

HarmonicGearhead®

High Performance Gear Head Series for Servo Motors HarmonicPlanetary® HPG series **Helical Gear Type**

Reduction ratio has been added to HarmonicPlanetary® HPG series lineup.

**Realizing noise reduction and higher torque capacity
by the helical gear adoption**

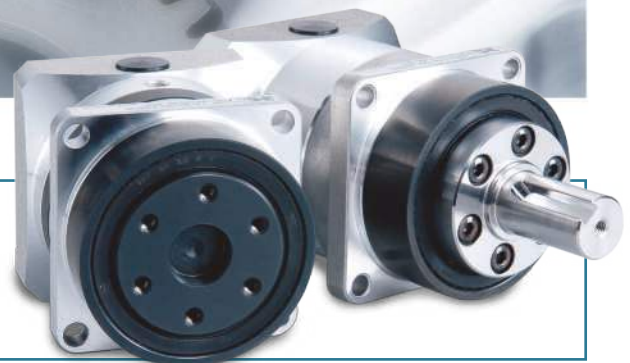
Completed full lineup for the low-speed reduction zone for the 3, 4, 5, 6, 7, 8, 9, 10 reduction ratios
New development of thin-walled elastic inner gear as a helical gear

All low-speed ratios from 3 through 10 of low reduction ratio have been added to HarmonicPlanetary® HPG series as a helical gear specification. The helical gear has also been adopted in the thin-walled elastic gears in order to secure high reliability by the extremely low backlash fluctuation by the time. Thanks to the helical gear characteristics, noise reduction and higher torque capacity (approximately 30% increased compared with conventional products) have been realized. We can offer the best-suited reduction ratio for your wide variety of machinery and equipment designs.



■ Features

- Enabling the optimal machine design due to the increase of variations of reduction ratio
- Noise reduction and higher torque capacity realized by the helical gear (approximately 30% increased compared with conventional products)
- Inheritance of the HPG series characteristics that are proud of high reliability has been adopted in the helical gear.



■ Model and Symbol

HPG - 20 R - 05 - J2 XXXX - Specification

Model name	Size	Design revision	Reduction ratio	Output shaft shape	Input-side form symbol	Special specifications
HPG Standard type HarmonicPlanetary*	11	R	4,5,6,7,8,9,10	F0: Flange output F20: Straight shaft (without key) F60: Straight shaft (with key and center tap attached)	4 to 6 digits alphabetical characters: Motor flange and Input shaft joint form symbol [Symbol differs depending on the mounting motor. For more information on the matching model with the servo motors of the other companies, refer to the model selection tool on the website (URL:http://hds-tech.jp/).]	Blank: Standard product SP: Special specifications BL1: Backlash of 1 arc-min or less, special specifications (Sizes from 14 to 32) D: Input-side shield bearing is changed to sealed type [DDU].
	14		3,4,5,6,7,8,9,10	F0: Flange output J2: Straight shaft (without key) J6: Straight shaft (with key and center tap attached)		
	20					
	32					

■ Rated Table

Table 2-1

Size	Reduction ratio	Rated output torque *1		Average load torque *2		Limit for repeated peak torque *3		Limit for momentary peak torque *4		Limit for average input speed *5	Maximum input speed *6	Moment of inertia *7 (Input-side converted value)		Mass *8	
		Nm	kgfm	Nm	kgfm	Nm	kgfm	Nm	kgfm	r/min	r/min	Shaft output	Flange output	Shaft output	Flange output
												x10 ⁻⁴ kgm ²	x10 ⁻⁴ kgm ²		
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	0.9					0.0035	0.0027		
	8	3.1	0.3	7.0	0.71	7	0.7					0.0026	0.0020		
	9	3.1	0.3	6.0	0.61	6	0.6					0.0021	0.0016		
14	10	3.4	0.3	5.0	0.51	5	0.5					0.0017	0.0013		
	3	4.0	0.4	9.0	0.92	20	2.0	56	5.7	3000	6000	0.089	0.072	0.55	0.45
	4	7.0	0.7	16	1.6	30	3.1					0.047	0.037		
	5	7.2	0.7	16	1.6	30	3.1					0.030	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			
20	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					0.010	0.0087		
	3	11	1.1	25	2.6	90	9.2	217	22	3000	6000	0.64	0.53	1.7	1.3
	4	23	2.3	51	5.2	133	14					0.36	0.30		
	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					0.070			
32	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		
	3	50	5.1	110	11	290	30	650	66	3000	6000	3.5	2.8	4.5	3.1
	4	77	7.9	170	17	400	41					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			
32	9	86	8.8	190	19	220	22					0.34	0.26		
	10	92	9.4	200	20	200	20					0.28	0.22		

*1: Rated output is set with the value of Life: L10 = 20000 hours when the number of input rotations is 3000 r/min, which is the rated rotational speed of the typical servo motors.

*2: The average load torque is the limit for average torque that is calculated from the load torque pattern, and 2000 hours life is a rough indication when the gear is operated at the 2000 r/min number of input rotations.

*3: This is the allowable peak torque applied when starting up or stopping during the operation cycle.

*4: This is the allowable maximum value of impact torque applied in an emergency stop or applied externally. Exceeding this torque could damage the speed reducer.

*5: This is the allowable maximum value of the average input speed during the operation. Be careful not to exceed this value especially when the operation is almost continuous.

*6: The max. input speed under the condition of non-continuous operation.

*7: The value for a single unit of speed reducer

*8: This indicates the mass of a single speed reducer. For more information on the values including input joint or motor flange, please contact us.

Performance Table

Table 3-1

Size	Reduction ratio	Transmission error *1		Repeatability *2	Starting torque *3		Back driving torque *4		No load running torque *5	
		arc min	x10 ⁻⁴ rad	arc sec	cNm	kgfcm	Nm	kgfm	cNm	kgfcm
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	0.40
	8				3.0	0.31	0.24	0.024	3.4	0.35
	9				2.8	0.29	0.25	0.026	3.0	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	0.51	0.052	13	1.3
	6				9.5	1.0	0.57	0.058	11	1.1
	7				9.0	0.92	0.63	0.064	9.4	1.0
	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	0.80	0.78	0.080	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	0.10	38	3.9
	5				22	2.2	1.1	0.11	30	3.1
	6				20	2.0	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
4		52	5.3	2.1	0.21				101	10
5		49	5.0	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	0.40				45	4.6
10		42	4.3	4.2	0.43				41	4.2

*1 The transmission accuracy is referred to as the difference between (1) Logical output rotation angle and (2) Actual output rotation angle when any rotation angle is given to the input. Note that the values in the table show the maximum values.

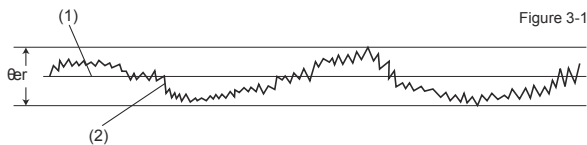


Figure 3-1

θ_{er} : Transmission accuracy

θ_1 : Input rotational speed

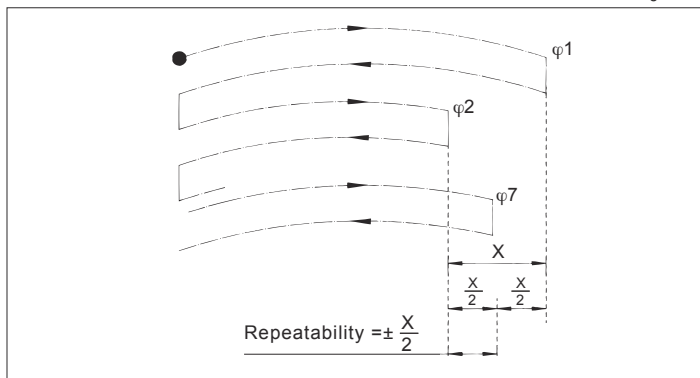
θ_2 : Actual output rotational angle

R : Gear reduction ratio of the HPG series

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

*2 The repeatability is calculated by repeating the positioning at any position from the same direction seven times, measuring the stop position of the output shaft, and calculating the maximum difference. Measured values are expressed by angles and displayed by the 1/2 (one-second) maximum difference with +/- sign attached. Note that the values in the table show the maximum values.

Figure 3-2



*3 Starting torque is referred to as a "Start-up torque" at the moment of starting rotation at the output side when torque is applied to the input side. Note that the values in the table show the maximum values.

Table 3-2

Load	No load
HPG speed reducer surface temperature	25 °C

*4 Back driving torque is referred to as a "Start-up torque" at the moment of starting rotation at the input side when torque is applied to the output side. Note that the values in the table show the maximum values.

Table 3-3

Load	No load
HPG speed reducer surface temperature	25 °C

*5 No load running torque is referred to as a torque at the input side that is required for rotating a speed reducer under the no load status. Note that the values in the table show the average values.

Table 3-4

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

Torque – Torsional Characteristics

Gear-head type standard product

Table 4-1

Size	Reduction ratio	Backlash		Single-side torsional quantity when $T_R \times 0.15$		Torsional stiffness	
				D		A/B	
		arc min	$\times 10^{-4}$ rad	arc min	$\times 10^{-4}$ rad	kgfm/arc min	$\times 100$ Nm/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 of BL1 specification (Backlash of 1 arc-min or less)

Table 4-2

Size	Reduction ratio	Backlash		Single-side torsional quantity when $T_R \times 0.15$		Torsional stiffness	
				D		A/B	
		arc min	$\times 10^{-4}$ rad	arc min	$\times 10^{-4}$ rad	kgfm/arc min	$\times 100$ Nm/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 stiffness (Wind-up curve)

The torsion corresponding to a torque occurs on the output side when the input and casing of the speed reducer are fixed, and then torque is applied to the output side. A loop is drawn, whose orbit is formed in the order from (1) to (2) to (3) to (4) to (5) (returns to (1)) as shown in Fig. 4-1, "Torque - torsional angle diagram" when the torque value is changed step by step in the order from (1) Forward rotation rated output torque, to (2) Zero, to (3) Reverse rotation rated output torque, to (4) Zero, to (5) Forward rotation rated output torque.

The figure shows that the gradient degree is small in the area between "0.15 x Rated output torque" and "Rated output torque," and the torsion stiffness value of the HPG series is an average value of this gradient.

It also shows that the gradient degree is large in the area between "Zero torque" and "0.15 x Rated output torque," which occurs due to the minute partial contact in the meshing part or load distribution imbalance in the planetary gear when the load is light.

The method of calculating the total torsional quantity (wind-up)

The following formula shows how to calculate the total torsional quantity (average value) at a single side when a load is applied to the speed reducer from the no load status.

Formula 4-1

Calculation formula

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

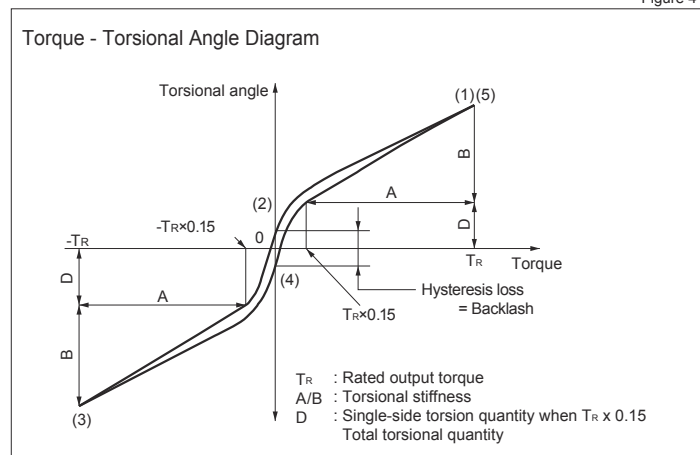
Symbols in calculation formula

θ	Total torsional quantity	—
D	Single-side torsional quantity when Rated output torque x 0.15 torque	Figure 4-1, Table 4-1 See Table 4-2.
T	Load torque	—
T_L	Rated output torque x 0.15 torque (= $T_R \times 0.15$)	See Figure 4-1.
A/B	Torsional stiffness	See Figure 4-1 and Tables 4-1 and 4-2.

Backlash (Hysteresis loss)

Widths (2) and (4) at the zero-torque portions shown in Fig. 4-1, "Torque - torsional angle diagram" are referred to as hysteresis loss. The hysteresis loss at the time from "Forward rotation rated output torque" to "Reverse rotation rated output torque" is defined as a backlash of the HPG series. The HPG series backlash is 3 arc-min or less at the initial shipping (1 arc-min or less for special product).

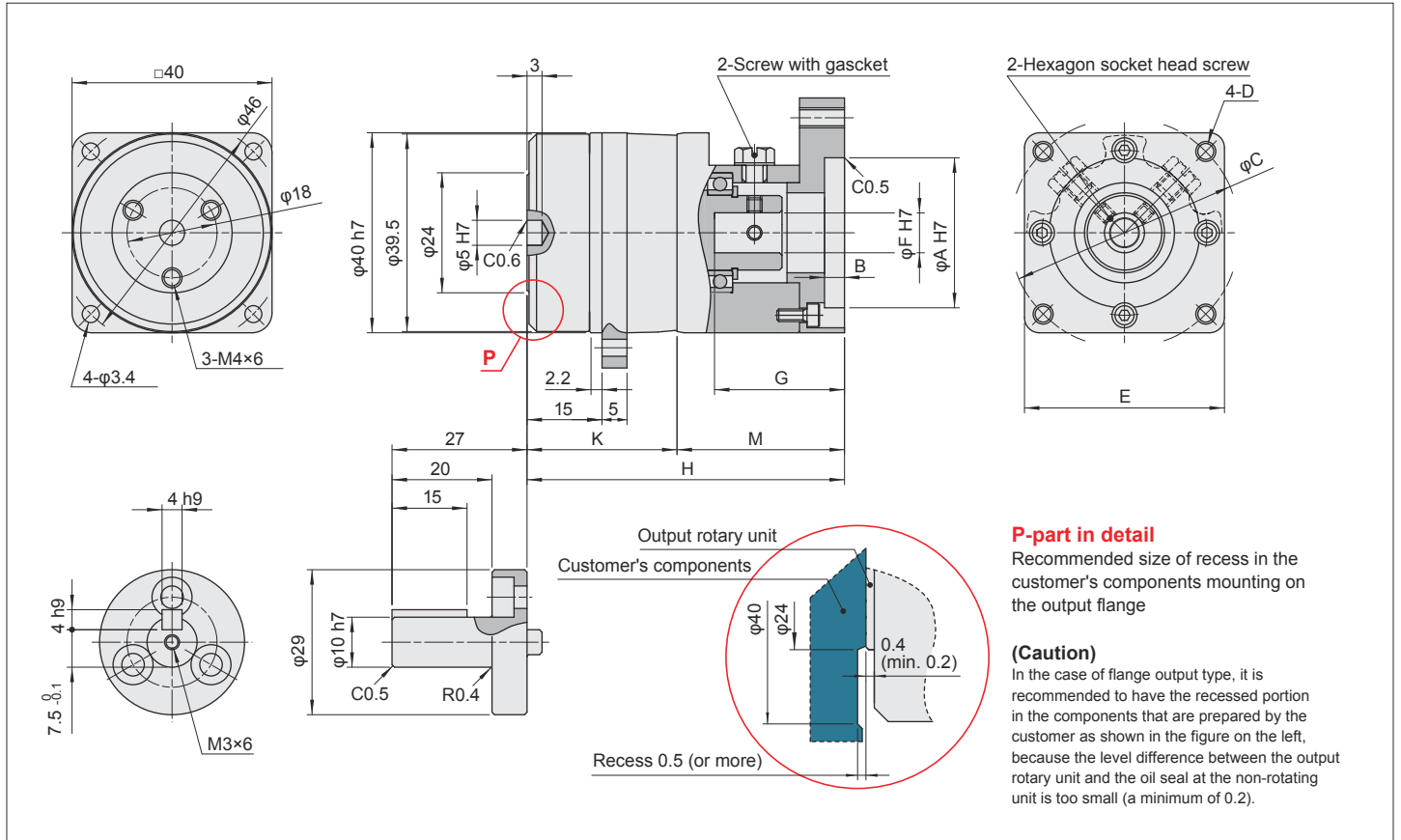
Figure 4-1



External Dimensions — Size 11

This dimension drawing describes the major dimensions. For more information on the details of dimensions and shapes, refer to the illustrated specifications issued by our company. This product CAD data can be downloaded from our website: URL: <http://www.hds.co.jp/>

Figure 5-1
Unit: mm



* Tolerance differs depending on the part manufacturing method (casting product, machining product). For more information on the tolerance of a dimension without a tolerance description, please contact us.

Dimension table

Table 5-1
Unit: mm

Form symbol ^{*1}	A (H7)	B	C	D	E	F (H7)		G	H	M	Mass (kg) ^{*2}			
						Min	Max				Reduction rate: 4,5,6,7,8,9,10			
											Shaft output	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-hole	□25						0.32	0.27		
RAC□	22		43.8	φ3.4 through-hole							0.33	0.28		
RAD□	30	4	46	M4×9	□40	5	8	25.5	54.5	33.5	0.40	0.35		
RAE□			45	M3×9									0.35	0.30
RAN□			48	M3×9										
RAF□	34		70	M4×9										
RAG□	50		70	M5×9	□60									
RAH□			60	M4×9										

The drawing measurement above shows the values of typical products. For more information other than on the products described above, please contact us. For more information on the details of dimensions and shapes, refer to the illustrated specifications issued by our company. For more information on the installation on a single unit of the speed reducer or on a special product, please contact us.

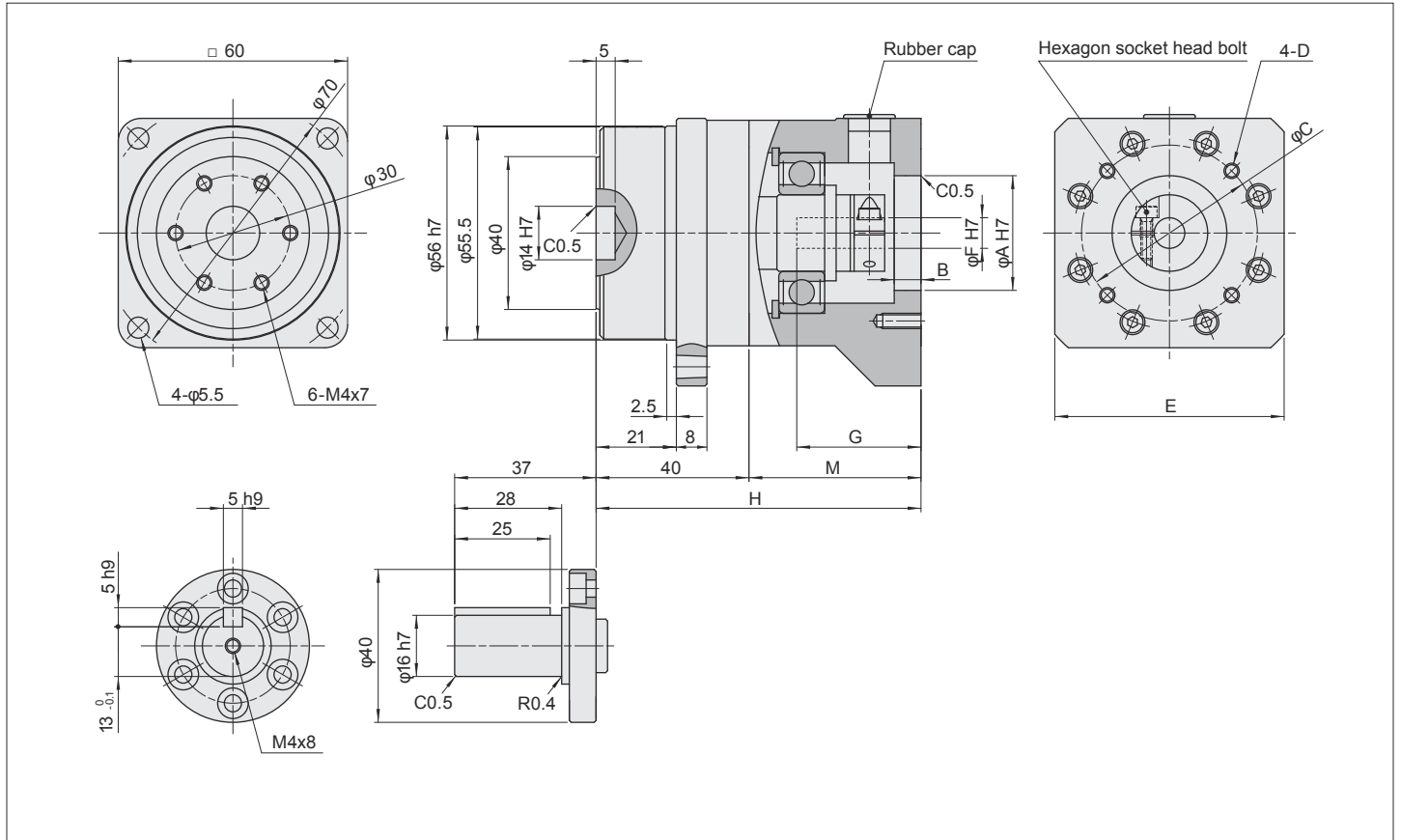
^{*1} The square shape (□) is replaced with the symbol of the input joint. For details, refer to the model selection tool on the website (URL:<http://hds-tech.jp/>).

^{*2} Mass may slightly differ depending on the gear reduction ratio and the dimension of the inner diameter.

External Dimensions — Size 14

This dimension drawing describes the major dimensions. For more information on the details of dimensions and shapes, refer to the illustrated specifications issued by our company. This product CAD data can be downloaded from our website: URL: <http://www.hds.co.jp/>

Figure 6-1
Unit: mm



* Tolerance differs depending on the part manufacturing method (casting product, machining product). For more information on the tolerance of a dimension without a tolerance description, please contact us.

Dimension table

Table 6-1
Unit: mm

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

The drawing measurement above shows the values of typical products. For more information other than on the products described above, please contact us.

For more information on the details of dimensions and shapes, refer to the illustrated specifications issued by our company.

For more information on the installation on a single unit of the speed reducer or on a special product, please contact us.

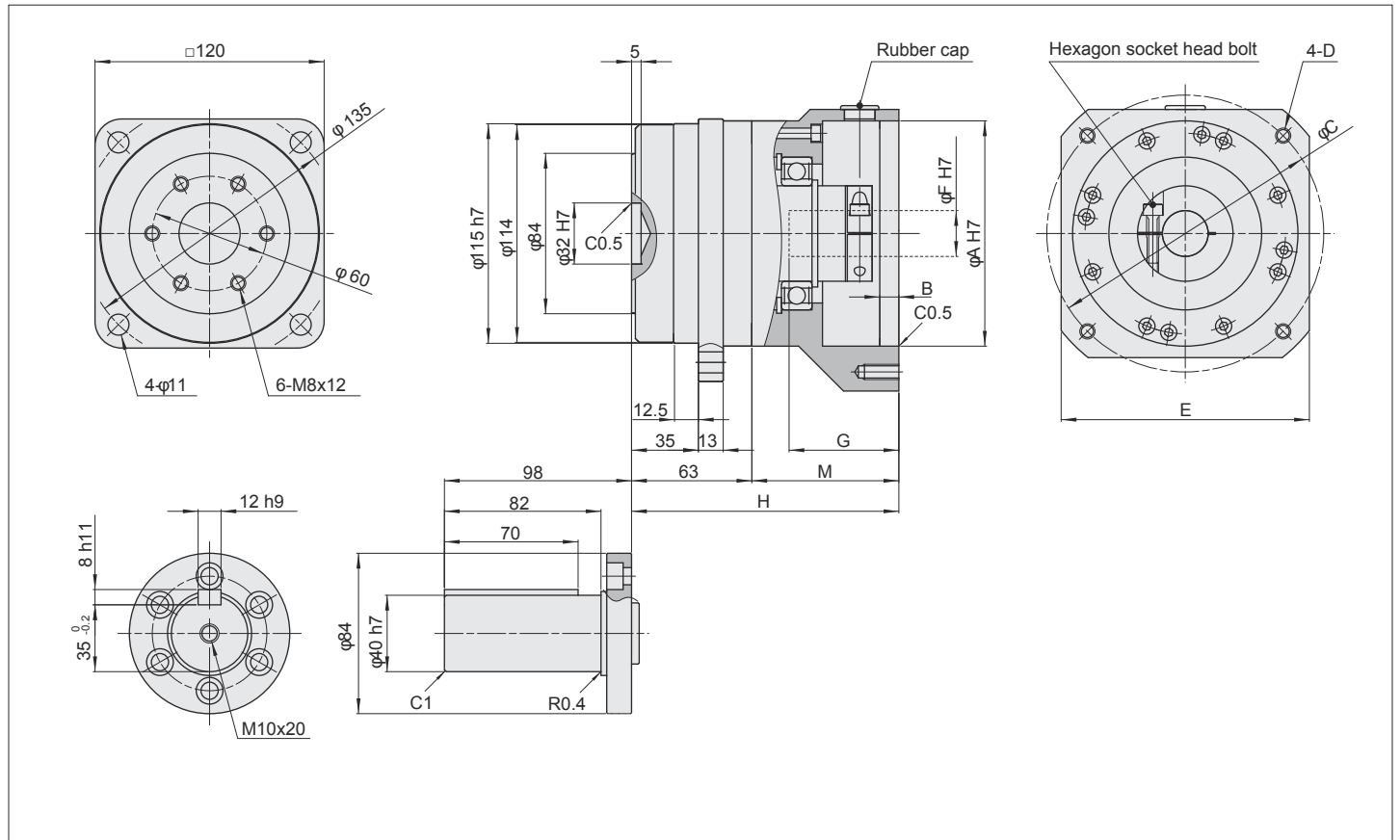
*1 The square shape (□) is replaced with the symbol of the input joint. For details, refer to the model selection tool on the website (URL:<http://hds-tech.jp/>).

*2 Mass may slightly differ depending on the gear reduction ratio and the dimension of the inner diameter.

External Dimensions — Size 32

This dimension drawing describes the major dimensions. For more information on the details of dimensions and shapes, refer to the illustrated specifications issued by our company. This product CAD data can be downloaded from our website: URL: <http://www.hds.co.jp/>

Figure 8-1
Unit: mm



* Tolerance differs depending on the part manufacturing method (casting product, machining product). For more information on the tolerance of a dimension without a tolerance description, please contact us.

Dimension table

Table 8-1
Unit: mm

Form symbol *1	A (H7)	B	C	D	E	F (H7)		G	H	M	Mass (kg) *3	
						Min	Max				Reduction rate: 3, 4, 5, 6, 7, 8, 9, 10	
											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□				M8×25								
PPB□□	114.3	6.5	200	M12×25	□180			81	164	101	9.1	7.7
PQP□□												
PPC□□	200		235		□220						9.2	7.8

The drawing measurement above shows the values of typical products. For more information other than on the products described above, please contact us.

For more information on the details of dimensions and shapes, refer to the illustrated specifications issued by our company.

For more information on the installation on a single unit of speed reducer or on the special product, please contact us.

*1 The square shape (□) is replaced with the symbol of the input joint. For details, refer to the model selection tool on the website (URL:<http://hds-tech.jp/>).

*2 There are two types of tolerance: H7 tolerance and over tolerance only for the φ35 size.

*3 Mass may slightly differ depending on the gear reduction ratio and the dimension of the inner diameter.

■ Notices on Handling Products

■ Size selection

In order to sufficiently demonstrate the excellent performance of the HarmonicPlanetary® HPG series, confirm the using conditions and select a size according to the flow chart.
For details, refer to the gear head series catalog, "Size selection" issued by our company.

■ Specification and procedure for the output shaft bearing

A precise cross roller bearing is built in for the purpose of directly supporting external load (on the output flange part).
In order to fully demonstrate the performance, check the maximum load moment load, cross roller bearing life, and static safety coefficient.
For details, refer to the gear head series catalog, "Specification and procedure for the output shaft bearing" issued by our company.

■ Handling instruction

In order to fully exert the excellent performance of gear head series, perform the installation and mounting works properly.
Follow the recommendation by our company when using mounting bolt and bolt tightening torque.
For details, refer to the gear head series catalog, "Handling instruction" issued by our company.
(Note) The Multemp AC-P (grease) is used as a lubrication for this specification.

■ Name of lubrication

Multemp AC-P
Manufacturer: KYODO YUSHI CO., LTD.

Table 9-1

Base oil	Composite hydrocarbon oil and diester	Consistency	280
Puffing agent	Lithium soap	Drop point	200 °C
Additives	Extreme-pressure additive and others	Appearance	Black viscose
Standard	NLGI 2		

■ Efficiency Characteristics

The speed reducer efficiency generally differs depending on the gear reduction ratio, input speed, load torque, temperature, and lubrication condition.
The next page shows the efficiency of the respective series under the measuring conditions described below: Note that the average value is shown on this graph.

■ Measuring condition

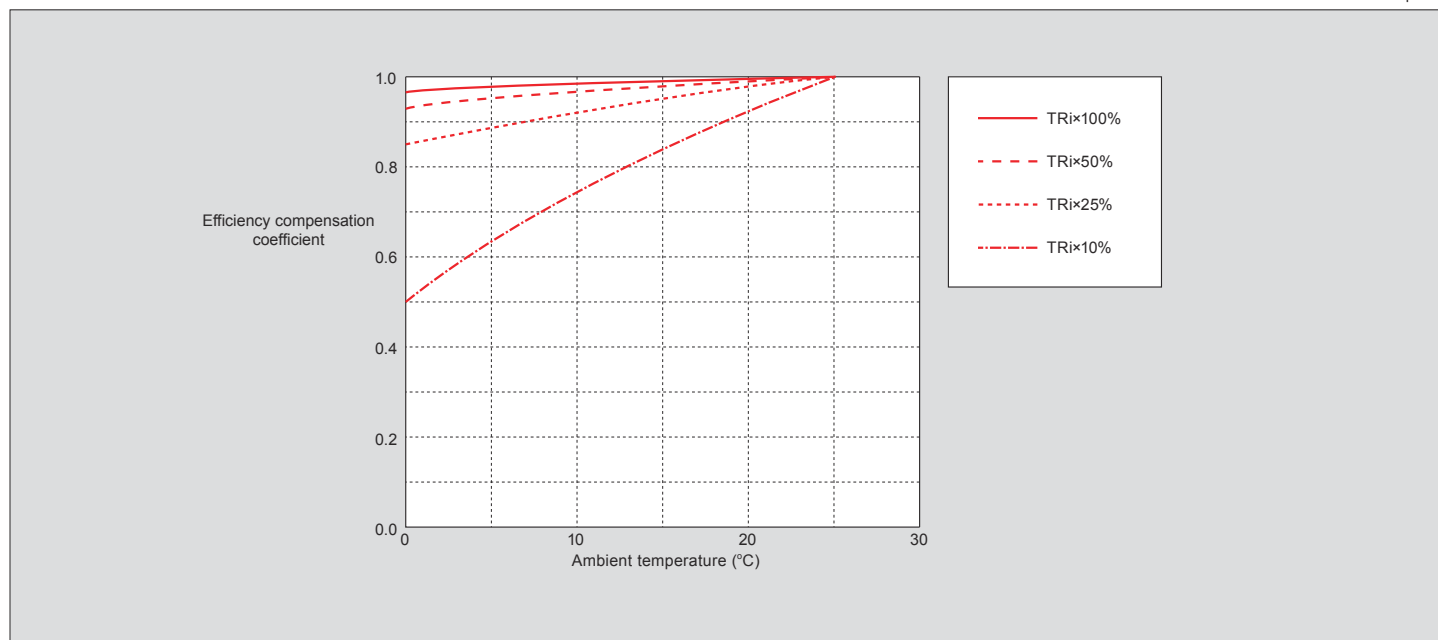
Table 9-2

Input speed	3000 r/min
Ambient temperature	25 °C
Lubricant	Multemp AC-P

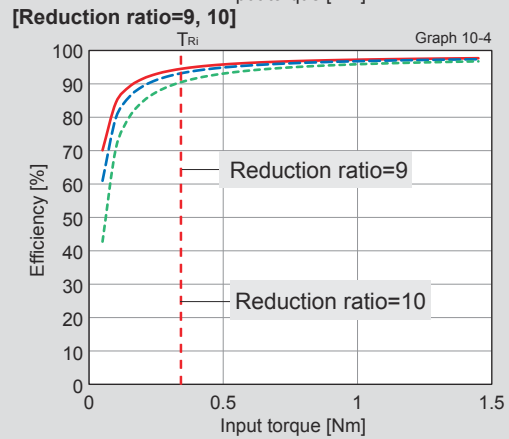
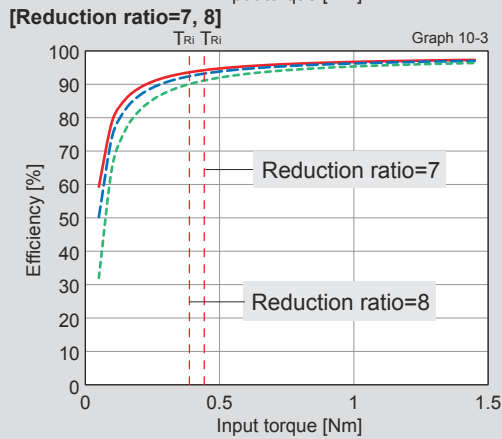
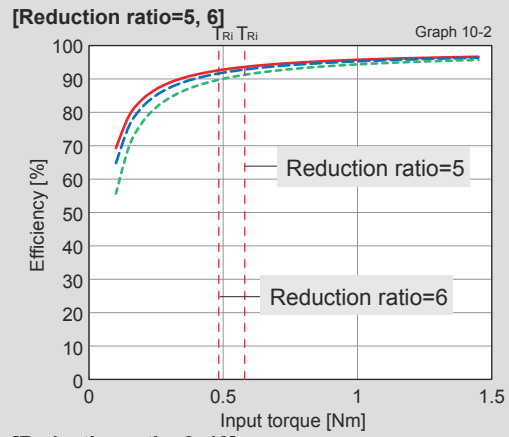
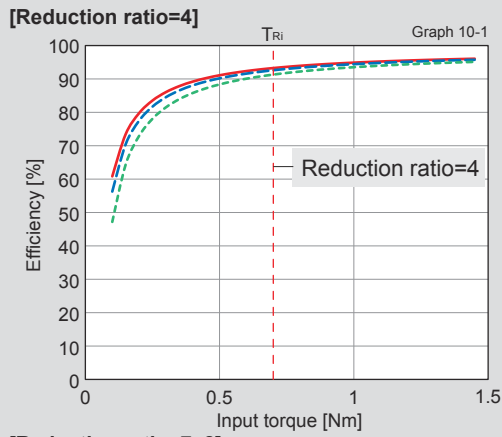
■ Efficiency compensation value at low temperature

For the efficient value when the ambient temperature is 25 °C or lower, calculate the value by multiplying the value at 25 °C by efficiency compensation value at low temperature. For the efficiency compensation value at low temperature, find the value corresponding to the ambient temperature and rated input torque (TR*) from the following graph.

Graph 9-1



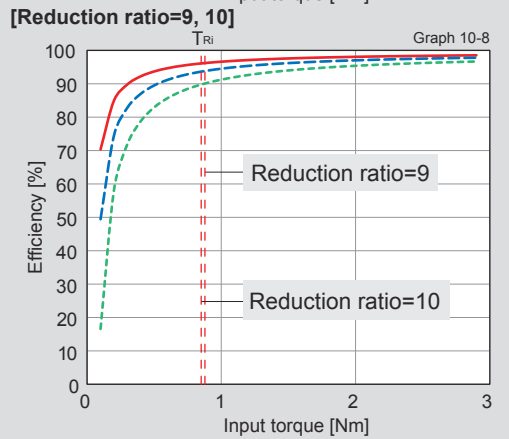
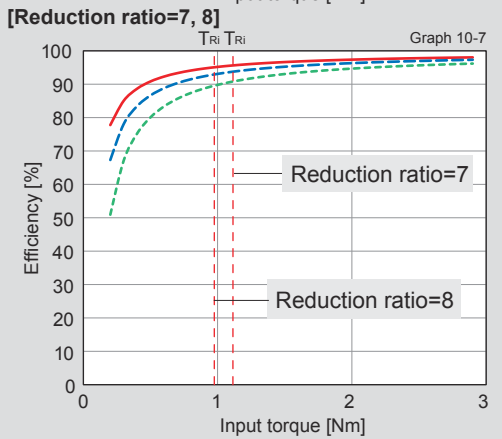
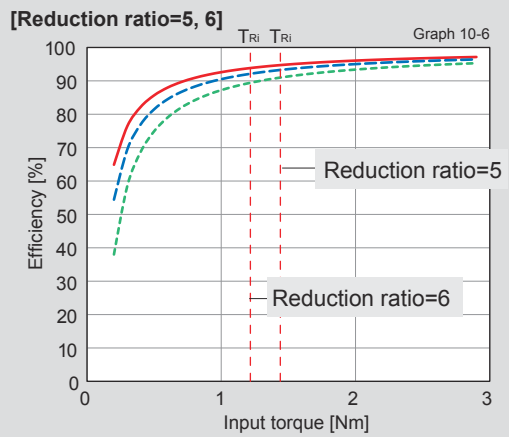
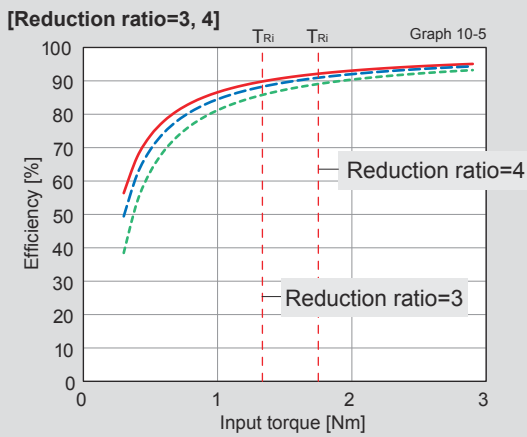
Size 11



T_{RI} TRI Input torque equivalent to the rated output torque

— Speed reducer single unit - - - Geary head type (Standard) - - - When the DDU bearing (bearing with double-sided contact seal) is installed to the input side of the gear head type (special product)

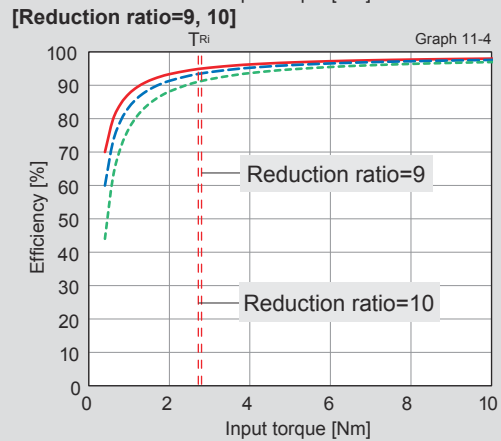
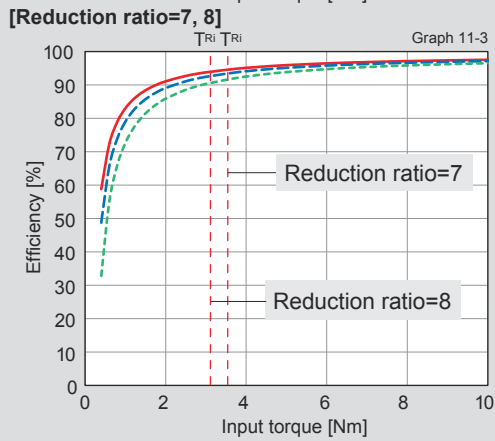
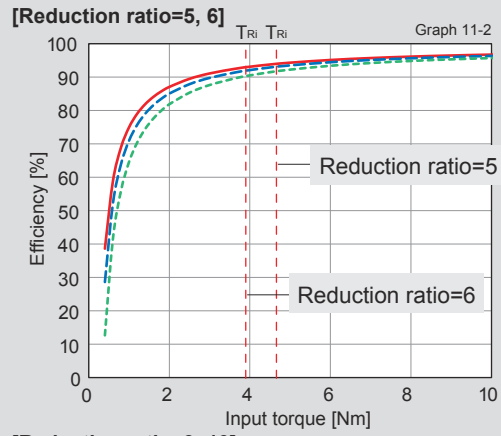
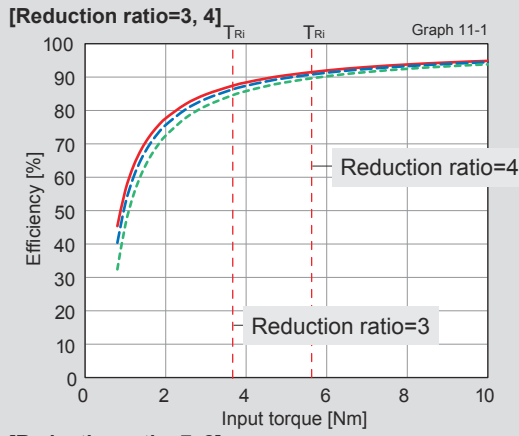
Size 14



T_{RI} TRI Input torque equivalent to the rated output torque

— Speed reducer single unit - - - Geary head type (Standard) - - - When the DDU bearing (bearing with double-sided contact seal) is installed to the input side of the gear head type (special product)

Size 20



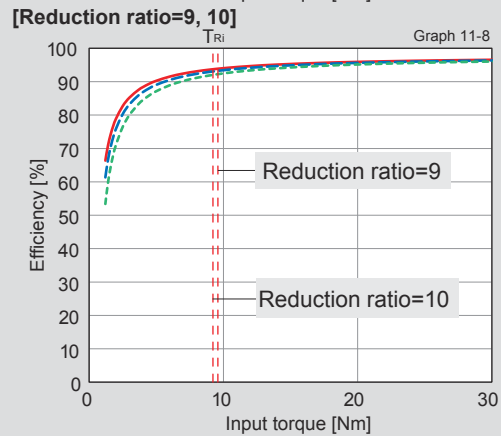
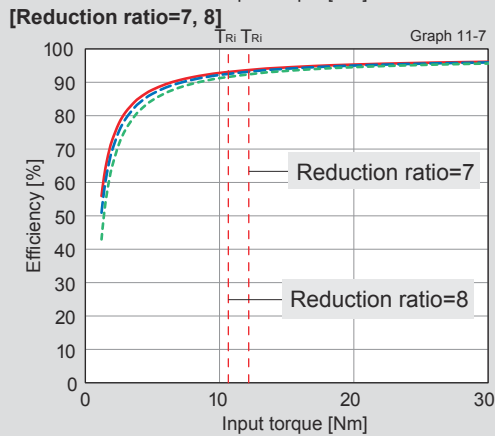
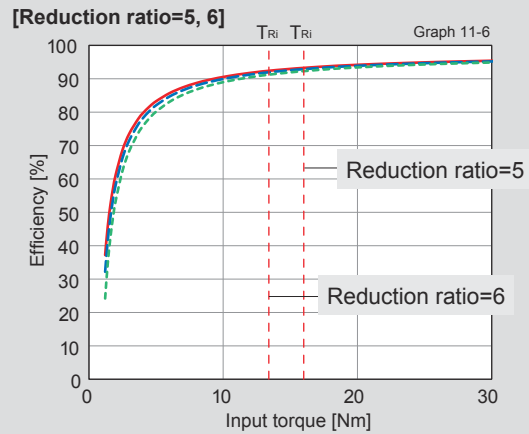
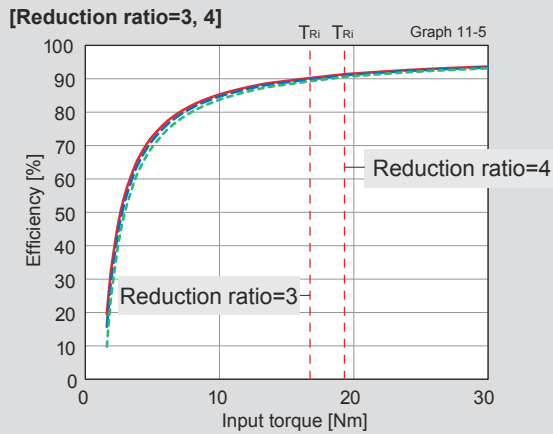
T_{RI} TRI Input torque equivalent to the rated output torque

— Speed reducer single unit

- - - Geary head type (Standard)

- - - When the DDU bearing (bearing with double-sided contact seal) is installed to the input side of the gear head type (special product)

Size 32



T_{RI} TRI Input torque equivalent to the rated output torque

— Speed reducer single unit

- - - Geary head type (Standard)

- - - When the DDU bearing (bearing with double-sided contact seal) is installed to the input side of the gear head type (special product)

■ Motor Capacity / Model Matching Table

The matching table is a guide for the combinations with the standard motors.

For information on the combination with specific motor, please contact our sales representatives.

Table 12-1

Motor capacity	Motor rating rotation speed	Reduction ratio							
		3	4	5	6	7	8	9	10
W	r/min								
50	3000		11	11	11	11	11	11	11
100	3000		11	11	11	11	14	14	14
150	3000		11	11	11	14	14	14	14
200	3000	14	14	14	14	14	14	20	20
400	3000	14	14	14	14	20	20	20	20
600	3000	20	20	20	20	20	20	20	20
750	3000	20	20	20	20	20	20	20	32
1000	3000	20	20	20	20	20	20	32	32
1500	3000	32	32	32	32	32	32	32	32
2000	3000	32	32	32	32	32	32	32	32
2500	3000	32	32	32	32	32	32	32	
3000	3000	32	32	32	32	32	32		
4000	3000	32	32	32	32	32			
5000	3000	32	32	32					

The numeric values in the table above shows the sizes of speed reducers. The mounting angle sizes for the respective sizes of speed reducer are shown below:

11 : □40 mm	14 : □60mm	20 : □90 mm	32 : □120 mm
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* Please contact our sales representative or distributor office for more information.

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