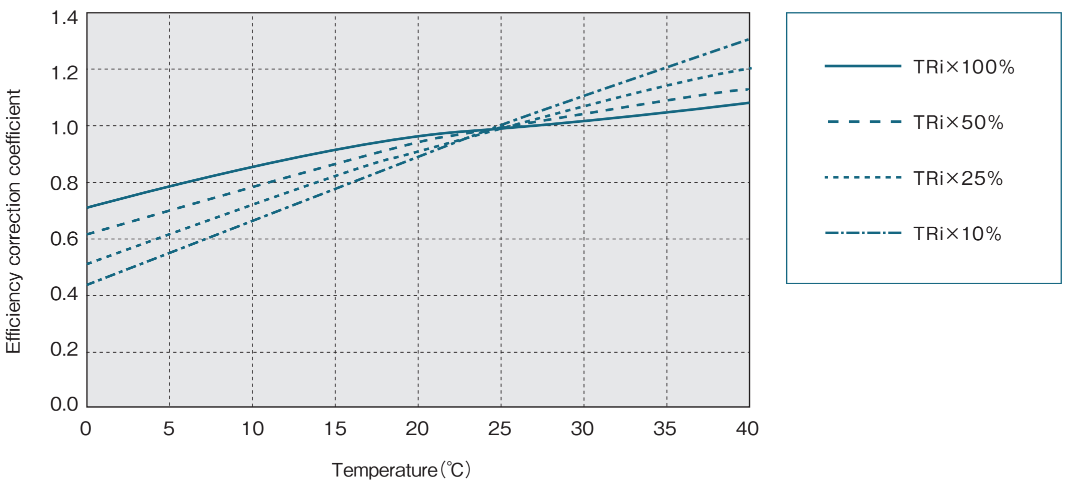



* Not applicable for HPG Right Angle Type. Contact us about the low-temperature characteristics for HPG Right Angle Type.

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

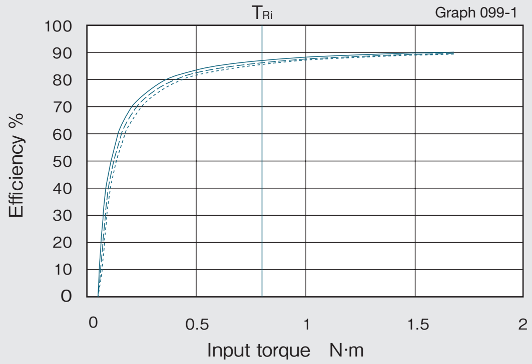
* TRi is an input torque (see pages 050 and 058) corresponding to output torque at 25°C.

Graph 098-2

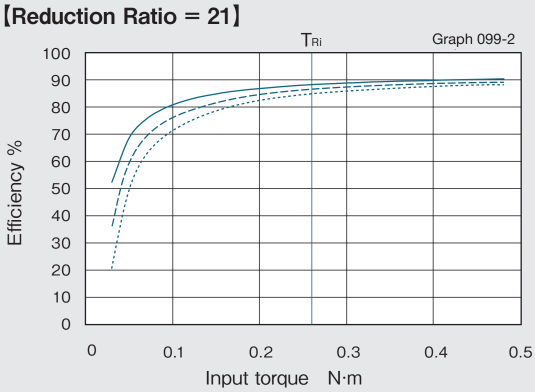


## ■Model No. 11: Gear Head Type HPGP

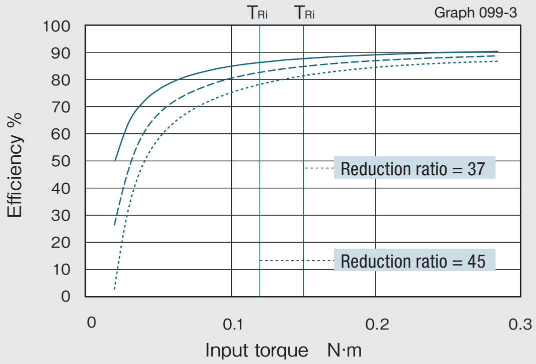
【Reduction Ratio = 5】




【Reduction Ratio = 21】



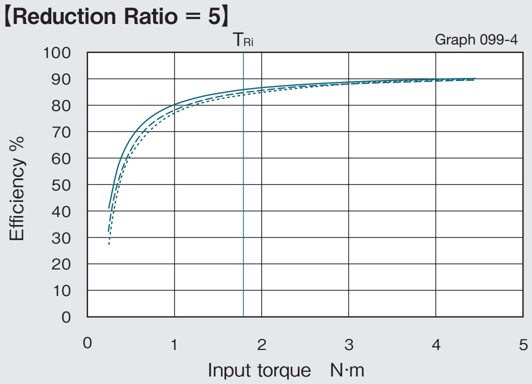

【Reduction Ratio = 37, 45】



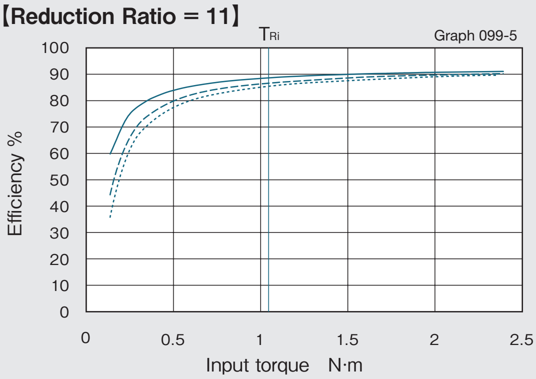

—— Speed reducer only　– – – Gear head type (standard item)　······ DDU bearing (bearing with double side rubber contact seal) assembled on input side of the gear head type (customized item)　TRi Input torque corresponding to output torque

## ■Model No. 14: Gear Head Type HPGP

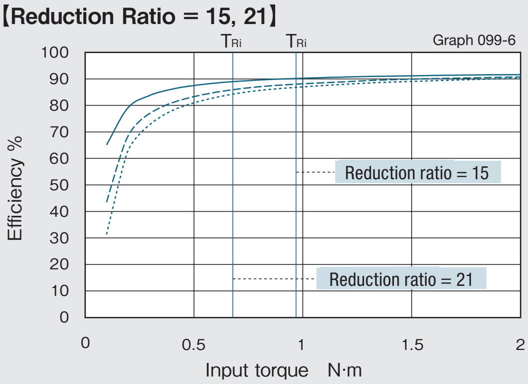
【Reduction Ratio = 5】



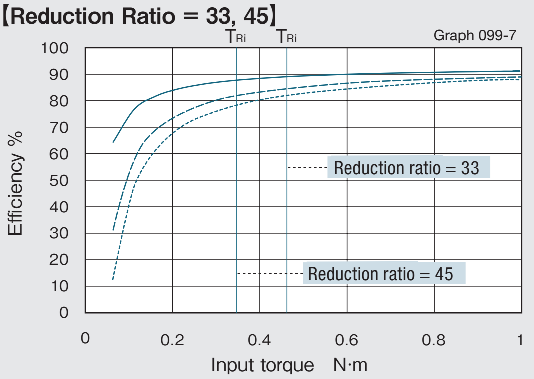

【Reduction Ratio = 11】




【Reduction Ratio = 15, 21】



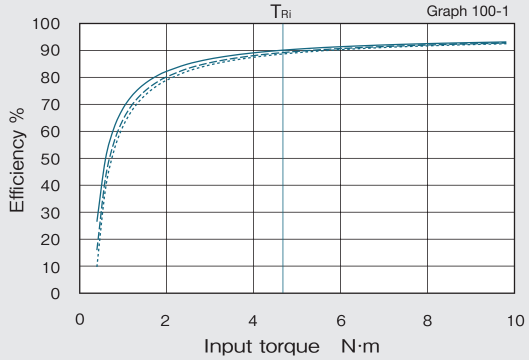

【Reduction Ratio = 33, 45】



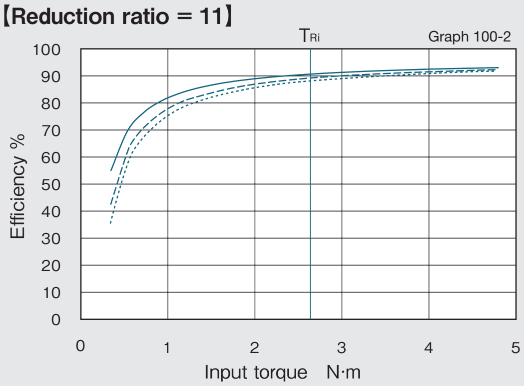

—— Speed reducer only　– – – Gear head type (standard item)　······ DDU bearing (bearing with double side rubber contact seal) assembled on input side of the gear head type (customized item)　TRi Input torque corresponding to output torque

## ■Model No. 20: Gear Head Type HPGP

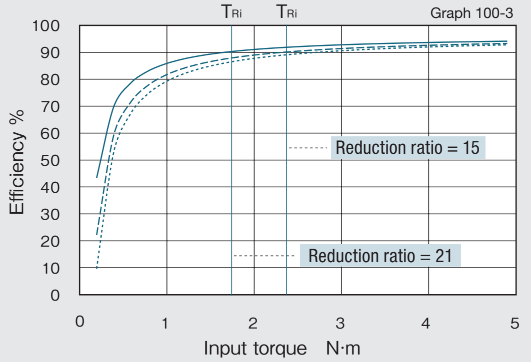
【Reduction ratio = 5】



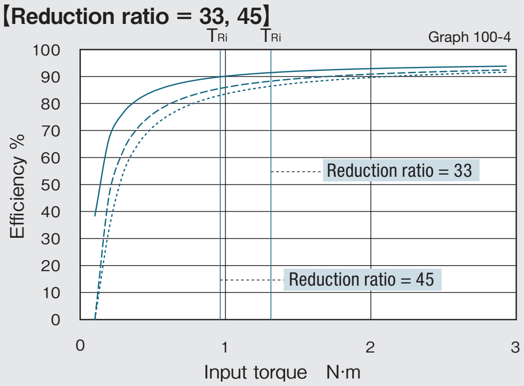

【Reduction ratio = 11】




【Reduction ratio = 15, 21】



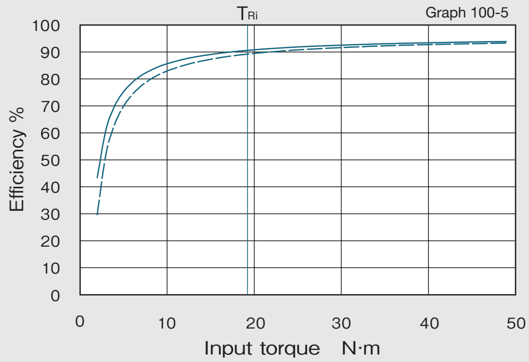

【Reduction ratio = 33, 45】



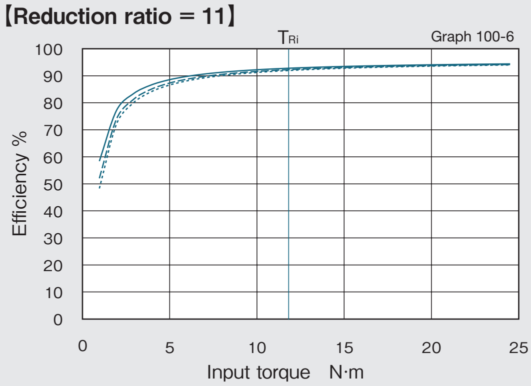

—— Speed reducer only
– – – Gear head type (standard item)
······ DDU bearing (bearing with double side rubber contact seal) assembled on input side of the gear head type (customized item)
TRi Input torque corresponding to output torque

## ■Model No. 32: Gear Head Type HPGP

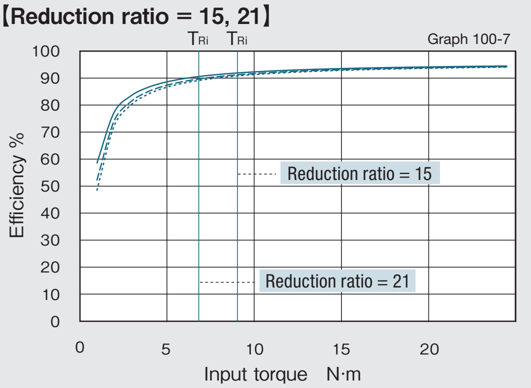
【Reduction ratio = 5】*1



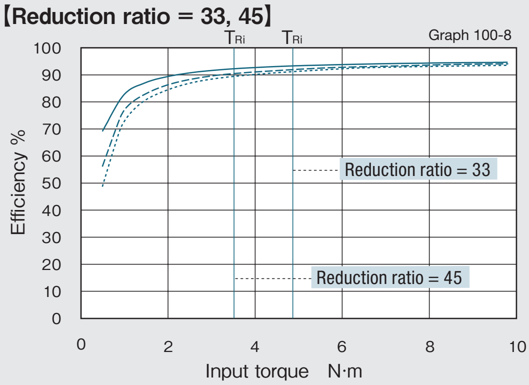

【Reduction ratio = 11】




【Reduction ratio = 15, 21】




【Reduction ratio = 33, 45】

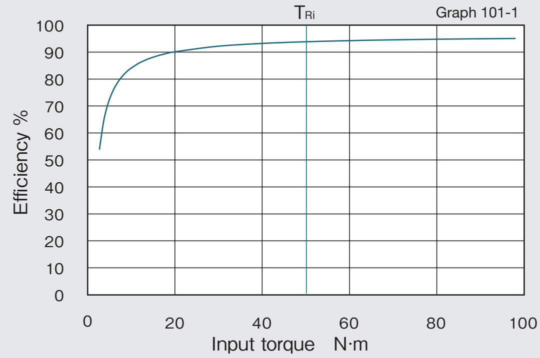



—— Speed reducer only
– – – Gear head type (standard item)
······ DDU bearing (bearing with double side rubber contact seal) assembled on input side of the gear head type (customized item)
TRi Input torque corresponding to output torque

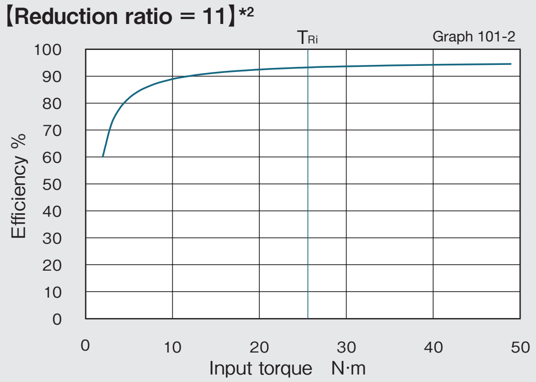
*1 Only one line is shown in graphs because the difference between the speed reducer only and a bearing assembled on the input side is small.

## ■Model No. 50: Gear Head Type HPGP

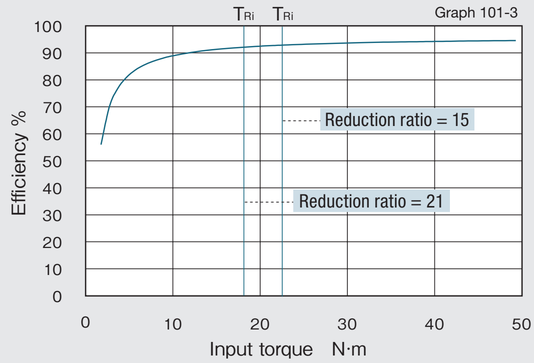
【Reduction ratio = 5】*2



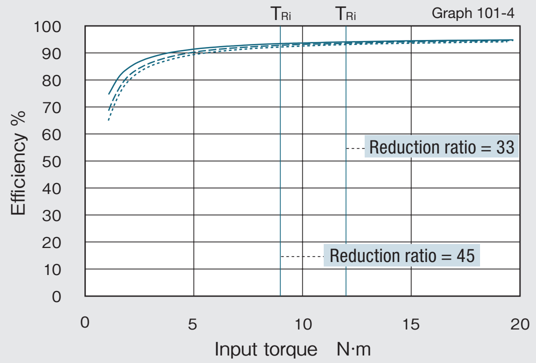

【Reduction ratio = 11】*2




【Reduction ratio = 15, 21】*2




【Reduction ratio = 33, 45】

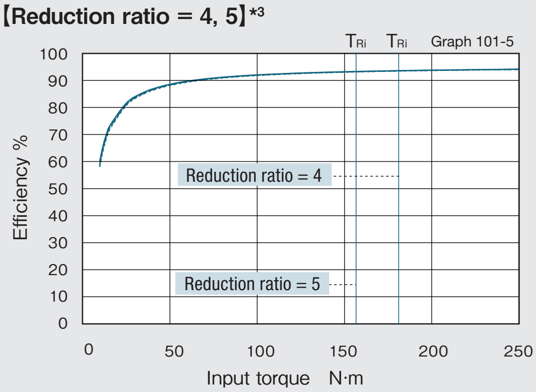



—— Speed reducer only
– – – Gear head type (standard item)
······ DDU bearing (bearing with double side rubber contact seal) assembled on input side of the gear head type (customized item)
TRi Input torque corresponding to output torque

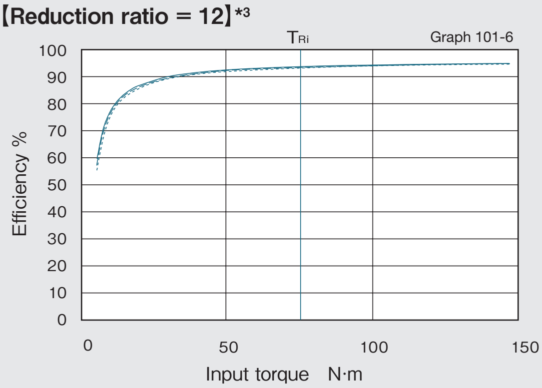
*2 Only one line is shown in graphs because the difference between the speed reducer only and a bearing assembled on the input side is small.

## ■Model No. 65: Gear Head Type HPGP

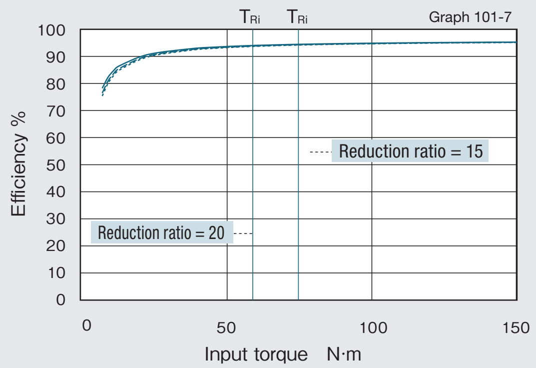
【Reduction ratio = 4, 5】*3



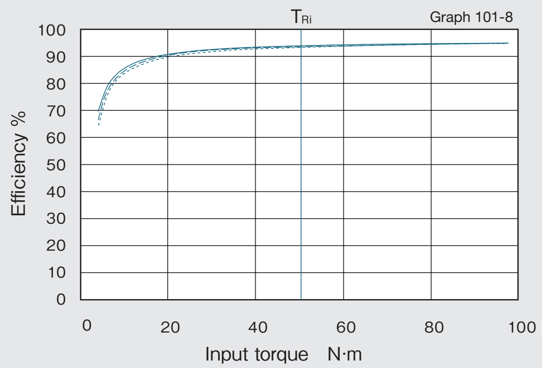

【Reduction ratio = 12】*3




【Reduction ratio = 15, 20】*3




【Reduction ratio = 25】*3

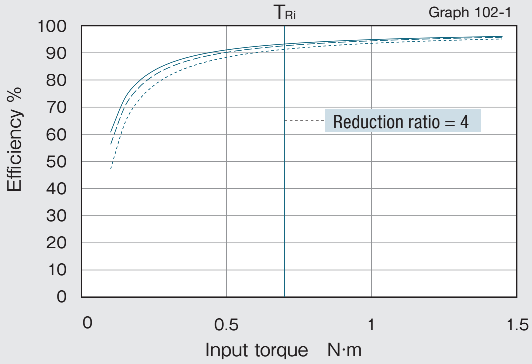



—— Speed reducer only
– – – Gear head type (standard item)
······ DDU bearing (bearing with double side rubber contact seal) assembled on input side of the gear head type (customized item)
TRi Input torque corresponding to output torque

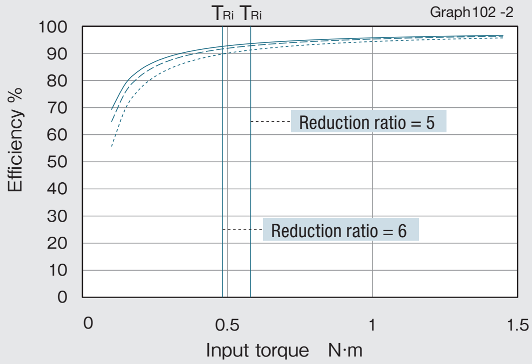
*3 Only one line is shown in graphs because the difference between the speed reducer only and a bearing assembled on the input side is small.

## ■Model No. 11: Helical Gear Type HPG HPG

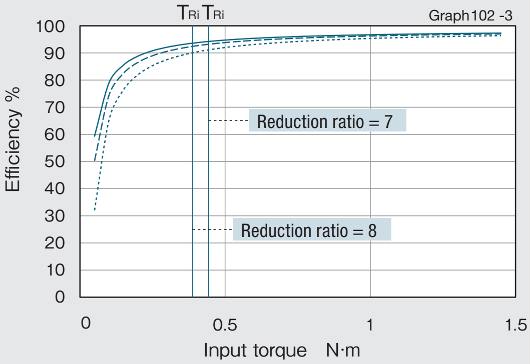
【Reduction ratio = 4】



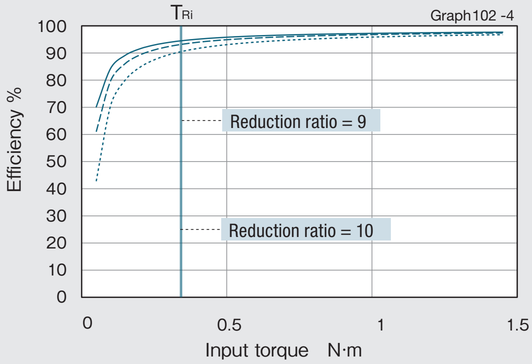

【Reduction ratio = 5,6】




【Reduction ratio = 7,8】



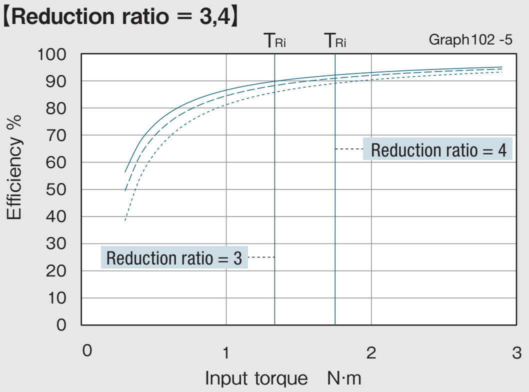

【Reduction ratio = 9,10】



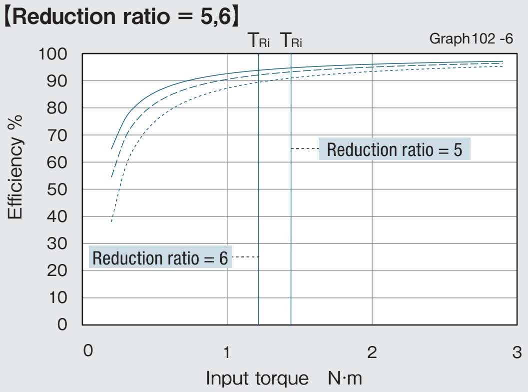

—— Speed reducer only  – – – Gear head type (standard item)  ······ DDU bearing (bearing with double side rubber contact seal) assembled on input side of the gear head type (customized item)  $T_{Ri}$ Input torque corresponding to output torque

## ■Model No. 14: Helical Gear Type HPG HPG

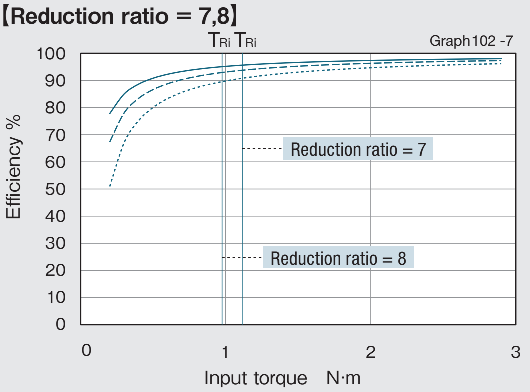
【Reduction ratio = 3,4】



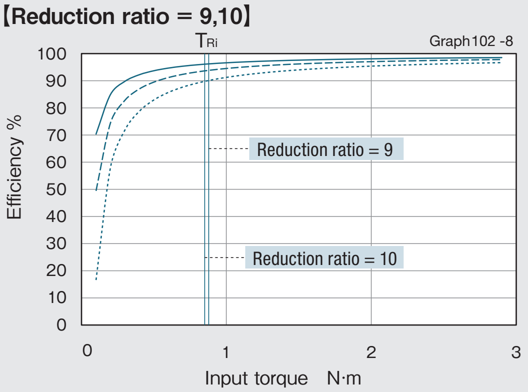

【Reduction ratio = 5,6】




【Reduction ratio = 7,8】



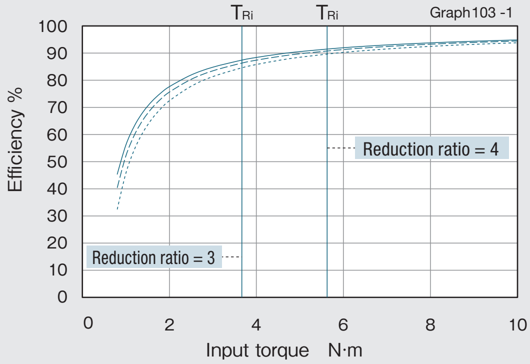

【Reduction ratio = 9,10】



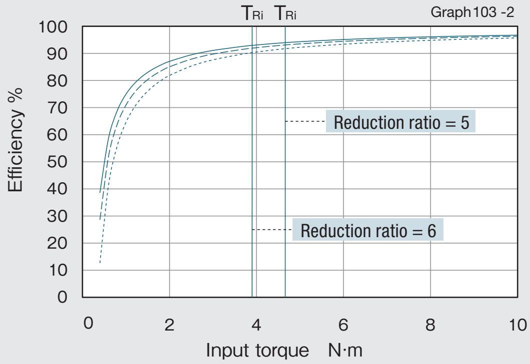

—— Speed reducer only  – – – Gear head type (standard item)  ······ DDU bearing (bearing with double side rubber contact seal) assembled on input side of the gear head type (customized item)  $T_{Ri}$ Input torque corresponding to output torque

## Model No. 20: Helical Gear Type HPG HPG

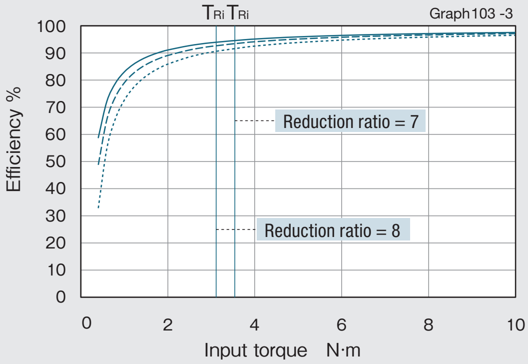
【Reduction ratio = 3,4】



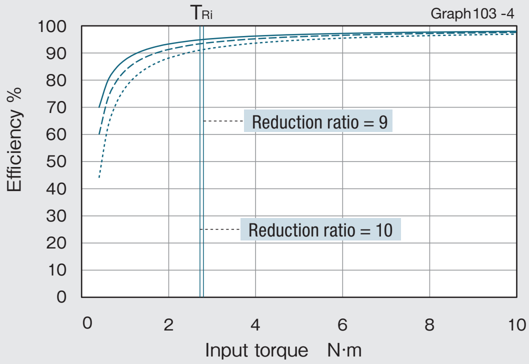

【Reduction ratio = 5,6】




【Reduction ratio = 7,8】



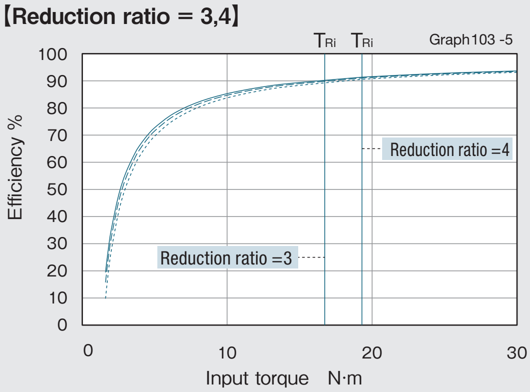

【Reduction ratio = 9,10】



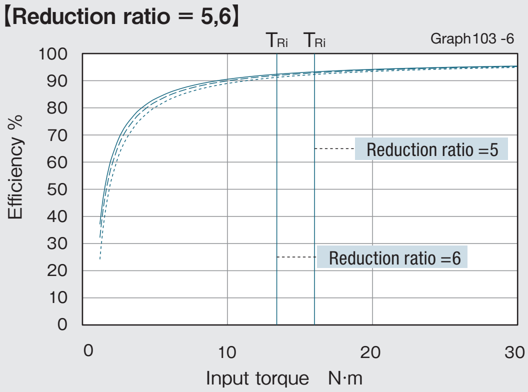

—— Speed reducer only
– – – Gear head type (standard item)
······ DDU bearing (bearing with double side rubber contact seal) assembled on input side of the gear head type (customized item)
$T_{Ri}$ Input torque corresponding to output torque

## Model No. 32: Helical Gear Type HPG

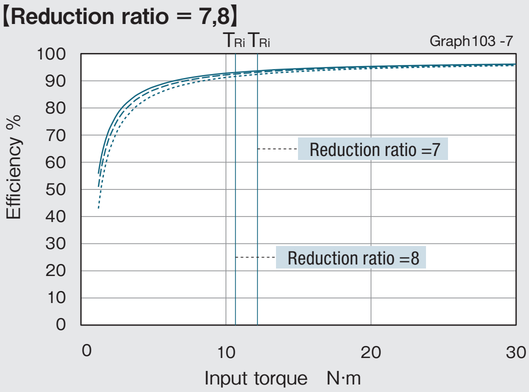
【Reduction ratio = 3,4】



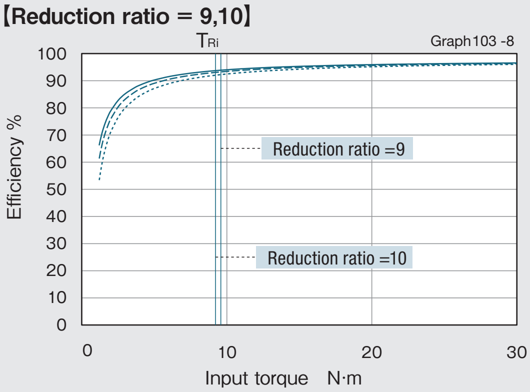

【Reduction ratio = 5,6】




【Reduction ratio = 7,8】



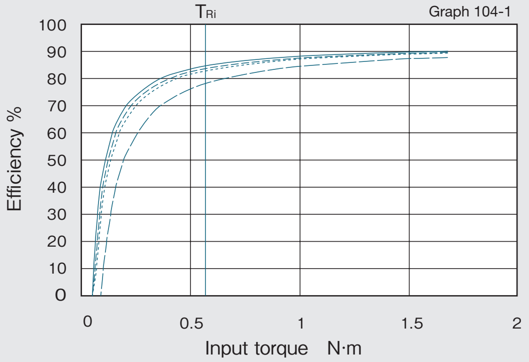

【Reduction ratio = 9,10】



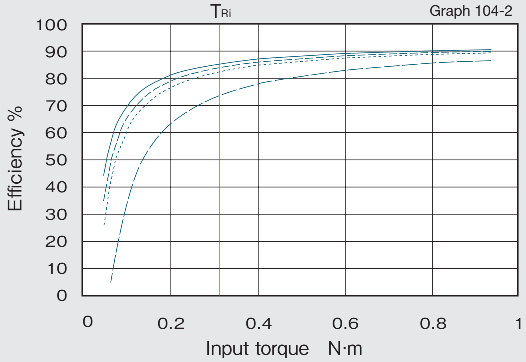

—— Speed reducer only
– – – Gear head type (standard item)
······ DDU bearing (bearing with double side rubber contact seal) assembled on input side of the gear head type (customized item)
$T_{Ri}$ Input torque corresponding to output torque

## ■Model No. 11: Gear Head Type/Input Shaft Unit Type HPG

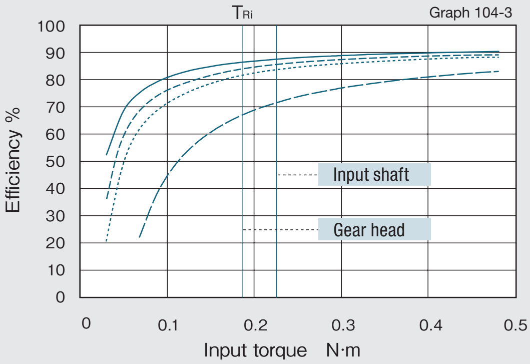
【Reduction ratio = 5】



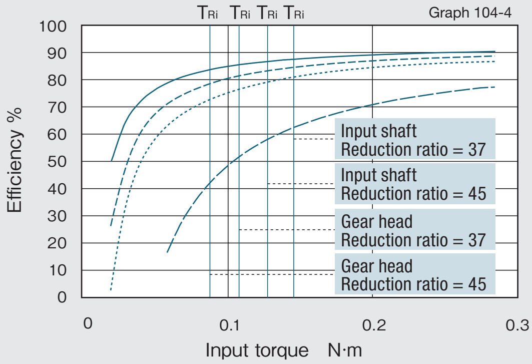

【Reduction ratio = 9】




【Reduction ratio = 21】



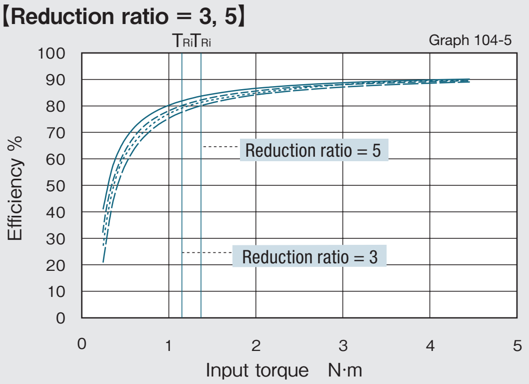

【Reduction ratio = 37, 45】



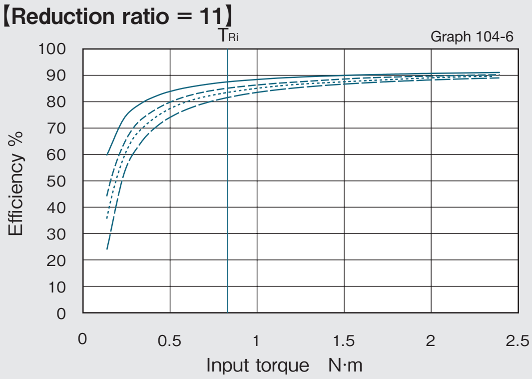

—— Speed reducer only
– – – Gear head type (standard item)
······ DDU bearing (bearing with double side rubber contact seal) assembled on input side of the gear head type (customized item)
— — Input shaft unit type
TRi Input torque corresponding to output torque

## ■Model No. 14: Gear Head Type/Input Shaft Unit Type HPG

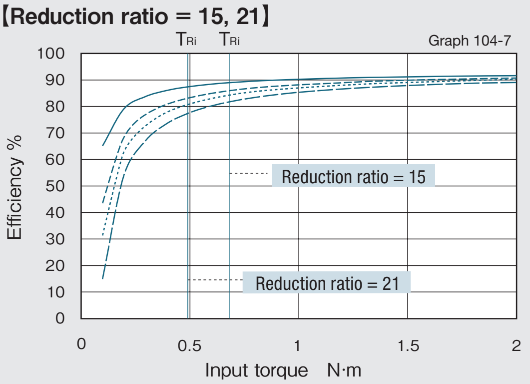
【Reduction ratio = 3, 5】



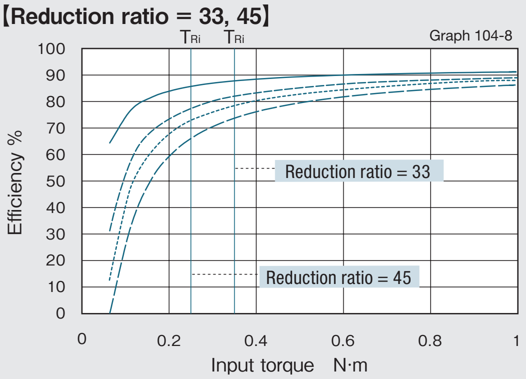

【Reduction ratio = 11】




【Reduction ratio = 15, 21】



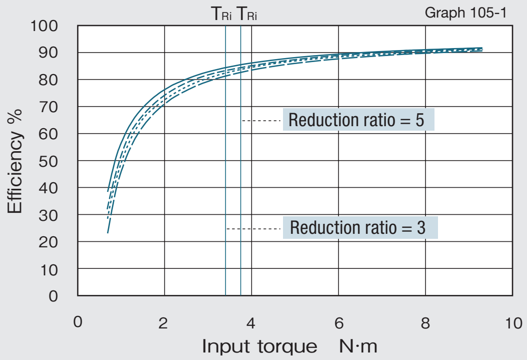

【Reduction ratio = 33, 45】



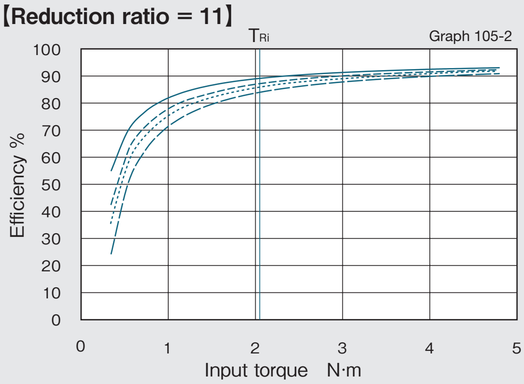

—— Speed reducer only
– – – Gear head type (standard item)
······ DDU bearing (bearing with double side rubber contact seal) assembled on input side of the gear head type (customized item)
— — Input shaft unit type
TRi Input torque corresponding to output torque

## ■Model No. 20: Gear Head Type/Input Shaft Unit Type HPG

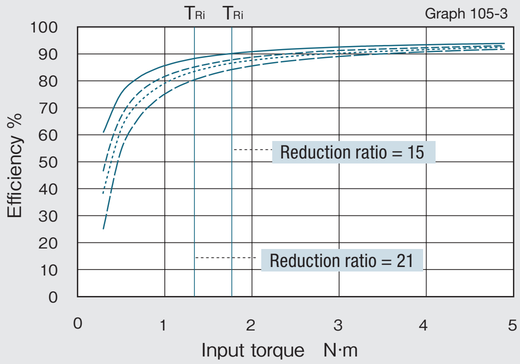
【Reduction ratio = 3, 5】



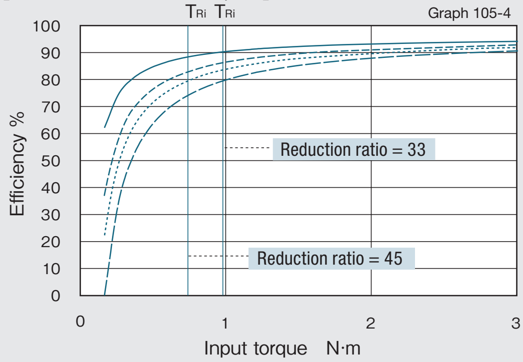

【Reduction ratio = 11】




【Reduction ratio = 15, 21】



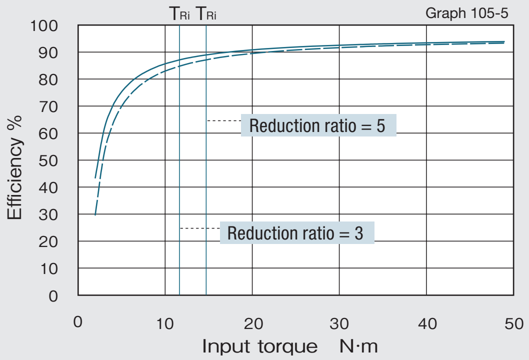

【Reduction ratio = 33, 45】



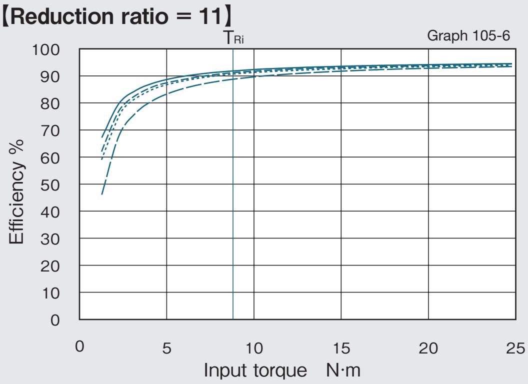

—— Speed reducer only
– – – Gear head type (standard item)
······ DDU bearing (bearing with double side rubber contact seal) assembled on input side of the gear head type (customized item)
— — Input shaft unit type
TRi Input torque corresponding to output torque

## ■Model No. 32: Gear Head Type/Input Shaft Unit Type HPG

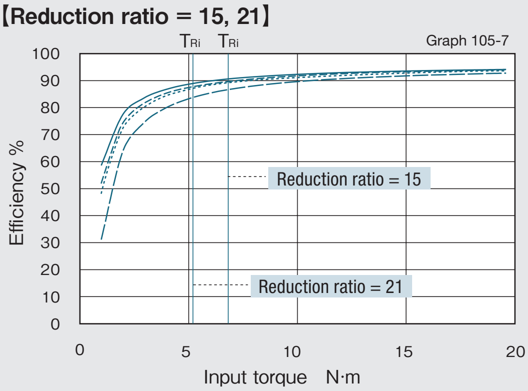
【Reduction ratio = 3, 5】*1



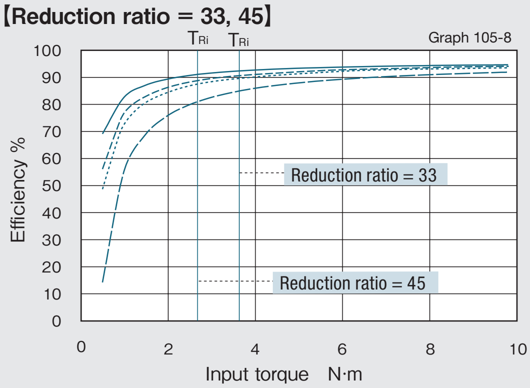

【Reduction ratio = 11】




【Reduction ratio = 15, 21】




【Reduction ratio = 33, 45】

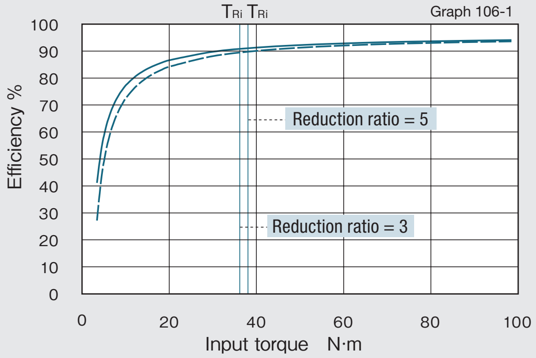



—— Speed reducer only
– – – Gear head type (standard item)
······ DDU bearing (bearing with double side rubber contact seal) assembled on input side of the gear head type (customized item)
— — Input shaft unit type
TRi Input torque corresponding to output torque

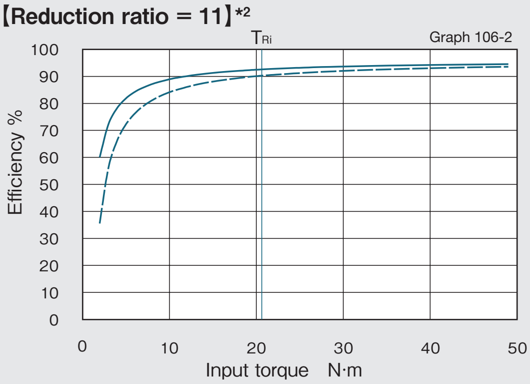
*1 Only one line is shown in graphs because the difference between the speed reducer only and a bearing assembled on the input side is small.

## ■Model No. 50: Gear Head Type/Input Shaft Unit Type HPG

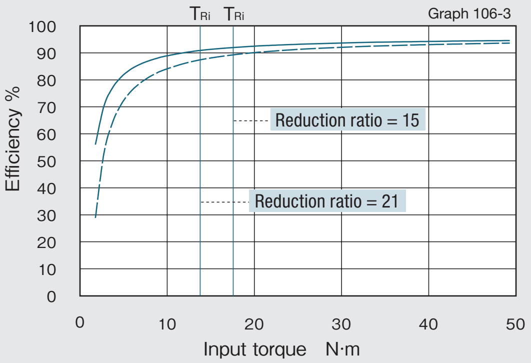
【Reduction ratio = 3, 5】*2



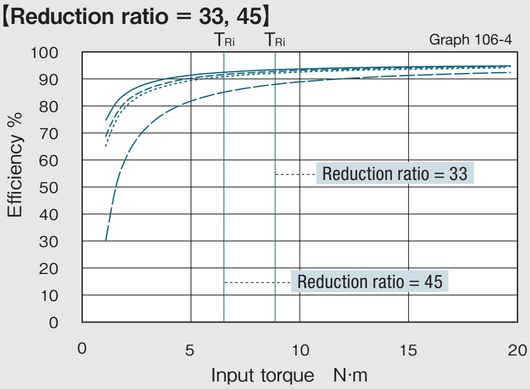

【Reduction ratio = 11】*2




【Reduction ratio = 15, 21】*2




【Reduction ratio = 33, 45】

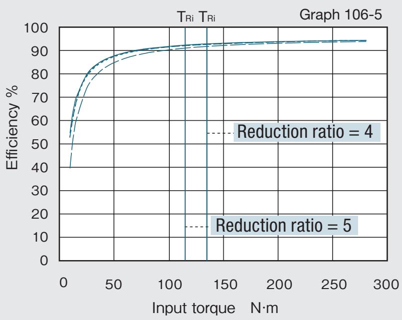



—— Speed reducer only
– – – Gear head type (standard item)
······ DDU bearing (bearing with double side rubber contact seal) assembled on input side of the gear head type (customized item)
—— Input shaft unit type
TRi Input torque corresponding to output torque

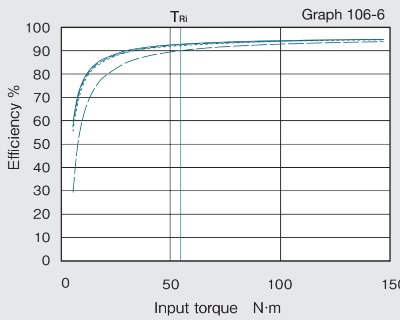
*2 Only one line is shown in graphs because the difference between the speed reducer only and a bearing assembled on the input side is small.

## ■Model No. 65: Gear Head Type/Input Shaft Unit Type HPG

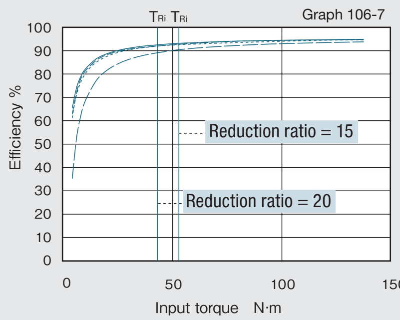
【Reduction ratio = 4, 5】*3



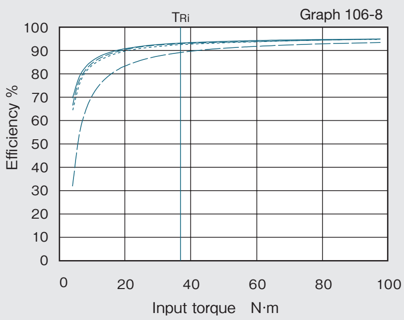

【Reduction ratio = 12】



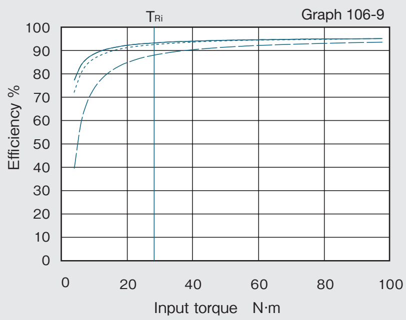

【Reduction ratio = 15, 20】



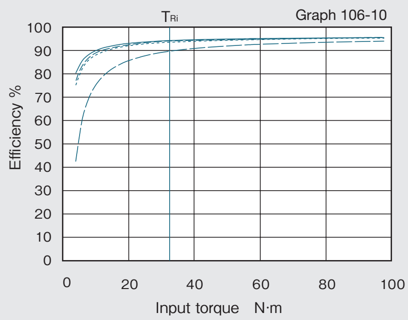

【Reduction ratio = 25】




【Reduction ratio = 40】*3




【Reduction ratio = 50】

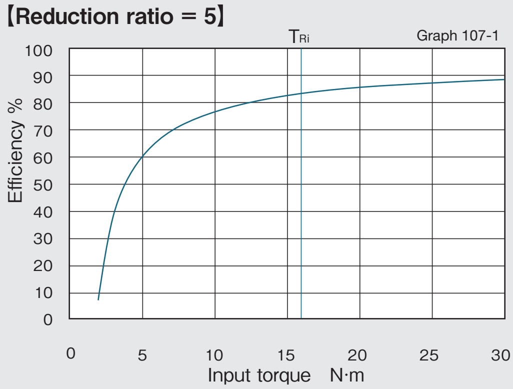



—— Speed reducer only
– – – Gear head type (standard item)
······ DDU bearing (bearing with double side rubber contact seal) assembled on input side of the gear head type (customized item)
—— Input shaft unit type
TRi Input torque corresponding to output torque

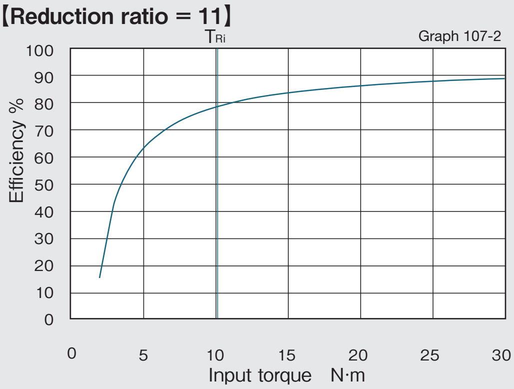
*3 Only one line is shown in graphs because the difference between the speed reducer only and a bearing assembled on the input side is small.

## ■Model No. 32 RA3: Orthogonal Shaft Gear Head Type HPG

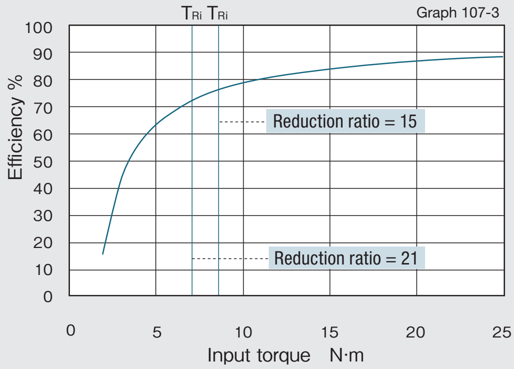
【Reduction ratio = 5】



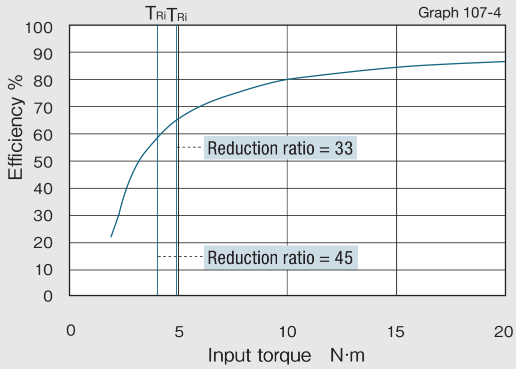

【Reduction ratio = 11】




【Reduction ratio = 15, 21】



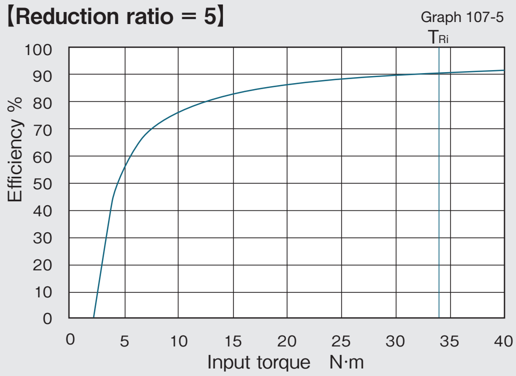

【Reduction ratio = 33, 45】



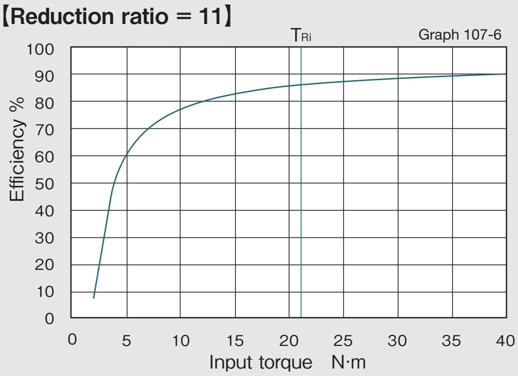

$T_{Ri}$ Input torque corresponding to output torque

## ■Model No. 50 RA3: Orthogonal Shaft Gear Head Type HPG

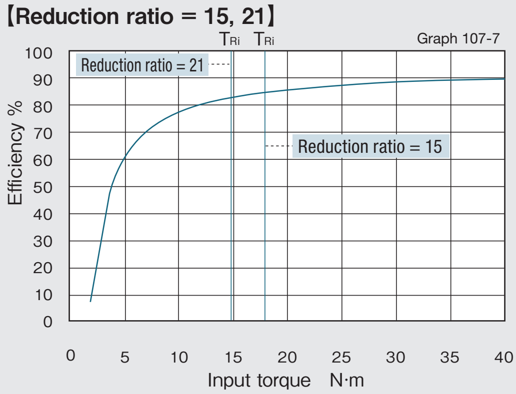
【Reduction ratio = 5】



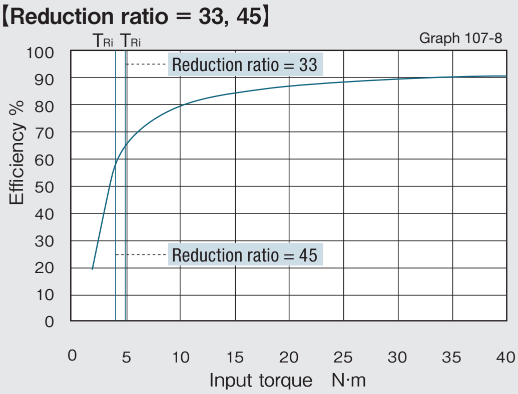

【Reduction ratio = 11】




【Reduction ratio = 15, 21】



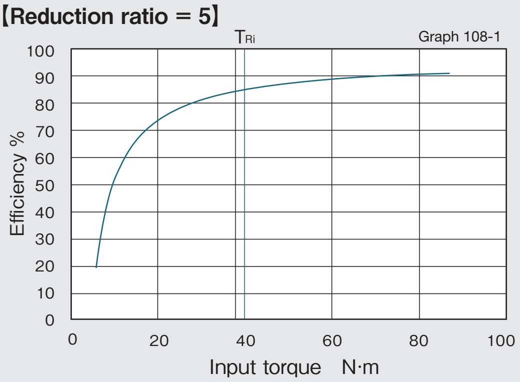

【Reduction ratio = 33, 45】



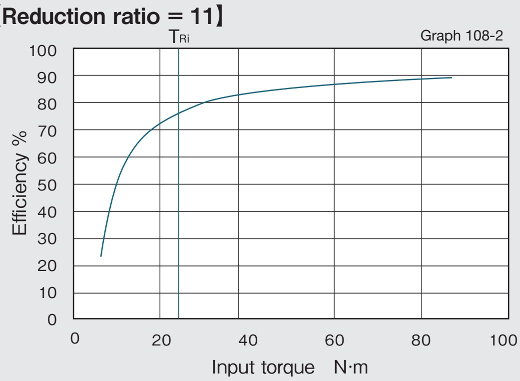

$T_{Ri}$ Input torque corresponding to output torque

## ■Model No. 50 RA5: Orthogonal Shaft Gear Head Type HPG

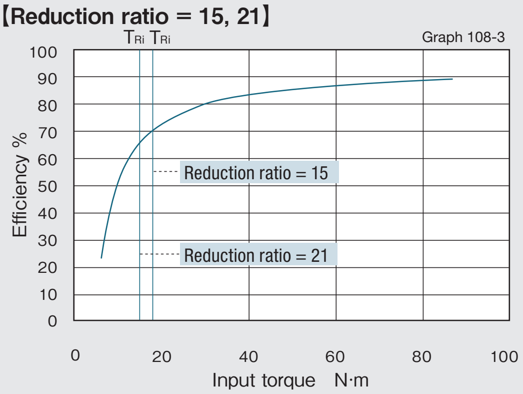
【Reduction ratio = 5】



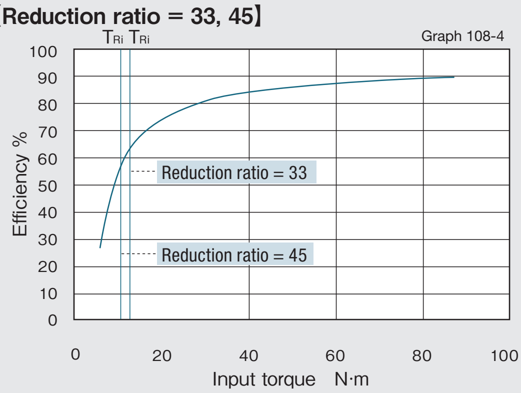

【Reduction ratio = 11】




【Reduction ratio = 15, 21】



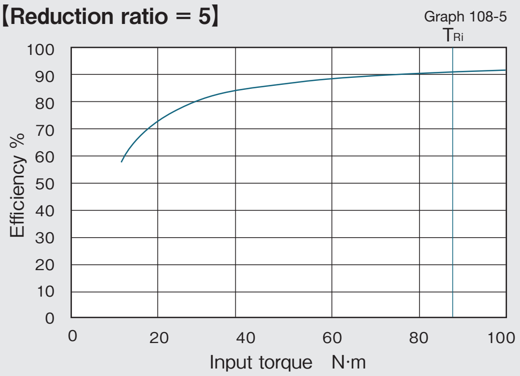

【Reduction ratio = 33, 45】



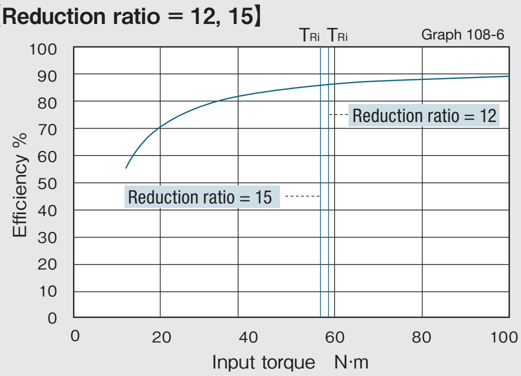

TRi Input torque corresponding to output torque

## ■Model No. 65 RA5: Orthogonal Shaft Gear Head Type HPG

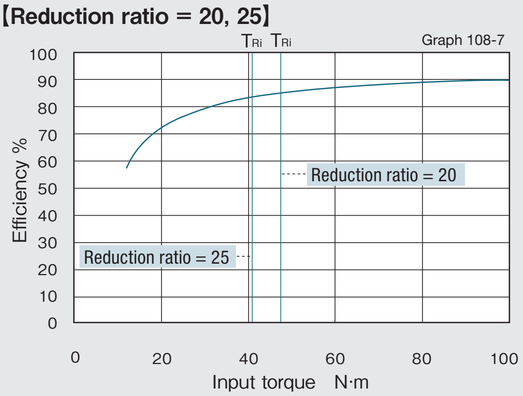
【Reduction ratio = 5】



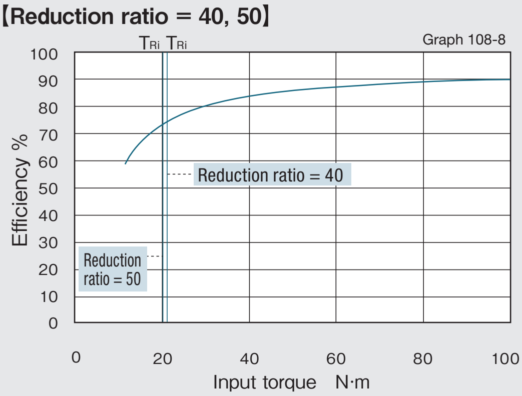

【Reduction ratio = 12, 15】




【Reduction ratio = 20, 25】

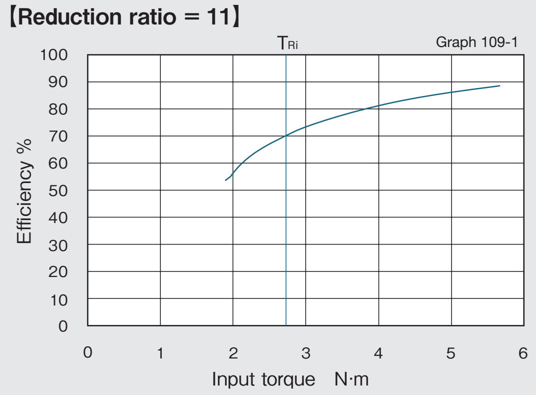



【Reduction ratio = 40, 50】

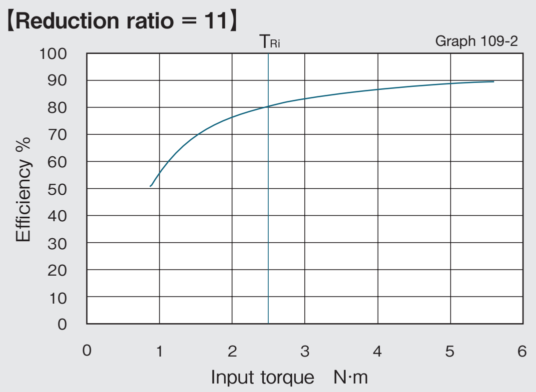



TRi Input torque corresponding to output torque

■Model No. 25: Hollow Shaft Unit Type HPF

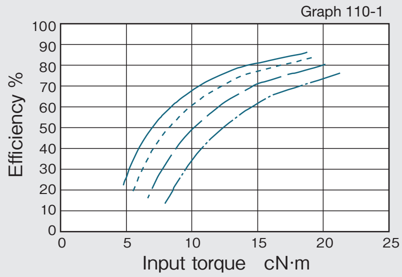



■Model No. 32: Hollow Shaft Unit Type HPF

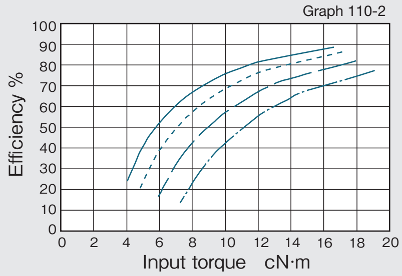


## ■Model No. 14: Gear Head Type CSG-GH CSF-GH

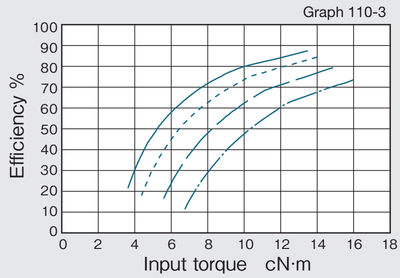
【Reduction ratio = 50】




【Reduction ratio = 80】



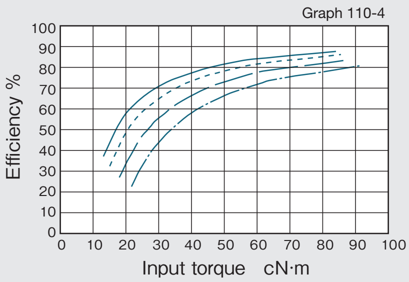

【Reduction ratio = 100】



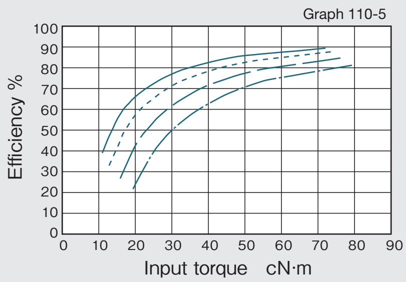

Input rotational speed ——— 500r/min - - - - - - 1000r/min —— — 2000r/min —·— 3500r/min

## ■Model No. 20: Gear Head Type CSG-GH CSF-GH

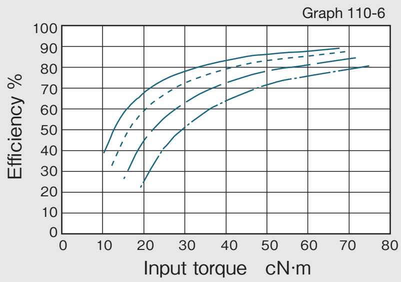
【Reduction ratio = 50】



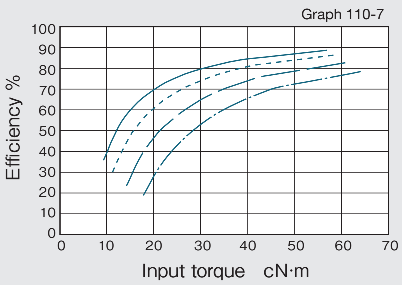

【Reduction ratio = 80】



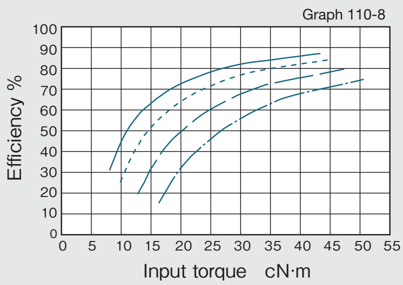

【Reduction ratio = 100】




【Reduction ratio = 120】




【Reduction ratio = 160】

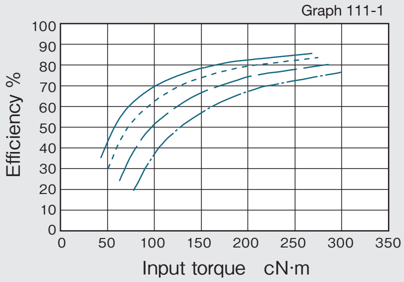



Input rotational speed ——— 500r/min - - - - - - 1000r/min —— — 2000r/min —·— 3500r/min

## ■Model No. 32: Gear Head Type CSG-GH CSF-GH

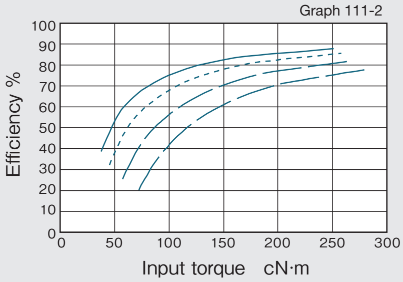
【Reduction ratio = 50】

Graph 111-1



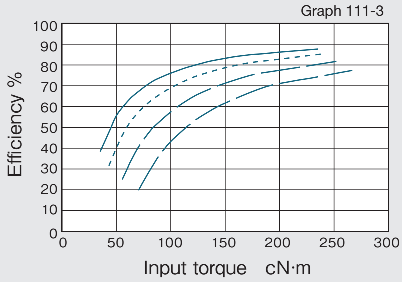

【Reduction ratio = 80】

Graph 111-2



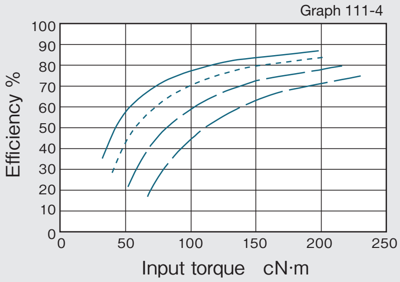

【Reduction ratio = 100】

Graph 111-3



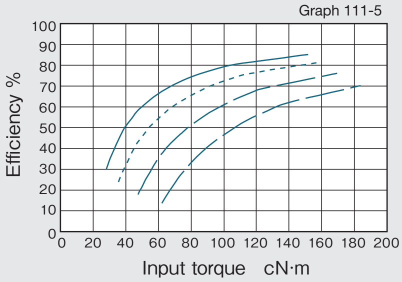

【Reduction ratio = 120】

Graph 111-4




【Reduction ratio = 160】

Graph 111-5

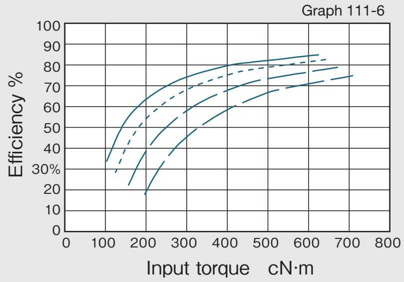



Input rotational speed ——— 500r/min - - - - - - 1000r/min — — 2000r/min —·— 3500r/min

## ■Model No. 45: Gear Head Type CSG-GH CSF-GH

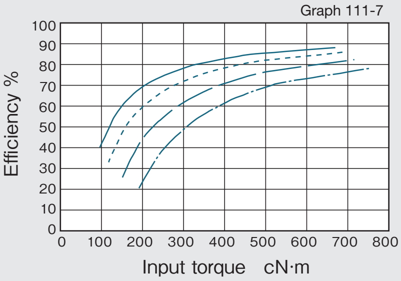
【Reduction ratio = 50】

Graph 111-6



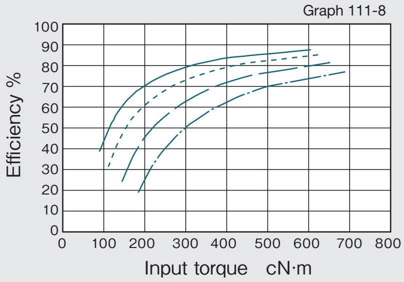

【Reduction ratio = 80】

Graph 111-7



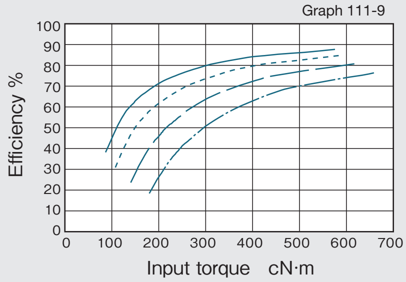

【Reduction ratio = 100】

Graph 111-8



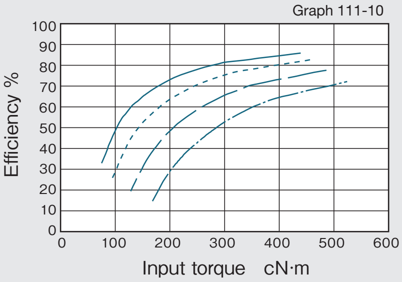

【Reduction ratio = 120】

Graph 111-9




【Reduction ratio = 160】

Graph 111-10

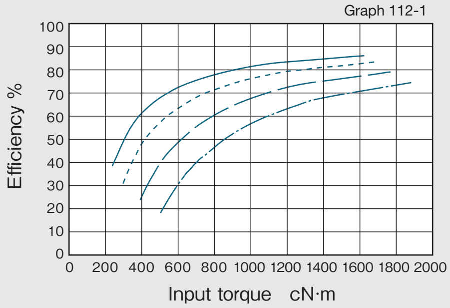



Input rotational speed ——— 500r/min - - - - - - 1000r/min — — 2000r/min —·— 3500r/min

■Model No. 65: Gear Head Type CSG-GH CSF-GH

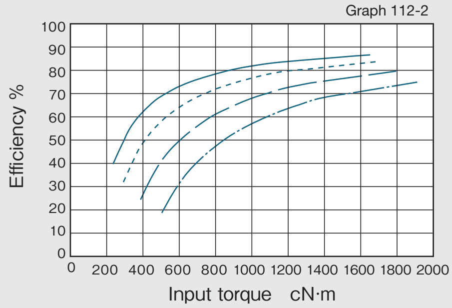
【Reduction ratio = 80】

Graph 112-1



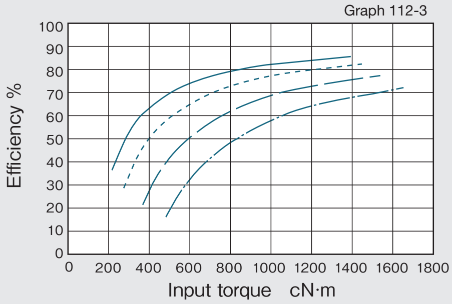

【Reduction ratio = 100】

Graph 112-2



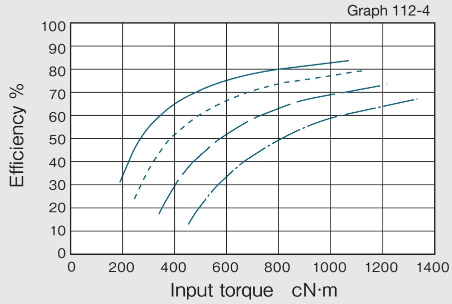

【Reduction ratio = 120】

Graph 112-3




【Reduction ratio = 160】

Graph 112-4




Input rotational speed —— 500r/min - - - - - - 1000r/min —— — 2000r/min ——·—— 3500r/min

# MEMO

# Output Shaft Bearing Specifications and Checking Procedure

A precision cross roller bearing is built in the HPG series to directly support the external load (output flange).
Check the maximum load moment load, life of the bearing and static safety coefficient to fully bring out the performance.

## Checking procedure

**(1) Checking the maximum load moment load (M*max*)**

Obtain the maximum load moment load (M*max*). → Maximum load moment load (M*max*) ≦ Permissible moment (Mc)

**(2) Checking the life**

Obtain the average radial load (Fr*av*) and the average axial load (Fa*av*). → Obtain the radial load coefficient (X) and the axial load coefficient (Y). → Calculate the life and check it.

**(3) Checking the static safety coefficient**

Obtain the static equivalent radial load coefficient (Po). → Check the static safety coefficient. (fs)

## Specification of output shaft bearing

**HPGP/HPG Series** Table 114-1, -2 and -3 indicate the specifications for gear head, orthogonal and input shaft type, and cross roller bearing.

Table 114-1

| Model No. | Pitch circle dia. of a roller | Offset amount | Basic rated load | | | | Permissible moment load Mc*3 | | Moment rigidity Km*4 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | dp | R | Basic dynamic rated load C*1 | | Basic static rated load Co*2 | | N·m | kgf·m | ×10^4 N·m/rad | kgf·m/arc-min |
| | m | m | N | kgf | N | kgf | | | | |
| 11 | 0.0275 | 0.006 | 3116 | 318 | 4087 | 417 | 9.50 | 0.97 | 0.88 | 0.26 |
| 14 | 0.0405 | 0.011 | 5110 | 521 | 7060 | 720 | 32.3 | 3.30 | 3.0 | 0.90 |
| 20 | 0.064 | 0.0115 | 10600 | 1082 | 17300 | 1765 | 183 | 18.7 | 16.8 | 5.0 |
| 32 | 0.085 | 0.014 | 20500 | 2092 | 32800 | 3347 | 452 | 46.1 | 42.1 | 12.5 |
| 50 | 0.123 | 0.019 | 41600 | 4245 | 76000 | 7755 | 1076 | 110 | 100 | 29.7 |
| 65 | 0.170 | 0.023 | 90600 | 9245 | 148000 | 15102 | 3900 | 398 | 364 | 108 |

(HPGP/HPG Standard Type) Table 114-2

| Model No. | Reduction ratio | Permissible radial load*5 | Permissible axial load*5 |
|---|---|---|---|
| | | N | N |
| 11 | 5 | 280 | 430 |
| | (9) | 340 | 510 |
| | 21 | 440 | 660 |
| | 37 | 520 | 780 |
| | 45 | 550 | 830 |
| 14 | (3) | 400 | 600 |
| | 5 | 470 | 700 |
| | 11 | 600 | 890 |
| | 15 | 650 | 980 |
| | 21 | 720 | 1080 |
| | 33 | 830 | 1240 |
| | 45 | 910 | 1360 |
| 20 | (3) | 840 | 1250 |
| | 5 | 980 | 1460 |
| | 11 | 1240 | 1850 |
| | 15 | 1360 | 2030 |
| | 21 | 1510 | 2250 |
| | 33 | 1729 | 2580 |
| | 45 | 1890 | 2830 |
| 32 | (3) | 1630 | 2430 |
| | 5 | 1900 | 2830 |
| | 11 | 2410 | 3590 |
| | 15 | 2640 | 3940 |
| | 21 | 2920 | 4360 |
| | 33 | 3340 | 4990 |
| | 45 | 3670 | 5480 |
| 50 | (3) | 3700 | 5570 |
| | 5 | 4350 | 6490 |
| | 11 | 5500 | 8220 |
| | 15 | 6050 | 9030 |
| | 21 | 6690 | 9980 |
| | 33 | 7660 | 11400 |
| | 45 | 8400 | 12500 |
| 65 | 4 | 8860 | 13200 |
| | 5 | 9470 | 14100 |
| | 12 | 12300 | 18300 |
| | 15 | 13100 | 19600 |
| | 20 | 14300 | 21400 |
| | 25 | 15300 | 22900 |
| | (40) | 17600 | 26300 |
| | (50) | 18900 | 28200 |

* The parenthesized reduction ratio value indicates the value for the HPG series.

(HPG Helical Gear Type) Table 114-3

| Model No. | Reduction ratio | Permissible radial load*5 | Permissible axial load*5 |
|---|---|---|---|
| | | N | N |
| 11 | 4 | 260 | 400 |
| | 5 | 280 | 430 |
| | 6 | 300 | 450 |
| | 7 | 310 | 470 |
| | 8 | 330 | 490 |
| | 9 | 340 | 510 |
| | 10 | 350 | 530 |
| 14 | 3 | 400 | 600 |
| | 4 | 440 | 660 |
| | 5 | 470 | 700 |
| | 6 | 490 | 740 |
| | 7 | 520 | 780 |
| | 8 | 540 | 810 |
| | 9 | 560 | 840 |
| | 10 | 580 | 860 |
| 20 | 3 | 840 | 1250 |
| | 4 | 910 | 1370 |
| | 5 | 980 | 1460 |
| | 6 | 1030 | 1540 |
| | 7 | 1080 | 1620 |
| | 8 | 1130 | 1680 |
| | 9 | 1170 | 1740 |
| | 10 | 1200 | 1800 |
| 32 | 3 | 1630 | 2430 |
| | 4 | 1770 | 2650 |
| | 5 | 1900 | 2830 |
| | 6 | 2000 | 2990 |
| | 7 | 2100 | 3130 |
| | 8 | 2180 | 3260 |
| | 9 | 2260 | 3380 |
| | 10 | 2330 | 3480 |

**CSG-GH/CSF-GH Series** Table 115-1 indicates the specifications for cross roller bearing.

Table 115-1

| Model No. | Pitch circle dia. of a roller | Offset amount | Basic rated load | | | | Permissible moment load Mc[*3] | | Moment rigidity Km[*4] | | Permissible radial load[*5] | Permissible axial load[*5] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | dp | R | Basic dynamic rated load C[*1] | | Basic static rated load Co[*2] | | | | ×10[4] N·m/rad | kgf·m/ arc-min | | |
| | m | m | N | kgf | N | kgf | N·m | kgf·m | | | N | N |
| 14 | 0.0405 | 0.011 | 5110 | 521 | 7060 | 720 | 27 | 2.76 | 3.0 | 0.89 | 732 | 1093 |
| 20 | 0.064 | 0.0115 | 10600 | 1082 | 17300 | 1765 | 145 | 14.8 | 17 | 5.0 | 1519 | 2267 |
| 32 | 0.085 | 0.014 | 20500 | 2092 | 32800 | 3347 | 258 | 26.3 | 42 | 12 | 2938 | 4385 |
| 45 | 0.123 | 0.019 | 41600 | 4245 | 76000 | 7755 | 797 | 81.3 | 100 | 30 | 5962 | 8899 |
| 65 | 0.170 | 0.0225 | 81600 | 8327 | 149000 | 15204 | 2156 | 220 | 323 | 96 | 11693 | 17454 |

**HPF Series** Table 115-2 indicates the specifications for cross roller bearing.

Table 115-2

| Model No. | Pitch circle dia. of a roller | Offset amount | Basic rated load | | | | Permissible moment load Mc[*3] | | Moment rigidity Km[*4] | | Permissible radial load[*5] | Permissible axial load[*5] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | dp | R | Basic dynamic rated load C[*1] | | Basic static rated load Co[*2] | | | | ×10[4] N·m/rad | kgf·m/ arc-min | | |
| | m | m | N | kgf | N | kgf | N·m | kgf·m | | | N | N |
| 25 | 0.085 | 0.0153 | 11400 | 1163 | 20300 | 2071 | 410 | 41.8 | 37.9 | 11.3 | 1330 | 1990 |
| 32 | 0.1115 | 0.015 | 22500 | 2296 | 39900 | 4071 | 932 | 95 | 86.1 | 25.7 | 2640 | 3940 |

(Note: Table 114-1, -2 and -3 Table 115-1 and -2)

(Note)
1. The basic dynamic rated load 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 rated load means a static load that gives a certain level of contact stress (4kN/mm$^2$) in the center of the contact area between rolling element receiving the maximum load and orbit.
3. The permissible moment load is a maximum moment load applied to the bearing. Within the permissible 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 values of the moment rigidity is the average value.
5. The permissible radial load and permissible 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, check in accordance with the calculations shown on the next page.

## How to obtain the maximum load moment load

HPGP HPG CSG-GH CSF-GH HPF

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

Formula 116-1

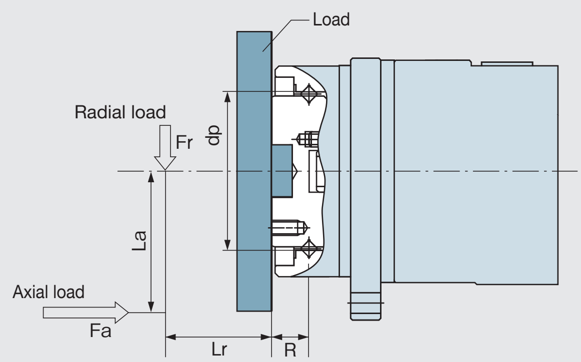
$$M_{max} = Fr_{max}(Lr+R) + Fa_{max} \cdot La$$

Symbol of Formula 116-1

| | | | |
|---|---|---|---|
| $Fr_{max}$ | Max. radial load | N (kgf) | See Fig. 116-1. |
| $Fa_{max}$ | Max. axial load | N (kgf) | See Fig. 116-1. |
| Lr, La | — | m | See Fig. 116-1. |
| R | Offset amount | m | See Fig. 116-1.<br>See "Specification of main bearing" of each series |

Fig. 116-1

External load influence diagram




## How to obtain the radial load coefficient and the axial load coefficient

HPGP HPG CSG-GH CSF-GH HPF

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

Formula 116-2

| Formula | X | Y |
|---|---|---|
| $\dfrac{Fa_{av}}{Fr_{av}+2(Fr_{av}(Lr+R)+Fa_{av} \cdot La)/dp} \leqq 1.5$ | 1 | 0.45 |
| $\dfrac{Fa_{av}}{Fr_{av}+2(Fr_{av}(Lr+R)+Fa_{av} \cdot La)/dp} > 1.5$ | 0.67 | 0.67 |

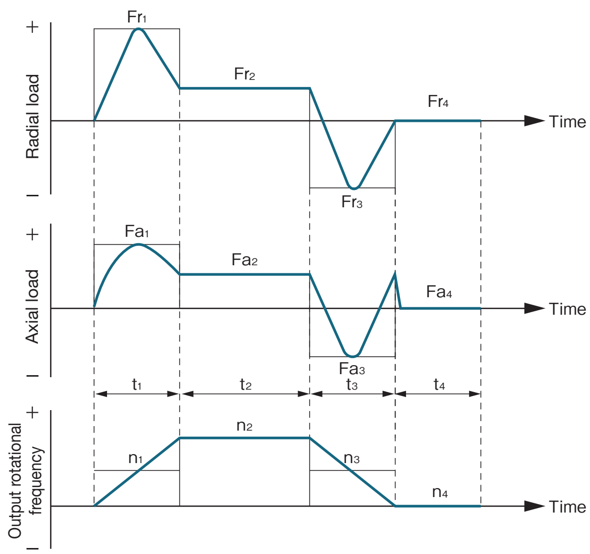
Symbol of Formula 116-2

| | | | |
|---|---|---|---|
| $Fr_{av}$ | Average radial load | N (kgf) | See "How to obtain the average load." |
| $Fa_{av}$ | Average axial load | N (kgf) | See "How to obtain the average load." |
| Lr, La | — | m | See Fig. 116-1. |
| R | Offset amount | m | See Fig. 116-1.<br>See "Output Shaft Bearing Specifications" of each series. |
| dp | Circular pitch of roller | m | See Fig. 116-1.<br>See "Output Shaft Bearing Specifications" of each series. |

## How to obtain the average load (Average radial load, average axial load, average output rotational frequency)

HPGP HPG CSG-GH CSF-GH HPF

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 ($Fr_{av}$)

Formula 116-3

$$Fr_{av} = \sqrt[10/3]{\frac{n_1t_1(|Fr_1|)^{10/3} + n_2t_2(|Fr_2|)^{10/3} \cdots n_nt_n(|Fr_n|)^{10/3}}{n_1t_1+n_2t_2+\cdots+n_nt_n}}$$

Note that the maximum radial load within the $t_1$ section is $Fr_1$ and the maximum radial load within the $t_3$ section is $Fr_3$.

How to obtain the average axial load ($Fa_{av}$)

Formula 116-4

$$Fa_{av} = \sqrt[10/3]{\frac{n_1t_1(|Fa_1|)^{10/3} + n_2t_2(|Fa_2|)^{10/3} \cdots n_nt_n(|Fa_n|)^{10/3}}{n_1t_1+n_2t_2+\cdots+n_nt_n}}$$

Note that the maximum axial load within the $t_1$ section is $Fa_1$ and the maximum axial load within the $t_3$ section is $Fa_3$.

How to obtain the average output rotational frequency ($N_{av}$)

Formula 116-5

$$N_{av} = \frac{n_1t_1+n_2t_2+\cdots+n_nt_n}{t_1+t_2+\cdots+t_n}$$

## How to obtain the life HPGP HPG CSG-GH CSF-GH HPF

Obtain the life of the cross roller bearing by Formula 117-1. You can obtain the dynamic equivalent radial load (Pc) by Formula 117-2.

Formula 117-1

$$L_{10}=\frac{10^6}{60\times N_{av}}\times\left(\frac{C}{f_w\cdot P_c}\right)^{10/3}$$

Symbol of Formula 117-1

| | | | |
|---|---|---|---|
| $L_{10}$ | Life | hour | – |
| $N_{av}$ | Ave. output speed | r/min | See “How to obtain the ave. load.” |
| C | Basic dynamic rated load | N (kgf) | See “Output Shaft Bearing Specs.” |
| Pc | Dynamic equi. radial load | N (kgf) | See Formula 117-2. |
| fw | Load coefficient | – | See Table 117-1. |

Formula 117-2

$$P_c=X\cdot\left(Fr_{av}+\frac{2(Fr_{av}(L_r+R)+Fa_{av}\cdot L_a)}{dp}\right)+Y\cdot Fa_{av}$$

Symbol of Formula 117-2

| | | | |
|---|---|---|---|
| $Fr_{av}$ | Average radial load | N (kgf) | See "How to obtain the ave. load." |
| $Fa_{av}$ | Average axial load | N (kgf) | See "How to obtain the ave. load." |
| dp | Circular pitch of roller | m | See “Output Shaft Bearing Specs.” |
| X | Radial load coefficient | – | See “How to obtain the radial load coefficient and the axial load coefficient.” |
| Y | Axial load coefficient | – | See “How to obtain the radial load coefficient and the axial load coefficient.” |
| Lr, La | – | m | See Fig. 116-1. See “External load influence diagram.” |
| R | Offset amount | m | See Fig. 116-1. See “External load influence diagram” and “Output Shaft Bearing Specs” of each series. |

### Load coefficient

Table 117-1

| Load status | fw |
|---|---|
| During smooth operation without impact or vibration | 1 to 1.2 |
| During normal operation | 1.2 to 1.5 |
| During operation with impact or vibration | 1.5 to 3 |

## How to obtain the life under oscillating movement HPGP HPG CSG-GH CSF-GH HPF

Obtain the life of the cross roller bearing under oscillating movement by Formula 117-3.

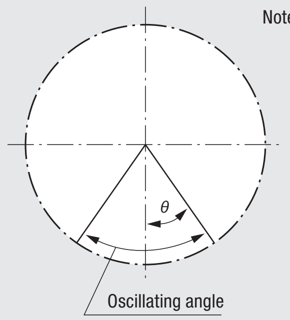
Formula 117-3

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

Symbol of Formula 117-3

| | | | |
|---|---|---|---|
| Loc | Rated life under oscillating movement | hour | – |
| n1 | No. of reciprocating oscillation per min. | cpm | – |
| C | Basic dynamic rated load | N (kgf) | See “Output Shaft Bearing Specs.” |
| Pc | Dynamic equivalent radial load | N (kgf) | See Formula 117-2. |
| fw | Load coefficient | – | See Table 117-1. |
| $\theta$ | Oscillating angle /2 | Deg. | See Fig. 117-1. |

Fig. 117-1




Note: When the oscillating angle is small (5° or less), it is difficult to generate an oil film on the contact surface of the orbit ring, and the rolling element and fretting may be generated. Contact us if this happens.

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

## How to obtain the static safety coefficient HPGP HPG CSG-GH CSF-GH HPF

In general, the basic static rated load (Co) is considered to be the permissible limit of the static equivalent load. However, obtain the limit based on the operating and required conditions. Obtain the static safety coefficient (fs) of the cross roller bearing by Formula 117-4. General values under the operating condition are shown in Table 117-2. You can obtain the static equivalent radial load (Po) by Formula 117-5.

Formula 117-4

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

Symbol of Formula 117-4

| | | | |
|---|---|---|---|
| Co | Basic static rated load | N (kgf) | See “Output Shaft Bearing Specs.” |
| Po | Static equivalent radial load | N (kgf) | See Formula 117-5. |

Formula 117-5

$$P_o=Fr_{max}+\frac{2M_{max}}{dp}+0.44Fa_{max}$$

Symbol of Formula 117-5

| | | | |
|---|---|---|---|
| $Fr_{max}$ | Max. radial load | N (kgf) | See “How to obtain the max. load moment load.” |
| $Fa_{max}$ | Max. axial load | N (kgf) | See “How to obtain the max. load moment load.” |
| $M_{max}$ | Max. load moment load | N·m (kgf·m) | See “How to obtain the max. load moment load.” |
| dp | Circular pitch of roller | m | See “Output Shaft Bearing Specs” of each series. |

### Static safety coefficient

Table 117-2

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

# Input Shaft Bearing Specifications and Checking Procedure

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

## Checking procedure HPG HPF

**(1) Checking maximum load**

Calculate:
Maximum load moment load (Mi *max*)
Maximum load axial load (Fai *max*)
Maximum load radial load (Fri *max*)

Maximum load moment load (Mi *max*) ≦ Permissible moment load (Mc)
Maximum load axial load (Fai *max*) ≦ Permissible axial load (Fac)
Maximum load radial load (Fri *max*) ≦ Permissible 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 shaft bearing

The specification of the input side main bearing of the input shaft type is shown below.

### Specification of input shaft bearing HPG

Table 118-1

| Model | Basic rated load | | | |
|---|---|---|---|---|
| | Basic dynamic rated load Cr | | Basic static rated load Cor | |
| | N | kgf | N | kgf |
| 11 | 2700 | 275 | 1270 | 129 |
| 14 | 5800 | 590 | 3150 | 320 |
| 20 | 9700 | 990 | 5600 | 570 |
| 32 | 22500 | 2300 | 14800 | 1510 |
| 50 | 35500 | 3600 | 25100 | 2560 |
| 65 | 51000 | 5200 | 39500 | 4050 |

Table 118-2

| Model | Permissible moment load Mc | | Permissible axial load Fac[*1] | | Permissible radial load Frc[*2] | |
|---|---|---|---|---|---|---|
| | N·m | kgf·m | N | kgf | N | kgf |
| 11 | 0.16 | 0.016 | 245 | 25 | 20.6 | 2.1 |
| 14 | 6.3 | 0.64 | 657 | 67 | 500 | 51 |
| 20 | 13.5 | 1.38 | 1206 | 123 | 902 | 92 |
| 32 | 44.4 | 4.53 | 3285 | 335 | 1970 | 201 |
| 50 | 96.9 | 9.88 | 5540 | 565 | 3226 | 329 |
| 65 | 210 | 21.4 | 8600 | 878 | 5267 | 537 |

### Specification of input shaft bearing HPF

Table 118-3

| Model | Basic rated load | | | |
|---|---|---|---|---|
| | Basic dynamic rated load Cr | | Basic static rated load Cor | |
| | N | kgf | N | kgf |
| 25 | 14500 | 1480 | 10100 | 1030 |
| 32 | 29700 | 3030 | 20100 | 2050 |

Table 118-4

| Model | Permissible moment load Mc | | Permissible axial load Fac[*1] | | Permissible radial load Frc[*3] | |
|---|---|---|---|---|---|---|
| | N·m | kgf·m | N | kgf | N | kgf |
| 25 | 10 | 1.02 | 1538 | 157 | 522 | 53.2 |
| 32 | 19 | 1.93 | 3263 | 333 | 966 | 98.5 |

(Note: Table 118-2 and 118-4)
(Note) 1. The permissible axial load is the tolerance of an axial load applied to the shaft center.
2. The permissible radial load of HPG series is the tolerance of a radial load applied to the shaft length center.
3. The permissible radial load of HPG series is the tolerance of a radial load applied to the point of 20 mm from the shaft edge (input flange edge face).

## ■Calculating maximum load moment load to input shaft HPG HPF

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

Formula 119-1

$$Mi_{max} = Fri_{max} \cdot Lri + Fai_{max} \cdot Lai$$

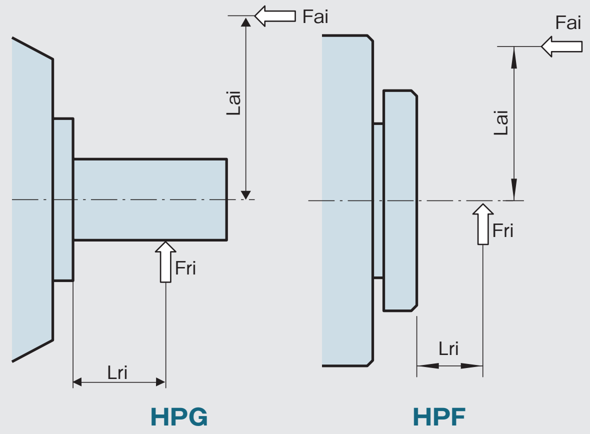
Symbol of Formula 119-1

| | | | |
|---|---|---|---|
| $Fri_{max}$ | Max. radial load | N (kgf) | See Fig. 119-1. |
| $Fai_{max}$ | Max. axial load | N (kgf) | See Fig. 119-1. |
| Lri,Lai | ———— | m | See Fig. 119-1. |

$Mi_{max} \leqq$ Mc (Permissible moment load)
$Fai_{max} \leqq$ Fac (Permissible axial load)

Fig. 119-1

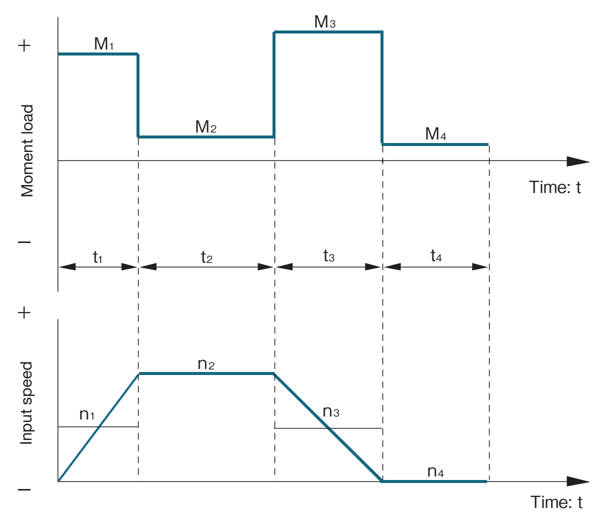
External load influence diagram




## ■How to obtain the average load (Average moment load, average axial load, average input rotational frequency) HPG HPF

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

Fig. 119-2




How to obtain the average moment load ($Mi_{av}$)

Formula 119-2

$$Mi_{av} = \sqrt[3]{\frac{n_1t_1(|Mi_1|)^3 + n_2t_2(|Mi_2|)^3 \cdots n_nt_n(|Mi_n|)^3}{n_1t_1 + n_2t_2 + \cdots + n_nt_n}}$$

How to obtain the average axial load ($Fai_{av}$)

Formula 119-3

$$Fai_{av} = \sqrt[3]{\frac{n_1t_1(|Fai_1|)^3 + n_2t_2(|Fai_2|)^3 \cdots n_nt_n(|Fai_n|)^3}{n_1t_1 + n_2t_2 + \cdots + n_nt_n}}$$

How to obtain the average output rotational frequency ($Ni_{av}$)

Formula 119-4

$$Ni_{av} = \frac{n_1t_1 + n_2t_2 + \cdots + n_nt_n}{t_1 + t_2 + \cdots + t_n}$$

## ■Calculating life of input side bearing

Calculate the bearing life according to Calculation Formula 119-5 and check the life.

Formula 119-5

$$L_{10} = \frac{10^6}{60 \times Ni_{av}} \times \left(\frac{Cr}{Pci}\right)^3$$

Symbol of Formula 119-5

| | | | |
|---|---|---|---|
| $L_{10}$ | Life | Hour | — |
| $Ni_{av}$ | Average input rotational speed | r/min | See Formula 119-4 |
| Cr | Basic dynamic rated load | N (kgf) | See Table 119-1 and -3 |
| Pci | Dynamic equivalent radial load | N | See Table 119-1 and -2 |

Dynamic equivalent radial load HPG

Table 119-1

| Model No. | Pci |
|---|---|
| 11 | 0.444 × $Mi_{av}$ + 1.426 × $Fai_{av}$ |
| 14 | 0.137 × $Mi_{av}$ + 1.232 × $Fai_{av}$ |
| 20 | 0.109 × $Mi_{av}$ + 1.232 × $Fai_{av}$ |
| 32 | 0.071 × $Mi_{av}$ + 1.232 × $Fai_{av}$ |
| 50 | 0.053 × $Mi_{av}$ + 1.232 × $Fai_{av}$ |
| 65 | 0.041 × $Mi_{av}$ + 1.232 × $Fai_{av}$ |

Dynamic equivalent radial load HPF

Table 119-2

| Model No. | Pci |
|---|---|
| 25 | 121 × $Mi_{av}$ + 2.7 × $Fai_{av}$ |
| 32 | 106 × $Mi_{av}$ + 2.7 × $Fai_{av}$ |

| | | |
|---|---|---|
| $Mi_{av}$ | Average moment load N·m (kgf·m) | See Formula 119-2 |
| $Fai_{av}$ | Average axial load N (kgf) | See Formula 119-3 |

# Handling Explanation

Assemble and mount your gear head series products correctly to ensure full demonstration of their excellent performance. Select bolts and observe tightening torques recommended by us.

## ■Motor assembly procedure HPGP HPG CSG-GH CSF-GH

For installing gear heads and motors, follow the procedure below.

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

(2) For HPGP/HPG series, coat a sealant on the surface that will mount the motor. (Recommended sealant: LOCKTITE 515)

(3) Slowly insert the motor into the speed reducer. Erect the speed reducer upright as illustrated in the figure below. Slide the speed reducer into the input shaft coupling by guiding the motor shaft into it without falling it down. If the speed reducer cannot be erected upright, tighten the bolts evenly little by little. Exercise due care and avoid tilting the motor when inserting it.

(4) Fasten the motor and speed reducer flange with bolts.

**Bolt* tightening torque**

Table 120-1

| Bolt size | | M2.5 | M3 | M4 | M5 | M6 | M8 | M10 | M12 |
|---|---|---|---|---|---|---|---|---|---|
| Tightening torque | N·m | 0.59 | 1.4 | 3.2 | 6.3 | 10.7 | 26.1 | 51.5 | 89.9 |
| | kgf·m | 0.06 | 0.14 | 0.32 | 0.64 | 1.09 | 2.66 | 5.25 | 9.17 |

*Recommended bolt name: JIS B 1176 Hexagon socket head bolt, Strength category: JIS B 1051 12.9 or higher
Caution: Always tighten bolts at the tightening torques specified above.

(5) Tighten the bolt onto the input shaft coupling. (Bolts or screws are mounted on the input shaft coupling upon delivery. Check the bolt size on the delivery specification drawing we provide.)

**Bolt tightening torque**

Table 120-2

| Bolt size | | M3 | M4 | M5 | M6 | M8 | M10 | M12 |
|---|---|---|---|---|---|---|---|---|
| Tightening torque | N·m | 2.0 | 4.5 | 9.0 | 15.3 | 37.2 | 73.5 | 128 |
| | kgf·m | 0.20 | 0.46 | 0.92 | 1.56 | 3.8 | 7.5 | 13.1 |

Caution: Always tighten the bolts at the tightening torque specified above. If the bolt is tightened at a torque below the specified torque, problems such as a slip may result. The bolt size may vary depending on the model and the shaft diameter of the mounted motor.

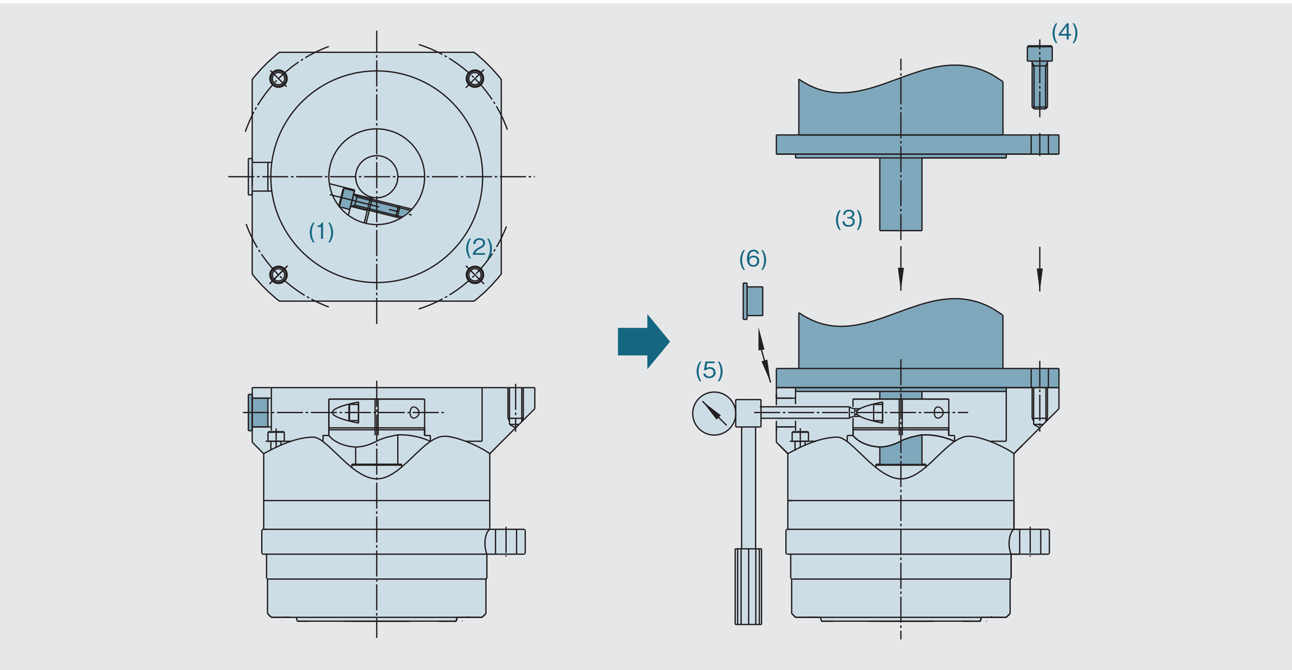
Two setscrews need to be tightened on Model No. 11. See dimensional outline drawing on page 019 (HPGP) and page 029 (HPG) for Model No. 11. Tighten the screws at the tightening torque specified below.

Table 120-3

| Fixing bolt size | | M3 |
|---|---|---|
| Tightening torque | N·m | 0.69 |
| | kgf·m | 0.07 |

(6) Insert the rubber cap provided. This completes the mounting work. (Model No. 11: Fasten screws with a gasket in two places)

Fig. 120-1



## ■Assembly of speed reducer HPGP HPG CSG-GH CSF-GH HPF

Some models of the orthogonal shaft type weigh 20 to 60 kg. No tap for eyebolt is provided because the mounting orientation varies depending on the customer's need. When mounting the reducer, hoist it by sling work, and pay sufficient attention to safety.
When assembling an HPG series product onto equipment, check the flatness of the mounting surface and any burrs on taps. Then clamp the flange (Part A in the diagram below) using the bolts.

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

Table 121-1

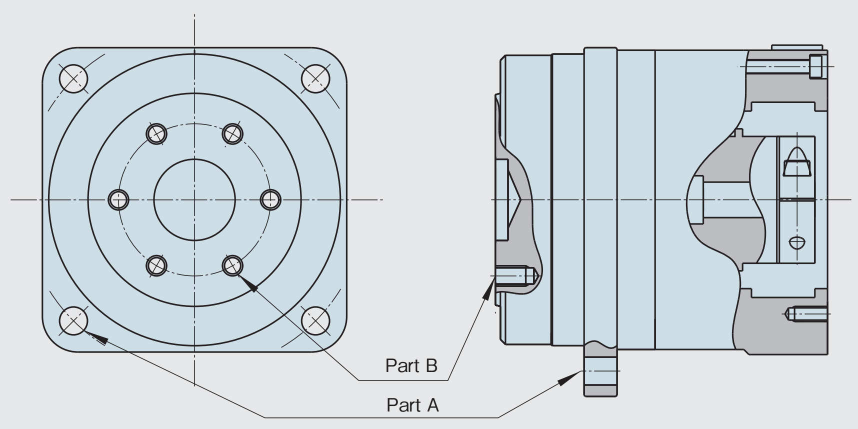
| Model | | HPGP / HPG / CSG-GH / CSF-GH | | | | | | HPF | |
|---|---|---|---|---|---|---|---|---|---|
| | | 11 | 14 | 20 | 32 | 45/50 | 65 | 25 | 32 |
| Number of bolts | | 4 | 4 | 4 | 4 | 4 | 4 | 12 | 12 |
| Bolt size | | M3 | M5 | M8 | M10 | M12 | M16 | M4 | M5 |
| Mounting PCD | mm | 46 | 70 | 105 | 135 | 190 | 260 | 127 | 157 |
| Tightening torque | N·m | 1.4 | 6.3 | 26.1 | 51.5 | 103 | 255 | 4.5 | 9.0 |
| | kgf·m | 0.14 | 0.64 | 2.66 | 5.25 | 10.5 | 26.0 | 0.46 | 0.92 |
| Transfer torque | N·m | 26.3 | 110 | 428 | 868 | 2030 | 5180 | 531 | 1060 |
| | kgf·m | 2.69 | 11.3 | 43.6 | 88.6 | 207 | 528 | 54.2 | 108 |

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

## ■Load mounting onto output part

When mounting a load onto the output part, take the specification of the output shaft bearing into consideration. (See pages 114 to 115.)

Fig. 121-1




## Product of output flange type

Bolt* tightening torque for output flange (Part B in the Fig. 121-1) HPGP

Table 121-2

| Model | | 11 | 14 | 20 | 32 | 50 | 65 |
|---|---|---|---|---|---|---|---|
| Number of bolts | | 4 | 8 | 8 | 8 | 8 | 8 |
| Bolt size | | M4 | M4 | M6 | M8 | M12 | M16 |
| Mounting PCD | mm | 18 | 30 | 45 | 60 | 90 | 120 |
| Tightening torque | N·m | 4.5 | 4.5 | 15.3 | 37.2 | 128.4 | 319 |
| | kgf·m | 0.46 | 0.46 | 1.56 | 3.8 | 13.1 | 32.5 |
| Transfer torque | N·m | 25.3 | 84 | 286 | 697 | 2407 | 5972 |
| | kgf·m | 2.58 | 8.6 | 29.2 | 71.2 | 245 | 609 |

* 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 Fig. 121-1) HPG

Table 121-3

| Model | | 11 | 14 | 20 | 32 | 50 | 65 |
|---|---|---|---|---|---|---|---|
| Number of bolts | | 3 | 6 | 6 | 6 | 14 | 6 |
| Bolt size | | M4 | M4 | M6 | M8 | M8 | M16 |
| Mounting PCD | mm | 18 | 30 | 45 | 60 | 100 | 120 |
| Tightening torque | N·m | 4.5 | 4.5 | 15.3 | 37.2 | 37.2 | 319 |
| | kgf·m | 0.46 | 0.46 | 1.56 | 3.8 | 3.80 | 32.5 |
| Transfer torque | N·m | 19.0 | 63 | 215 | 524 | 2036 | 4480 |
| | kgf·m | 1.9 | 6.5 | 21.9 | 53.4 | 207.8 | 457 |

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

## Product of output flange type

### Bolt* tightening torque for output flange (Part B in the Fig. 121-1) CSG-GH

Table 122-1

| Model | | 14 | 20 | 32 | 45 | 65 |
|---|---|---|---|---|---|---|
| Number of bolts | | 8 | 8 | 10 | 10 | 10 |
| Bolt size | | M4 | M6 | M8 | M12 | M16 |
| Mounting PCD | mm | 30 | 45 | 60 | 94 | 120 |
| Tightening torque | N·m | 4.5 | 15.3 | 37 | 128 | 319 |
| | kgf·m | 0.46 | 1.56 | 3.8 | 13.1 | 32.5 |
| Transfer torque | N·m | 84 | 287 | 867 | 3067 | 7477 |
| | kgf·m | 8.6 | 29.3 | 88.5 | 313 | 763 |

* 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 Fig. 121-1) CSF-GH

Table 122-2

| Model | | 14 | 20 | 32 | 45 | 65 |
|---|---|---|---|---|---|---|
| Number of bolts | | 6 | 6 | 6 | 16 | 8 |
| Bolt size | | M4 | M6 | M8 | M8 | M16 |
| Mounting PCD | mm | 30 | 45 | 60 | 100 | 120 |
| Tightening torque | N·m | 4.5 | 15.3 | 37.2 | 37.2 | 319 |
| | kgf·m | 0.46 | 1.56 | 3.80 | 3.80 | 32.5 |
| Transfer torque | N·m | 63 | 215 | 524 | 2326 | 5981 |
| | kgf·m | 6.5 | 21.9 | 53.4 | 237 | 610 |

* 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 Fig. 121-1) HPF

Table 122-3

| Model | | 25 | 32 |
|---|---|---|---|
| Number of bolts | | 12 | 12 |
| Bolt size | | M4 | M5 |
| Mounting PCD | mm | 77 | 100 |
| Tightening torque | N·m | 4.5 | 9.0 |
| | kgf·m | 0.46 | 0.92 |
| Transfer torque | N·m | 322 | 675 |
| | kgf·m | 32.9 | 68.9 |

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

## Product of output shaft type

Exercise caution and avoid applying an impact to the output shaft when mounting a pulley, pinion and other parts. An impact will deteriorate the speed reducer precision and may cause a failure.

## ■Mechanical precision

Using a high-precision cross roller bearing as its output shaft bearing, an output part with a high mechanical precision is realized. The mechanical precision of the output shaft and mounting flange are specified below.

Fig. 123-1

Output shaft shape: FO (flange)

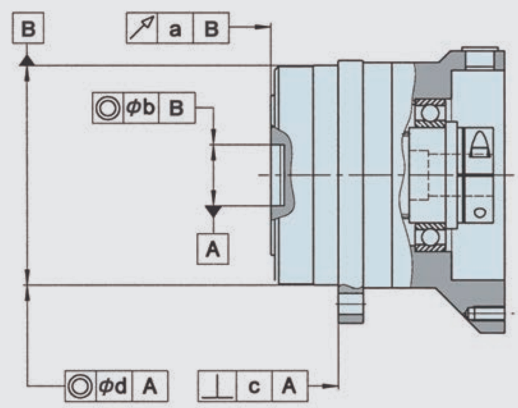
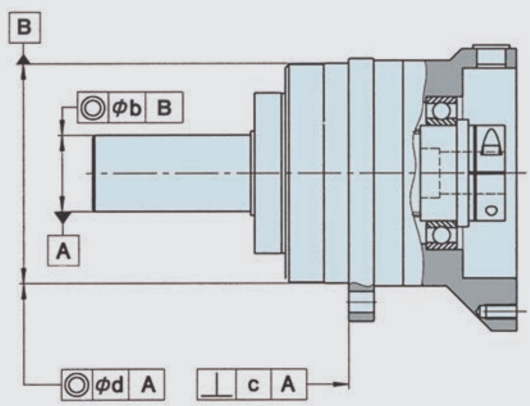



Fig. 123-2

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




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

Table 123-1

| Model | Planar runout of output flange a | Runout of spigot joint of output flange or output shaft b | Planar runout of mounting flange c | Runout of mounting spigot joint d |
|---|---|---|---|---|
| 11 | 0.020 | 0.030 | 0.050 | 0.040 |
| 14 | 0.020 | 0.040 | 0.060 | 0.050 |
| 20 | 0.020 | 0.040 | 0.060 | 0.050 |
| 32 | 0.020 | 0.040 | 0.060 | 0.050 |

**HPGP** **HPG**

Table 123-2

| | | | | |
|---|---|---|---|---|
| 50 | 0.020 | 0.040 | 0.060 | 0.050 |
| 65 | 0.040 | 0.060 | 0.090 | 0.080 |

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

Table 123-3

| | | | | |
|---|---|---|---|---|
| 45 | 0.020 | 0.040 | 0.060 | 0.050 |
| 65 | 0.020 | 0.040 | 0.060 | 0.050 |

**HPF**

Table 123-4

| | | | | |
|---|---|---|---|---|
| 25 | 0.020 | 0.040 | 0.060 | 0.050 |
| 32 | 0.020 | 0.040 | 0.060 | 0.050 |

* T.I.R.: Total indicator reading. Total reading on a dial gauge when the part to be measured is turned one turn.

(T.I.R.* Unit: mm)

## ■Lubrication

### Prevention of grease and oil leak

(Common to all models)

- Avoid using it with other grease.
- A countermeasure for leakage is considered for the structure. However, please note that it is not complete depending on the application and operating condition. To completely implement the countermeasure for leakage, prepare the pan or seal separately.
- Set the rubber cap part facing upward when installing to the speed reducer mounted horizontally.

(CSG/CSF-GH Series)

- When using the product at constant load or in one direction continuously, it may cause lubrication problems. Contact our sales office if the product will be used in this way.

### Sealing mechanism

(Common to all models)

- A countermeasure for leakage is considered for the input shaft. However, depending on the application, please take measures against oil leakage on the devise being installed side.
- A fluorine resin oil seal with a dust ripple (Model No. 11 of HPGP/HPG series is without dust ripple) in the output shaft, a sealed packing or an o-ring on each junction surface, and non-contact shielded bearing (customized specification is contact type: DDU type*) on the motor joint coupling part of gear head are used. On CSG/CSF-GH series, non-contact shielded bearing and a fluorine resin oil seal with a spring are used.
  * DDU type: Bearing with a rubber contact seal on both sides
- It is recommended to change input side shielded bearing to DDU type if the motor is mounted below the reducer and run at constant load continuously or start and stop frequently.

(HPGP/HPG/HPF Series)

- Compared with the standard products, the efficiency of the shielded bearing on the input shaft side is slightly lowered in the DDU type (special products) of the HPGP/HPG series gear head. (See pages 099 to 109.)
- When assembling the HPGP/HPG series gear head and motor, apply the sealant to the mounting surface of the motor. (See page 120.)
- An oil seal without spring is used in the input shaft side of HPG series input shaft type and HPF series hollow shaft type. It can be changed to an oil seal with spring for improved seal reliability. However, the efficiency may become slightly lower (HPG series for Models 14 or higher).
- Do not remove the screw plug and seal cap of the HPG seires orthogonal shaft type (See page 067). Removing them may cause leakage of grease or deterioration in precision.

## ■Lubricant

**HPGP/HPG/HPF Series**

The standard lubrication method for the HPGP/HPG/HPF series is greasing.
As products are greased and shipped, additional application of grease during assembly is not necessary. The grease replacement is not required within the range of the speed reducer life. By employing the planetary speed reducer mechanism and dedicated grease that excel in the theoretical efficiency, the high efficiency has been achieved.

### Name of lubricant

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

| | |
|---|---|
| Base oil: Refined mineral oil | Consistency: 265 to 295 at 25°C |
| Soap radical: Lithium soap | Dropping point: 198°C |
| Additive: Extreme pressure agent and other | Product appearance: Green |
| Standard: NLGI No. 2 | |

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

| | |
|---|---|
| Base oil: Refined mineral oil | Consistency: 282 at 25°C |
| Soap radical: Lithium soap | Dropping point: 200°C |
| Additive: Extreme pressure agent and other | Product appearance: Light brown |
| Standard: NLGI No. 2 | |

Multemp AC-P specification (HPG Helical Gear Type)
Manufacturer: Kyodo Yushi Co., Ltd.

| | |
|---|---|
| Base oil: Composite hydrocarbon oil, diester | Consistency: 280 at 25°C |
| Soap radical: Lithium soap | Dropping point: 200°C or higher |
| Additives: Extreme pressure agent, other | Product appearance: Black and viscous |
| Standard: NLGI No. 2 | |

PYRONOC UNIVERSAL 00 specifications (Orthogonal shaft type)
Manufacturer: Nippon Oil Co.

| | |
|---|---|
| Base oil: Refined mineral oil | Consistency: 420 at 25°C |
| Soap radical: Urea | Dropping point: 250°C or higher |
| Standard: NLGI No. 00 | Product appearance: Light yellow |

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

Quality of the lubricant may deteriorate if the ambient operating temperature is high or low. Please contact our sales office or distributor if this is the case.
The value of the temperature rise depending on the heat radiation conditions of the speed reducer installation parts (housing) arranged by the customers and on the ambient temperature. It is appropriate to regard the surface temperature 70ºC of the speed reducer as the reference upper limit.

## CSG-GH/CSF-GH Series

The standard lubrication method for the CSG-GH/CSF-GH series is greasing.
As products are greased and shipped, additional application of grease during assembly is not necessary.

### Name of lubricant

Harmonic Grease® SK-1A specification (Model No. 20, 32, 45, 65)
Manufacturer: Harmonic Drive Systems Inc.
This has been developed as grease exclusively for HarmonicDrive® and is excellent in durability and efficiency compared to commercial general-purpose grease.

Base oil: Refined mineral oil
Soap radical: Lithium soap
Additive: Extreme pressure agent and other
Standard: NLGI No. 2
Consistency: 265 to 295 at 25°C
Dropping point: 197°C
Product appearance: Yellow

Harmonic Grease® SK-2 specification (Model No. 14)
Manufacturer: Harmonic Drive Systems Inc.
This has been developed exclusively for the compact HarmonicDrive® and is excellent in smoothness during wave generator rotation by liquefying extreme-pressure additive.

Base oil: Refined mineral oil
Soap radical: Lithium soap
Additive: Extreme pressure agent and other
Standard: NLGI No. 2
Consistency: 265 to 295 at 25°C
Dropping point: 198°C
Product appearance: Green

### Ambient operating temperature range: 0°C to +40°C

Quality of the lubricant may deteriorate if the ambient operating temperature is high or low. Please contact our sales office or distributor if this is the case.
The value of the temperature rise depending on the heat radiation conditions of the speed reducer installation parts (housing) arranged by the customers and on the ambient temperature. It is appropriate to regard the surface temperature 70ºC of the speed reducer as the reference upper limit.

### When to replace grease

Abrasion of the sliding parts of HarmonicDrive® is influenced by grease performance. Grease performance changes by temperature and deteriorates rapidly as the temperature rises. Therefore, the grease needs to be replaced earlier than usual. The graph on the right indicates the time to replace the grease from the relation between the grease temperature and the total number of rotations when the average load torque is equal to or less than the output torque at 2000 r/min. Obtain the time to replace the grease from the following calculation formula when the average load torque exceeds the rated torque at 2000 r/min.

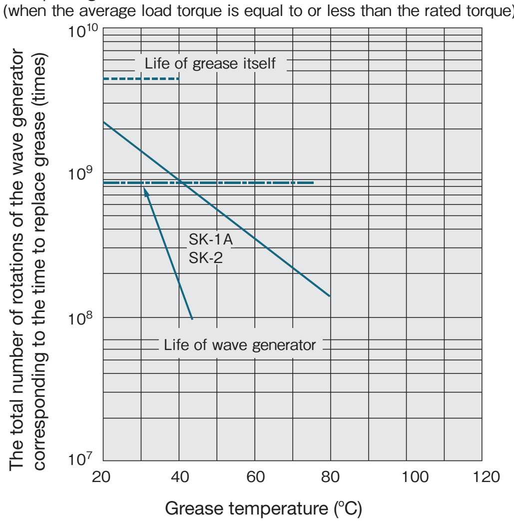
Calculation formula when the average load torque exceeds the rated torque — Formula 125-1

$$L_{GT} = L_{GTn} \times \left(\frac{Tr}{T_{av}}\right)^3$$

Symbols of formula — Table 125-1

| | | | |
|---|---|---|---|
| $L_{GT}$ | Replacement timing if it is equal to output torque or more | Number of rotation | – |
| $L_{GTn}$ | Replacement timing if it is equal to output torque or less | Number of rotation | See Graph 125-1. |
| Tr | Output torque at 2000 r/min | N·m, kgf·m | See the "Rating table" on pages 050 and 058. |
| $T_{av}$ | Average load torque on the output side | | Calculation formula: See page 048. |

When to replace grease:
$L_{GTn}$ (when the average load torque is equal to or less than the output torque at 2000 r/min) — Graph 125-1




* Life of wave generator indicates the 10% of damage probability.

### Precautions when refilling with grease

Since the adverse effect may occur due to the refill or discharge amount of grease, such as grease leakage or increase in the starting torque. Strictly observe the following items.
- Note that the refill amount value listed in Table 125-2 is a reference value for refilling with grease once. Do not exceed the value significantly.
- Discharge the same amount of grease as the refill amount before refilling with grease. The adverse effect does not occur until 2 times of grease refill. For refilling with grease 3 times or more, be sure to discharge the same amount of grease. Use an air, etc. to discharge grease.

Reference value of grease refill amount for replacement — Table 125-2

| Model | 14 | 20 | 32 | 45 | 65 |
|---|---|---|---|---|---|
| Refill amount: g | 0.8 | 3.2 | 6.6 | 11.6 | 78.6 |

## Warranty

Products that are described in this catalog are warranted as follows:

### Warranty period

Under the condition that the products are handled, used and maintained properly followed each item of the technical materials, the manuals, and this catalog, all the products are warranted against defects in workmanship and materials for the shorter period of either one year after delivery or 2,000 hours of operation time.

### Warranty terms

All the products are warranted against defects in workmanship and materials for the warranted period.
This limited warranty does not apply to any product that has been subject to:

**(1) User's misapplication, improper installation, inadequate maintenance, or misuse.**
**(2) Disassembling, modification or repair by others than Harmonic Drive Systems, Inc.**
**(3) Imperfection caused by the other than the products.**
**(4) Disaster or others that does not belong to the responsibility of Harmonic Drive Systems, Inc.**

Our liability shall be limited exclusively to repairing or replacing the product only found by Harmonic Drive Systems, Inc. to be defective.
Harmonic Drive Systems, Inc. shall not be liable for consequential damages of other equipment caused by the defective products, and shall not be liable for the incidental and consequential expenses and the labor costs for detaching and installing to the driven equipment

## Discarding

When discarding a product, sort parts into different materials and dispose of the parts as industrial waste in accordance with the laws and regulations of municipalities. The materials of the parts can be classified into three categories.

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

## Trademark

“HarmonicDrive” is registered trademark of Harmonic Drive Systems Inc. products.
The academic or general nomenclature is “strain wave gearing”.

# For Safe Use

⚠ **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.

## Limited Applications

### This product cannot be used for the following applications:

* Space equipment
* Aircraft equipment
* Nuclear power equipment
* Equipment and apparatus used in domestic homes
* Vacuum equipment
* Automotive equipment
* Game equipment
* Equipment that directly works on human bodies
* Equipment for transport of humans
* Equipment for use in a special environment

Please consult Harmonic Drive Systems beforehand when intending to use one of its product for the aforementioned applications.
Install a safety device that avoids an accident even if output of this product becomes uncontrollable due to breakdown when using it in equipment that affects human lives and that may trigger serious damage.

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

**Caution**

**Use only in a specified environment.**
- In case of using HarmonicDrive® and Hamonic Planetary® please ensure the following environmental conditions are complied with:
  - Ambient temperature 0 to 40℃
  - No splashing of water or oil
  - Do not expose to corrosive or explosive gas
  - No dust such as metal powder

**Caution**

**Install the equipment in a specified manner.**
- Carry out assembly precisely in the specified order according to the catalog.
- Observe our recommended tightening methods (such as bolts used).
- Operating the equipment without precise assembly can cause troubles such as generation of vibration, reduction of life, deterioration of precision and breakdown.

**Caution**

**Install the equipment in a specified precision.**
- Design and assemble parts to keep the recommended installation precision on the catalog.
- Failure to keep the precision can cause troubles such as generation of vibration, reduction of life, deterioration of precision and breakdown.

**Caution**

**Use the specified lubricant.**
- Using other lubricant than our recommended products can reduce the life. Replace the lubricant in a specified condition.
- Grease is sealed in a unit product. Do not mix other kinds of grease.

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

**Warning**

**Do not put a finger into the gearing to turn it.**
- If the gearing is turned by inserting a finger into it to turn it, the finger may be caught in the gear, resulting in an unexpected injury. Do not attempt this under any circumstances.

**Warning**

**Large model Nos. (45, 50 and 65) are heavy. Handle them carefully.**
- They are heavy and may cause lower-back pain or an injury by dropping, fall or clipping during their handling. Wear protective shoes and use a support when handling a product.

**Caution**

**Be careful in handling products and parts.**
- Do not give strong shock to parts and units with a hammer.
- If you use the equipment in a damaged condition, the specified performance may not be retained. It can also cause troubles such as breakdown.

**Caution**

**Do not use parts from different part sets.**
- Our products are manufactured with a set of parts specifically made for each product. If parts from different sets are used, the intended performance level cannot be maintained.

**Caution**

**Oil leakage caution**
- Although a high reliability oil seal is used on the output shaft, it cannot completely guarantee against oil leakage. Please apply grease, oil, or other protective measures depending on your application.

**Caution**

**Apply torque within the permissible range.**
- Do not apply torque exceeding the instantaneous permissible max. torque. Applying excess torque can cause troubles such as loose tightening bolts, generation of backlash and breakdown.
- Striking an arm directly attached to the output shaft can damage the arm and make the output shaft uncontrollable.

**Caution**

**Do not break down unit products.**
- Do not break down and reassemble unit products. Original performance may not be reproduced.

**Caution**

**Stop operating the system when an anomaly is detected**
- Shut down the system promptly if an abnormal sound or vibration is detected, rotation is stopped, abnormally high temperature is generated, an abnormal current value is observed or other anomalies are detected. Continuing to operate the system without stopping may adversely affect the system.
- Please contact our sales office or distributor if an anomaly is detected.

**Caution**

- Rust-proofing was applied before shipping. However, please note that rusting occurs earlier depending on the customers' storage environment.
- Although black oxide finish is applied to some of our products, it dose not guarantee the antirust effect.

## Handling Lubricant

**Warning**

**Precautions on handling lubricant**
- Lubricant got in the eye can cause an inflammation. Wear protective glasses to prevent it from getting in your eye when you handle it.
- Lubricant coming in contact with the skin can cause an inflammation. Wear protective gloves to prevent it from contacting your skin when you handle it.
- Do not eat it (to avoid diarrhea and vomiting).
- When you open the container, you might have your hand cut by it. Wear protective gloves.
- Keep lubricant off children.

**Warning**

**First-aid**
- If lubricant gets in your eye, you should wash your eye with clean water for 15 minutes and submit to medical treatment.
- If lubricant comes in contact with your skin, you should thoroughly wash it with water and soap.
- If you swallowed it, you should immediately submit to medical treatment without throwing it up by constraint.

**Caution**

**Treatment of waste oil and containers**
- Treatment methods are obliged by law. Treat wastes appropriately according to the law. If you are unsure how to treat them, you should consult with the dealer before treating them.
- Do not apply pressure on an empty container. The container may blow up.
- Do not weld, heat, drill or cut the container. The remainder may ignite with an explosion.

**Caution**

**Storage**
- Tightly plug the container after use to prevent intrusion of dusts and water. Avoid direct sunlight to store lubricant in a dark place.

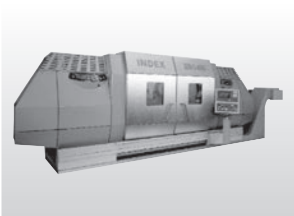
## Discarding

**Caution**

**Please discard as industrial waste.**
- Please discard as industrial waste when discarding.

# Major Applications of Our Products


Metal Working Machines

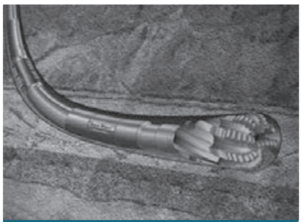

Processing Machines


Measurement, Analytical and Test Systems

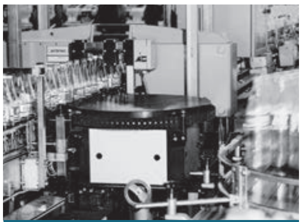

Medical Equipment


Telescopes

Source: National observatory of Inter-University Research Institute Corporation


Energy

Courtesy of Halliburton/Sperry Drilling Services


Crating and Packaging Machines


Communication Equipment


Space Equipment

Rover image created by Dan Maas, copyrighted to Cornell and provided courtesy NASA/ JPL-Caltech.

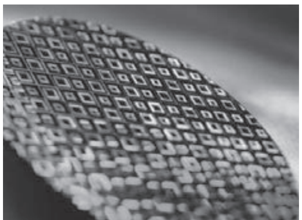

Glass and Ceramic Manufacturing Systems


Robots


Humanoid Robots

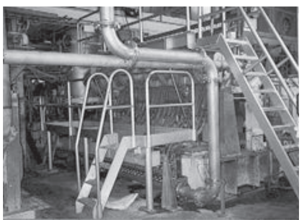
Source: Honda Motor Co., Ltd.


Printing, Bookbinding and Paper Machines

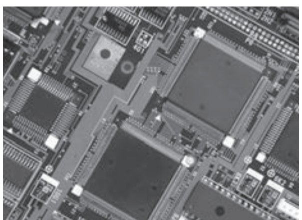

Semiconductor Manufacturing Systems


Optical Machines


Wood, Light Metal and Plastic Machine Tools


Paper-making Machines


Flat Panel Display Manufacturing Systems


Printed Circuit Board Manufacturing Machines


Aircraft Technology

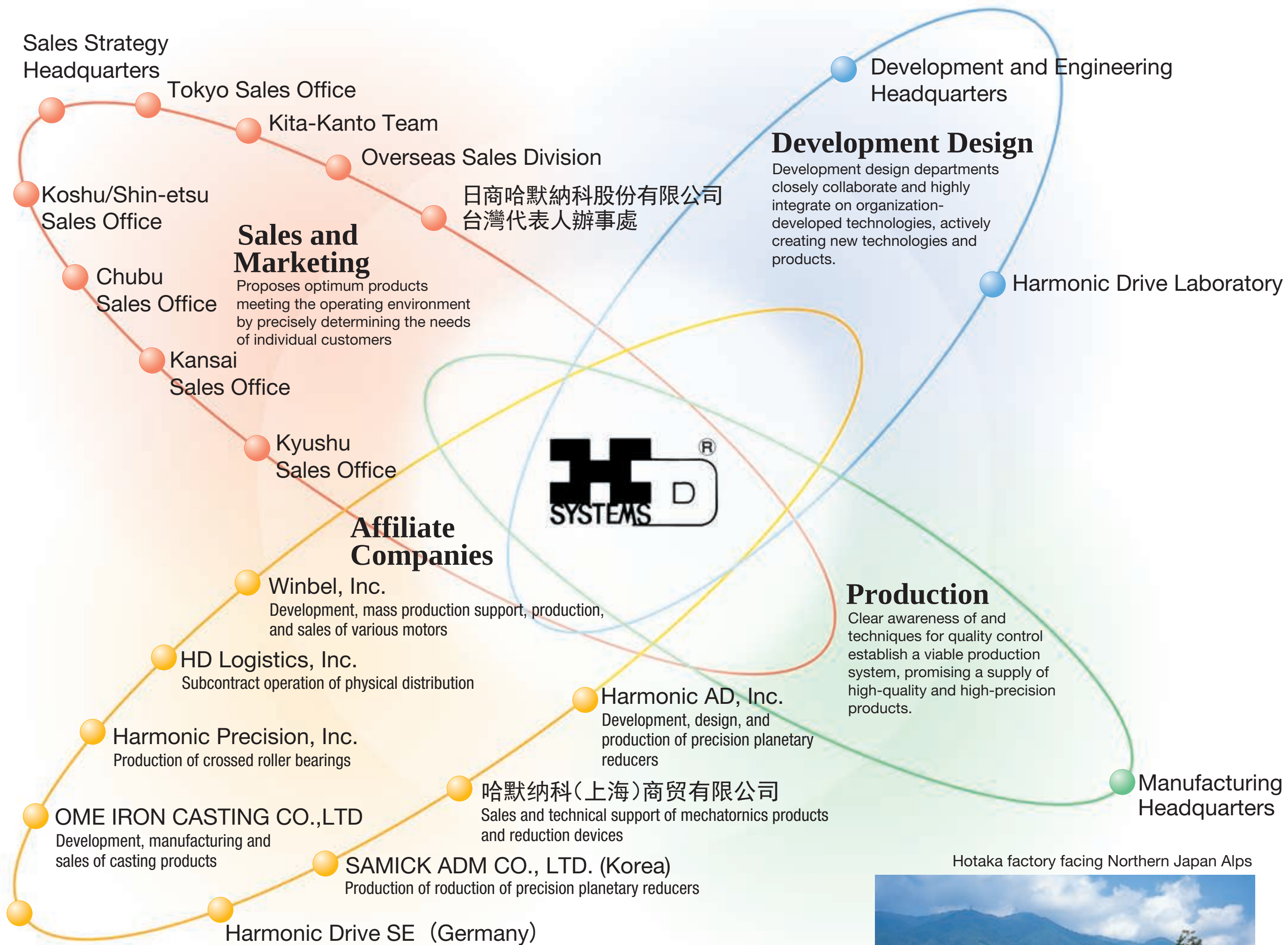
MEMO

MEMO

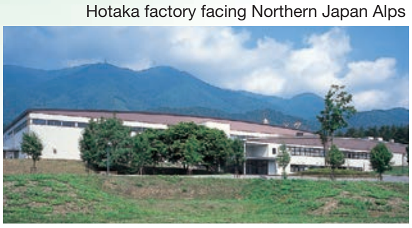
# As a Specialist in Precision Control Field

**Through close cooperation in areas of development, design, production and marketing, Harmonic Drive Systems creates unique products tailored to customer needs.**

In 1995 and 1998, Harmonic Drive Systems respectively obtained approvals for ISO 9001 (International Quality Management Standard) and for ISO 14001 (International Environmental Management Systems) from TÜV Product Service, a German accreditation organization. The approvals signify global recognition of the quality assurance and environment management systems of Harmonic Drive Systems.



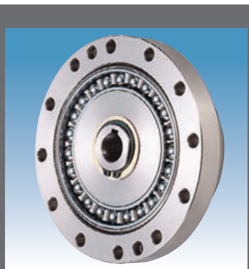

Hotaka factory facing Northern Japan Alps



## OTHER PRODUCTS

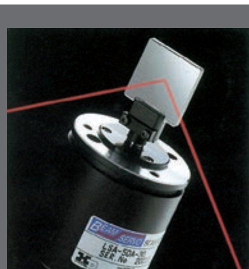
### HarmonicDrive®

As “strain wave gearing”, the HarmonicDrive® speed reducer features more precision motion control through a unique mechanism.



### Beam Servo®

Galvano scanners are developed based on the small motors and optical sensor technology, which are researched by HarmonicDrive®. Smooth operation is realized by high response and precision of optical scanning.

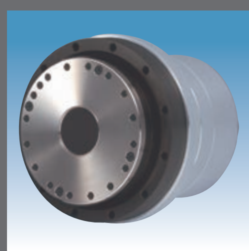


### Harmonic Linear®

The linear actuators compactly combining a precision screw and HarmonicDrive®. Versatile series are available for ultra precision positioning and high driving force.

### Rotary motion

High-torque actuators that are optimally combined with each servo motor with HarmonicDrive® and excellent control characteristics.



Harmonic Drive Systems Inc.

Information desk for urgent repair and inquiry [Information desk for urgent repair request and technical consultation]

• **TEL: CS department 0263 (83) 6812**

• Business hours: Monday ~ Friday 9:00~12:00 13:00~ 17:00 (Except Saturdays, Sundays, national holidays and our specified days off)

HarmonicDrive® HarmonicPlanetary® HarmonicGrease® HarmonicGearhead® HarmonicLinear® BEAM SERVO® Harmonicsyn®

Registered Trademark in Japan

Certifications for ISO 14001 and ISO 9001 and obtained from TÜV Product Service GmbH

https://www.hds.co.jp/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